Preface

The Abstract Window Tookit (AWT) provides the user interface for Java programs. Unless you want to construct your own GUI or use a crude text-only interface, the AWT provides the tools you will use to communicate with the user. Although we are beginning to see some other APIs for building user interfaces, like Netscape's IFC (Internet Foundation Classes), those alternative APIs will not be in widespread use for some time, and some will be platform specific. Likewise, we are beginning to see automated tools for building GUIs in Java; Sun's JavaBeans effort promises to make such tools much more widespread. (In fact, the biggest changes in Java 1.1 prepare the way for using the various AWT components as JavaBeans.) However, even with automated tools and JavaBeans in the future, an in-depth knowledge of AWT is essential for the practicing Java programmer.

The major problem facing Java developers these days is that AWT is a moving target. Java 1.0.2 is being replaced by Java 1.1, with many significant new features. Java 1.1 was released on February 18, 1997, but it isn't clear how long it will take for 1.1 to be accepted in the market. The problem facing developers is not just learning about the new features and changes in Java 1.1, but also knowing when they can afford to use these new features in their code. In practice, this boils down to one question: when will Netscape Navigator support Java 1.1? Rumor has it that the answer is "as soon as possible"—and we all hope this rumor is correct. But given the realities of maintaining a very complex piece of software, and the fact that Netscape is currently in the beta process for Navigator 4.0, there's a possibility that "as soon as possible" and "soon" aren't the same thing. In other words, you should expect Java 1.0.2 to stick around for a while, especially since Web users won't all replace their browsers as soon as Navigator has 1.1 support.

This state of affairs raises obvious problems for my book. Nothing would have made me happier than to write a book that covered AWT 1.1 only. It would be significantly shorter, for one thing, and I wouldn't have to spend so much effort pointing out which features are present in which release. But that's not the current reality. For the time being, programmers still need to know about 1.0.2. Therefore, this book covers both releases thoroughly. There are many examples using 1.0.2; many more examples that require 1.1; and more examples showing you how to update 1.0.2 code to use 1.1's features.

Sun has done a good job of maintaining compatibility between versions: 1.0 code runs under Java 1.1, with very few exceptions. All of the 1.0 examples in this book have been tested under Java 1.1. However, Java 1.1—and particularly, AWT 1.1—offer many advantages over older releases. If nothing else, I hope this book convinces you that you should be looking forward to the day when you can forget about writing code for Java 1.0.2.

New Features of AWT in Java 1.1

Having spent all this time talking about 1.0.2 and 1.1 and the transitional state we're currently in and having alluded briefly to the advantages of Java 1.1, you deserve a brief summary of what has changed. Of course, you'll find the details in the book.

Improved event handling

Java 1.1 provides a completely new event model. Instead of propagating events to all objects that might possibly have an interest, objects in Java 1.1 register their interest in particular kinds of events and get only the events they're interested in hearing. The old event model is still supported, but the new model is much more efficient.

The new event model is also important in the context of JavaBeans. The old events were pretty much specific to AWT. The new model has been designed as a general purpose feature for communication between software components. Unfortunately, how to use events in this more general sense is beyond the scope of this book, but you should be aware that it's possible.

New components and containers

Java 1.1 provides one new component, the `PopupMenu`, and one new container, the `ScrollPane`. Pop-up menus are a staple of modern user interfaces; providing them fixes a serious omission. `ScrollPane` makes it trivial to implement scrolling; in Java 1.0, you had to do scrolling "by hand." In Java 1.1, you also get menu shortcuts (i.e., the ability to select menu items using the keyboard), another standard feature of modern user interfaces.

Java 1.1 also introduces a `LightweightPeer`, which means that it is possible to create "lightweight components." To do so, you subclass `Component` or `Container` directly; this wasn't possible in earlier releases. For simple operations, lightweight components are much more efficient than full-fledged components.

Clipboards

Java 1.1 lets you read from and write to the system clipboard and create private clipboards for use by your programs. The clipboard facility is a down payment on a larger data transfer facility, which will support drag and drop. (No promises about when drag and drop will appear.)

Printing

Java 1.1 gives components the ability to print.

The rest

There are many other new features, including more flexible use of cursors; the ability to use system color schemes, and thus make your program look like other software in the run-time environment; more image filters to play with; and the ability to prescale an image.

Deprecated Methods and JavaBeans

One of the biggest changes in Java 1.1 doesn't concern the feature set at all. This was the addition of many new methods that differ from a method of Java 1.0 in name only. There are hundreds of these, particularly in AWT. The new method names show an important future direction for the AWT package (in fact, all of Java). The new names obey the naming conventions used by JavaBeans, which means that all AWT classes are potentially Beans. These conventions make it possible for an application builder to analyze what a component does based on its public methods. For example, the method `setFont()` changes the value of the component's `Font` property. In turn, this means that you will eventually be able to build user interfaces and, in some cases, entire applications, inside some other tool, without writing any Java code at all. An application builder will be able to find out what it needs to know about any component by looking at the component itself, and letting you customize the component and its interactions with others.

Comments in the JDK source code indicate that the older method names have been "deprecated," which means that you should consider the old names obsolete and avoid using them; they could disappear in a future release.

Reworking AWT to comply with JavaBeans is both necessary and inevitable. Furthermore, it's a good idea to get into the habit of following the same conventions for your own code; the advantages of JavaBeans are much greater than the inconvenience of changing your coding style.

Other Changes in Java

Other new features are scattered throughout the rest of the Java classes, most notably, improvements in the networking and I/O packages and support for internationalization. Some new features were added to the language itself, of which the most important is "inner classes." For the most part, I don't discuss these changes; in fact, I stay away from them and base non-AWT code on the 1.0.2. release. Though these changes are important, covering the new material in AWT is enough for one book. If I used a new feature at this point, I would feel that I owed you an explanation, and this book is already long enough. A future edition will update the code so that it doesn't rely on any older features.

What This Book Covers

The *Java AWT Reference* is the definitive resource for programmers working with AWT. It covers all aspects of the AWT package, in versions 1.0.2 and 1.1. If there are any changes to AWT after 1.1 (at least two patch releases are expected), we will integrate them as soon as possible. Watch the book's Web site http://www.ora.com/catalog/javawt/ for details on changes.

Specifically, this book completely covers the following packages:

`java.awt` (1.0 and 1.1)
`java.awt.image` (1.0 and 1.1)
`java.awt.event` (new to 1.1)
`java.awt.datatransfer` (new to 1.1)
`java.awt.peer` (1.0 and 1.1)
`java.applet` (1.0 and 1.1)

The book also covers some aspects of the `sun.awt` package (some interesting and useful layout managers) and the `sun.audio` package (some more flexible ways of working with audio files). It also gives a brief overview of the behind-the-scenes machinery for rendering images, much of which is in the `sun.awt.image` package.

Organization

The *Java AWT Reference* is divided into two large parts. The first part is a thorough guide to using AWT. Although this guide is organized by class, it was designed to flow logically, rather than alphabetically. I know that few people read a book like this from beginning to end, but if you want to, it's possible. With a few exceptions, you should be able to read the early chapters without knowing the material that's covered in the later chapters. You'll want to read this section to find out how any chunk of the AWT package works in detail.

The second part is a set of documentation pages typical of what you find in most reference sets. It is organized alphabetically by package, and within each package, alphabetically by class. It is designed to answer questions like "What are the arguments to the `FilteredImageSource` constructor?" The reference section provides brief summaries, rather than detailed discussions and examples. When you use a typical reference book, you're usually trying to look up some detail, rather than learn how something works from scratch.

In other words, this book provides two views of AWT: terse summaries designed to help you when you need to look something up quickly, and much more detailed explanations designed to help you understand how to use AWT to the fullest. In doing so, it goes well beyond the standard reference manual. A reference manual alone gives you a great view of hundreds of individual trees; this book gives you the trees, but also gives you the forest that allows you to put the individual pieces in context. There are dozens of complete examples, together with background information, overview material, and other information that doesn't fit into the standard reference manual format.

About the Source Code

The source code for the programs presented in this book is available online. See http://www.ora.com/catalog/javawt/ for downloading instructions.

Obtaining the Example Programs

The example programs in this book are available electronically in a number of ways: by FTP, Ftpmail, BITFTP, and UUCP. The cheapest, fastest, and easiest ways are listed first. If you read from the top down, the first one that works for you is probably the best. Use FTP if you are directly on the Internet. Use Ftpmail if you are not on the Internet but can send and receive electronic mail to Internet sites (this includes CompuServe users). Use BITFTP if you send electronic mail via BITNET. Use UUCP if none of the above works.

FTP

To use FTP, you need a machine with direct access to the Internet. A sample session is shown, with what you should type in **boldface**.

```
% ftp ftp.ora.com
Connected to ftp.ora.com.
220 FTP server (Version 6.21 Tue Mar 10 22:09:55 EST 1992) ready.
Name (ftp.ora.com:yourname): anonymous
331 Guest login ok, send domain style e-mail address as password.
Password: yourname@yourhost.com (use your user name and host here)
230 Guest login ok, access restrictions apply.
ftp> cd /published/oreilly/java/awt
```

```
250 CWD command successful.
ftp> binary (Very important! You must specify binary transfer for compressed files.)
200 Type set to I.
ftp> get examples.tar.gz
200 PORT command successful.
150 Opening BINARY mode data connection for examples.tar.gz.
226 Transfer complete.
ftp> quit
221 Goodbye.
%
```

The file is a compressed *tar* archive; extract the files from the archive by typing:

```
% zcat examples.tar.gz | tar xvf -
```

System V systems require the following *tar* command instead:

```
% zcat examples.tar.gz | tar xof -
```

If *zcat* is not available on your system, use separate *gunzip* and *tar* commands.

```
% gunzip examples.tar.gz
% tar xvf examples.tar
```

Ftpmail

Ftpmail is a mail server available to anyone who can send electronic mail to, and receive it from, Internet sites. This includes any company or service provider that allows email connections to the Internet. Here's how you do it.

You send mail to *ftpmail@online.ora.com*. (Be sure to address the message to *ftpmail* and not to *ftp*.) In the message body, give the FTP commands you want to run. The server will run anonymous FTP for you and mail the files back to you. To get a complete help file, send a message with no subject and the single word "help" in the body. The following is a sample mail session that should get you the examples. This command sends you a listing of the files in the selected directory and the requested example files. The listing is useful if there's a later version of the examples you're interested in.

```
% mail ftpmail@online.ora.com
Subject:
reply-to yourname@yourhost.com     Where you want files mailed
open
cd /published/oreilly/java/awt
dir
mode binary
uuencode
get examples.tar.gz
quit
.
```

A signature at the end of the message is acceptable as long as it appears after "quit."

BITFTP

BITFTP is a mail server for BITNET users. You send it electronic mail messages requesting files, and it sends you back the files by electronic mail. BITFTP currently serves only users who send it mail from nodes that are directly on BITNET, EARN, or NetNorth. BITFTP is a public service of Princeton University. Here's how it works.

To use BITFTP, send mail containing your FTP commands to *BITFTP@PUCC*. For a complete help file, send HELP as the message body.

The following is the message body you send to BITFTP:

```
FTP ftp.uu.net NETDATA
USER anonymous
PASS yourname@yourhost.edu  Put your Internet email address here (not your BITNET address)
CD /published/oreilly/java/awt
DIR
BINARY
GET examples.tar.gz
QUIT
```

Once you've got the desired file, follow the directions under FTP to extract the files from the archive. Since you are probably not on a UNIX system, you may need to get versions of *uudecode*, *uncompress*, *atob*, and *tar* for your system. VMS, DOS, and Mac versions are available. The VMS versions are on *gatekeeper.dec.com* in */pub/VMS*.

UUCP

UUCP is standard on virtually all UNIX systems and is available for IBM-compatible PCs and Apple Macintoshes. The examples are available by UUCP via modem from UUNET; UUNET's connect-time charges apply.

If you or your company has an account with UUNET, you have a system somewhere with a direct UUCP connection to UUNET. Find that system, and type:

```
uucp uunet\!~/published/oreilly/java/awt/examples.tar.gz yourhost\!~/yourname/
```

The backslashes can be omitted if you use the Bourne shell (*sh*) instead of *csh*. The file should appear some time later (up to a day or more) in the directory */usr/spool/uucppublic/yourname*. If you don't have an account, but would like one so that you can get electronic mail, contact UUNET at 703-204-8000.

Once you've got the desired file, follow the directions under FTP to extract the files from the archive.

Other Java Books and Resources

This book is part of a series of Java books from O'Reilly & Associates that covers everything you wanted to know, and then some. The *Java AWT Reference* is paired with the *Java Fundamental Class Reference* to document the entire Core Java API. Other books in the series provide an introduction (*Exploring Java*) and document the virtual machine (*Java Virtual Machine*), the language (*Java Language Reference*), multithreaded programming (*Java Threads*), and network programming (*Java Network Programming*), with more to come. *Java in a Nutshell* is another popular Java book in the Nutshell series from O'Reilly. For a complete up-to-date list of the available Java resources, refer to http://www.ora.com/info/java/.

In addition to the resources from O'Reilly, Sun's online documentation on Java is maintained at http://www.javasoft.com/nav/download/index.html. Information on specific Java-capable browsers can be found at their respective Web sites, which are listed in Table 1. More are sure to be on the way. (Some browsers are platform specific, while others are multi-platform.)

Table 1: Popular Web Browsers that Support Java

Browser	**Location**
Netscape Navigator	http://home.netscape.com/comprod/products/navigator/
Microsoft's Internet Explorer	http://www.microsoft.com/ie
Sun's HotJava	http://www.javasoft.com/HotJava/
Oracle's PowerBrowser	http://www.oracle.com/products/websystem/powerbrowser
Apple's Cyberdog	http://cyberdog.apple.com/

Newsgroups also serve as a discussion area for Java-related topics. The *comp.lang.java* group has formally split into several others. The new groups are:

comp.lang.java.advocacy *comp.lang.java.machine*
comp.lang.java.announce *comp.lang.java.programmer*
comp.lang.java.beans *comp.lang.java.security*
comp.lang.java.databases *comp.lang.java.setup*
comp.lang.java.gui *comp.lang.java.softwaretools*
comp.lang.java.help *comp.lang.java.tech*

For folks without time to dig through all the noise, *Digital Espresso* provides a periodic digest of the newsfeed at http://www.io.org./˜mentor/DigitalEspresso.html. A list of

Java FAQs is at http://www-net.com/java/faq/; one of the most interesting is *Cafe Au Lait*, at http://sunsite.unc.edu/javafaq/. (*Cafe Au Lait* is written by Elliotte Rusty Harold, author of *Java Network Programming*.)

Local Java user groups are another good resource. (Having founded one myself, I'm biased.) What they offer varies greatly, but unless you look at one, you are potentially leaving out a vast resource for knowledge and experience. Lists of area user groups are available from JavaSoft at http://www.javasoft.com/Mail/usr-grp.html; also check out the Sun User Group's Special Interest Group for Users of Java at http://www.sug.org/Java/groups.html. In addition to the usual monthly meetings and forums, some maintain a mailing list for technical exchanges.

Security is a major issue with Java. If you are interested in reading more about Java security issues, Princeton University's Safe Internet Programming Web site at http://www.cs.princeton.edu/sip/News.html is an excellent resource.

About Java

Java is one of 13,000 islands that makes up Indonesia, whose capital is Jakarta (see Figure 1). It is home to about 120 million people with an area about 50,000 square miles. While on the island, you can hear traditional music such as gamelan or angklung. The island also has a dangerous volcano named Merapi, which makes up part of the Pacific "Ring of Fire." In 1891, fossils from Pithecanthropus erectus, better known as "Java man" (*homo javanensis*) were discovered on the island by Eugene Dubois.

Java's main export is a coffee that is considered spicy and full bodied, with a strong, slightly acidic flavor. O'Reilly has shown good taste in staying away from the pervasive coffee theme in its book titles and cover designs. (However, if you're ever in Sebastopol, check out the coffee at AromaRoasters in Santa Rosa.)

Conventions Used in This Book

Italic is used for:

- Pathnames, filenames, and program names
- Internet addresses, such as domain names and URLs

`Typewriter Font` is used for:

- Anything that might appear in a Java program, including keywords, method names, variables names, class names, and interface names

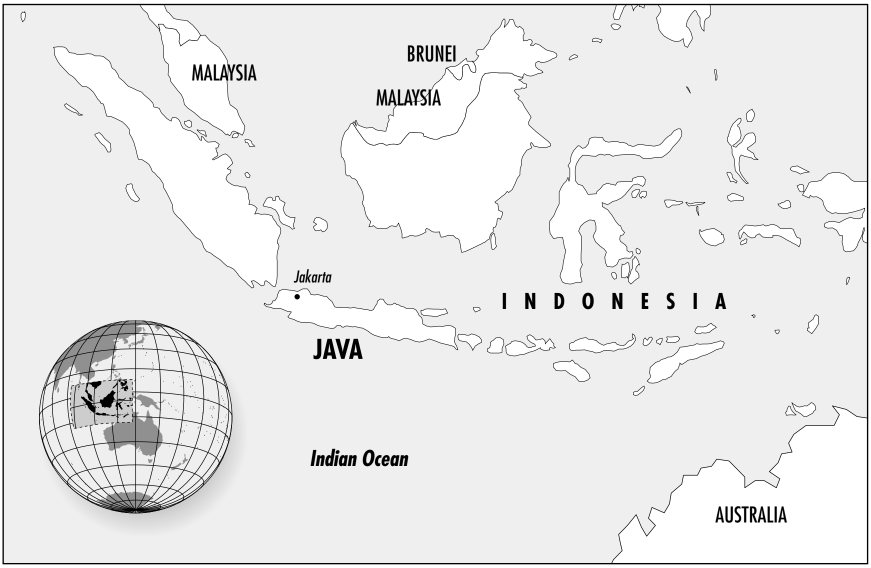


Figure 1: Map of Java, Indonesia

- Command lines and options that should be typed verbatim on the screen
- Tags that might appear in an HTML document

To sort out the potential for confusion between different versions, I use the following dingbats throughout the book:

★ Identifies a method, variable, or constant that is new in Java 1.1.

☆ Identifies a method from Java 1.0 that has been deprecated. Deprecated methods are available for compatibility but may disappear in a future release. These methods are tagged with the `@deprecated` flag, which causes the Java 1.1 compiler to display a warning message if you use them.

Request for Comments

We invite you to help us improve the book. If you have an idea that could make this a more useful resource, or if you find a bug in an example program or an error in the text, please let us know by sending email to *bookquestions@ora.com.*

As Java continues to evolve, we may find it necessary to issue errata for this book or to release updated examples or reference information. This information will be found at the book's Web site http://www.ora.com/catalog/javawt/.

Acknowledgments

I am grateful to many people who helped me along while working on this book, especially my wife, Lisa, and her patience during this whole process. A special thanks goes to our Old English sheep dog, Sir Dudley Fuzzybuns McDuff for gladly sharing the house with me during the entire process. I am grateful to the people at Sun who helped me become involved with Java so early on: Pete Seymour, Anne Pettitt, Tom McGinn, and Jen Sullivan-Volpe. I am also grateful to my employers, Rapid Systems Solutions (when I started) and the MageLang Institute (when I finished), who let me work on the book. Another thanks goes out to Dale Carnegie Training and John Captain, whose human relations class helped me feel comfortable with public speaking, without which I would not have become immersed in Java so quickly.

Particular thanks are owed to the technical reviewers: Yadu Zambre, Andy Cohen, David Flanagan, Jen Sullivan-Volpe, and Dan Jacobs. All of them performed an invaluable service with their thorough reviews and helped spot my errors and omissions. It seemed everyone contributed many bits of text that eventually found their way into the final product.

Random thanks go out to the many people on the Internet who I never met but provided valuable information, from the newsgroups and mailing lists: Simon "FISH" Morris, Mike Gallant, Eric Link, and many others whose names I did not write down.

Bits and pieces of various figures were borrowed from David Flanagan's book, *Java in a Nutshell*, and Patrick Niemeyer's and Joshua Peck's book, *Exploring Java*. The class hierarchy diagrams come from David's book. These diagrams were based on similar diagrams by Charles L. Perkins. His original efforts are available at http://rendezvous.com/java/.

For the gang at O'Reilly who gave me the opportunity to write this work, I thank everyone who helped along the way. For series editor, Mike Loukides, thanks for all your time and effort, especially with the early drafts. Best of luck to Mike and Judy with their new bundle of joy, Alexandra. Special thanks to Jonathan Knudsen who updated the reference section for the new release. Thanks to Nancy Crumpton and John Files for book production and project management, and to Trina Jackson, Paula Ferguson, and Andy Oram who helped during the review stages. Thanks also to the O'Reilly Tools group, Ellen Siever, Erik Ray, and Lenny Muellner; to Seth Maislin, the indexer; and David Futato and Danny Marcus who handled the proofreading and QCs.

The final product is much better because of their help.

In this chapter:

- *Components*
- *Peers*
- *Layouts*
- *Containers*
- *And the Rest*
- *Summary*

1

Abstract Window Toolkit Overview

For years, programmers have had to go through the hassles of porting software from BSD-based UNIX to System V Release 4–based UNIX, from OpenWindows to Motif, from PC to UNIX to Macintosh (or some combination thereof), and between various other alternatives, too numerous to mention. Getting an application to work was only part of the problem; you also had to port it to all the platforms you supported, which often took more time than the development effort itself. In the UNIX world, standards like POSIX and X made it easier to move applications between different UNIX platforms. But they only solved part of the problem and didn't provide any help with the PC world. Portability became even more important as the Internet grew. The goal was clear: wouldn't it be great if you could just move applications between different operating environments without worrying about the software breaking because of a different operating system, windowing environment, or internal data representation?

In the spring of 1995, Sun Microsystems announced Java, which claimed to solve this dilemma. What started out as a dancing penguin (or Star Trek communicator) named Duke on remote controls for interactive television has become a new paradigm for programming on the Internet. With Java, you can create a program on one platform and deliver the compilation output (byte-codes/class files) to every other supported environment without recompiling or worrying about the local windowing environment, word size, or byte order. The first generation of Java programs consisted mostly of fancy animation applets that ran in a web browser like Netscape Navigator, Internet Explorer, or HotJava. We're beginning to see the next generation now: powerful distributed applications in areas ranging from commerce to medical imaging to network management. All of these applications require extreme portability: Joe's Online Bait Shop doesn't have the time or energy to port its “Online Bait Buyer” program to every platform on the Internet but doesn’t want to limit its market to a specific platform. Java neatly solves their problem.

Windowing systems present the biggest challenges for portability. When you move an application from Windows to the Macintosh, you may be able to salvage most of the computational guts, but you’ll have to rewrite the window interface code completely. In Java, this part of the portability challenge is addressed by a package called AWT, which stands for Abstract Window Toolkit (although people have come up with many other expansions). AWT provides the magic of maintaining the local look and feel of the user’s environment. Because of AWT, the same application program can look appropriate in any environment. For example, if your program uses a pull-down list, that list will look like a Windows list when you run the program under Windows; a Macintosh list when you run the program on a Mac; and a Motif list when you run the program on a UNIX system under Motif. The same code works on all platforms. In addition to providing a common set of user interface components, AWT provides facilities for manipulating images and generating graphics.

This book is a complete programmer’s guide and reference to the `java.awt` package (including `java.awt.image`, `java.awt.event`, `java.awt.datatransfer`, and `java.awt.peer`). It assumes that you’re already familiar with the Java language and class libraries. If you aren’t, *Exploring Java*, by Pat Niemeyer and Josh Peck, provides a general introduction, and other books in the O’Reilly Java series provide detailed references and tutorials on specific topics. This chapter provides a quick overview of AWT: it introduces you to the various GUI elements contained within the `java.awt` package and gives you pointers to the chapters that provide more specific information about each component. If you’re interested in some of the more advanced image manipulation capabilities, head right to Chapter 12, *Image Processing*. The book ends with a reference section that summarizes what you need to know about every class in AWT.

In using this book, you should be aware that it covers two versions of AWT: 1.0.2 and 1.1. The Java 1.1 JDK (Java Developer’s Kit) occurred in December 1996. This release includes many improvements and additions to AWT and is a major step forward in Java’s overall functionality. It would be nice if I could say, “Forget about 1.0.2, it’s obsolete—use this book to learn 1.1.” However, I can’t; at this point, since browsers (Netscape Navigator in particular) still incorporate 1.0.2, and we have no idea when they will incorporate the new release. As of publication, Navigator 4.0 is in beta test and incorporates 1.0.2. Therefore, Java release 1.0.2 will continue to be important, at least for the foreseeable future.

In this summary, we'll point out new features of Java 1.1 as they come up. However, one feature deserves mention and doesn't fit naturally into an overview. Many of the methods of Java 1.0.2 have been renamed in Java 1.1. The old names still work but are "deprecated." The new names adhere strictly to the design patterns discussed in the JavaBeans documentation:* all methods that retrieve the value of an object's property begin with "get," all methods that set the value of a property begin with "set," and all methods that test the value of some property begin with "is." For example, the `size()` method is now called `getSize()`. The Java 1.1 compiler issues warnings whenever you used a deprecated method name.

1.1 Components

Modern user interfaces are built around the idea of "components": reusable gadgets that implement a specific part of the interface. They don't need much introduction: if you have used a computer since 1985 or so, you're already familiar with buttons, menus, windows, checkboxes, scrollbars, and many other similar items. AWT comes with a repertoire of basic user interface components, along with the machinery for creating your own components (often combinations of the basic components) and for communicating between components and the rest of the program.

The next few sections summarize the components that are part of AWT. If you're new to AWT, you may find it helpful to familiarize yourself with what's available before jumping into the more detailed discussions later in this book.

1.1.1 Static Text

The `Label` class provides a means to display a single line of text on the screen. That's about it. They provide visual aids to the user: for example, you might use a label to describe an input field. You have control over the size, font, and color of the text. Labels are discussed in Section 5.2. Figure 1-1 displays several labels with different attributes.

1.1.2 User Input

Java provides several different ways for a user to provide input to an application. The user can type the information or select it from a preset list of available choices. The choice depends primarily on the desired functionality of the program, the user-base, and the amount of back-end processing that you want to do.

---

* http://splash.javasoft.com/beans/spec.html

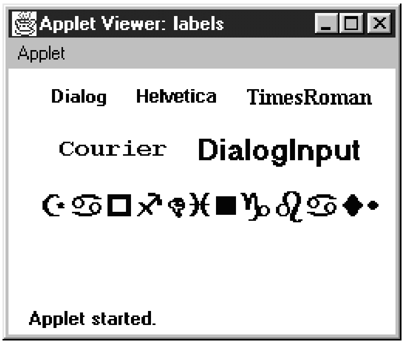


Figure 1–1: Multiple Label instances

1.1.2.1 The TextField and TextArea classes

Two components are available for entering keyboard input: `TextField` for single line input and `TextArea` for multi-line input. They provide the means to do things from character-level data validation to complex text editing. These are discussed in much more detail in Chapter 8, *Input Fields*. Figure 1-2 shows a screen that contains various `TextField` and `TextArea` components.

Figure 1–2: TextField and TextArea elements

1.1.2.2 The Checkbox and CheckboxGroup classes

The remaining input-oriented components provide mechanisms for letting the user select from a list of choices. The first such mechanism is `Checkbox`, which lets you select or deselect an option. The left side of the applet in Figure 1-3 shows a checkbox for a Dialog option. Clicking on the box selects the option and makes the box change appearance. A second click deselects the option.

The CheckboxGroup class is not a component; it provides a means for grouping checkboxes into a mutual exclusion set, often called a set of radio buttons. Selecting any button in the group automatically deselects the other buttons. This behavior is useful for a set of mutually exclusive choices. For example, the right side of the applet in Figure 1-3 shows a set of checkboxes for selecting a font. It makes sense to select only one font at a time, so these checkboxes have been put in a CheckboxGroup.

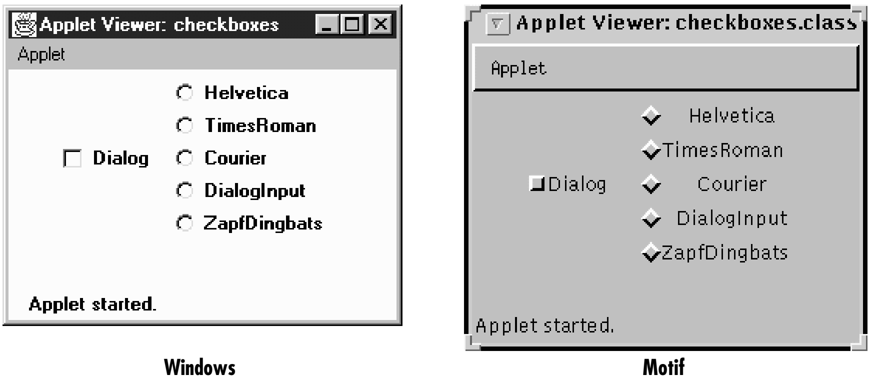


Figure 1–3: Examples of Checkbox and CheckboxGroup

The appearance of a checkbox varies from platform to platform. On the left, Figure 1-3 shows Windows; the right shows Motif. On most platforms, the appearance also changes when a checkbox is put into a CheckboxGroup.

1.1.2.3 The Choice class

Checkbox and CheckboxGroup present a problem when the list of choices becomes long. Every element of a CheckboxGroup uses precious screen real estate, which limits the amount of space available for other components. The Choice class was designed to use screen space more efficiently. When a Choice element is displayed on the screen, it takes up the space of a single item in the list, along with some extra space for decorations. This leaves more space for other components. When the user selects a Choice component, it displays the available options next to or below the Choice. Once the user makes a selection, the choices are removed from the screen, and the Choice displays the selection. At any time, only one item in a Choice may be selected, so selecting an item implicitly deselects everything else. Section 9.1 explores the details of the Choice class. Figure 1-4 shows examples of open (on the right of the screens) and closed (on the left) Choice items in Windows 95 and Motif.

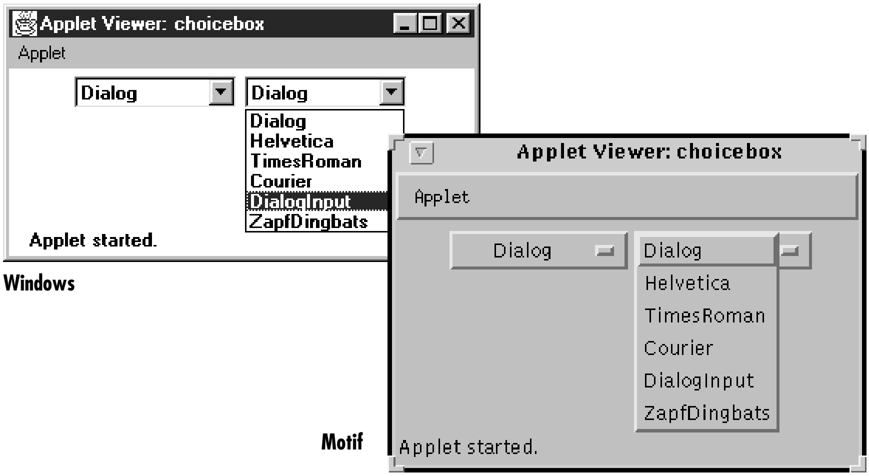


Figure 1–4: Open and closed Choice items

1.1.2.4 The List class

Somewhere between `Choice` and `CheckboxGroup` in the screen real estate business is a component called `List`. With a `List`, the user is still able to select any item. However, the programmer recommends how many items to display on the screen at once. All additional choices are still available, but the user moves an attached scrollbar to access them. Unlike a `Choice`, a `List` allows the user to select multiple items. Section 9.2 covers the `List` component. Figure 1-5 shows `List` components in different states.

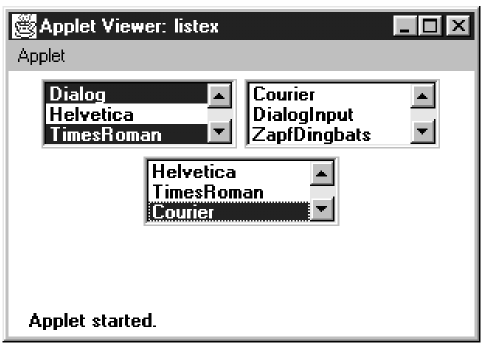


Figure 1–5: List components in different states

1.1.2.5 Menus

Most modern user interfaces use menus heavily; therefore, it's no surprise that Java supports menus. As you'd expect, Java menus look like the menus in the windowing environment under which the program runs. Currently, menus can only appear within a `Frame`, although this will probably change in the future. A `Menu` is a fairly complex object, with lots of moving parts: menu bars, menu items, etc. Java 1.1 adds hot keys to menus, allowing users to navigate a menu interface using keyboard shortcuts. The details of `Menu` are explored in Chapter 10, *Would You Like to Choose from the Menu?* Figure 1-6 shows frames with open menus for both Windows and Motif. Since tear-off menus are available on Motif systems, its menus look and act a little differently. Figure 1-6 also includes a tear-off menu. The shortcuts (Ctrl+F8) are newly supported in Java 1.1.

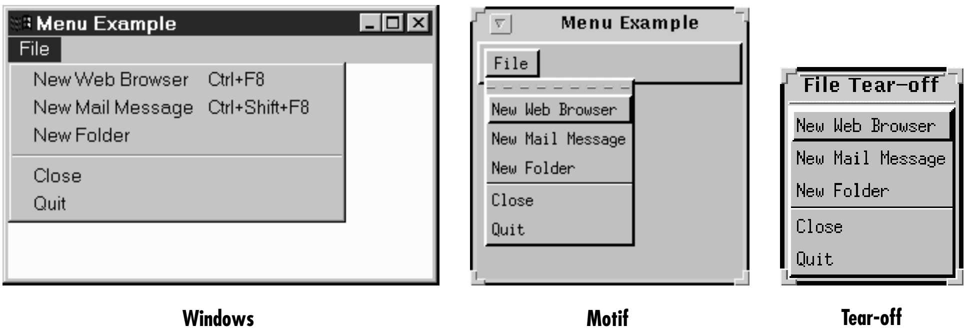


Figure 1–6: Examples of menus

1.1.2.6 The PopupMenu class

The `PopupMenu` class is new to Java 1.1. Pop-up menus can be used for context-sensitive, component-level menus. Associated with each `Component` can be its own pop-up menu. The details of creating and working with the `PopupMenu` class and the fun time you have catching their events are covered in Chapter 10, *Would You Like to Choose from the Menu?* Figure 1-7 shows an example of a pop-up menu.

1.1.3 Event Triggers

Java provides two components whose sole purpose is to trigger actions on the screen: `Button` and `Scrollbar`. They provide the means for users to signal that they are ready to perform an operation. (Note that all components except labels generate events; I'm singling out buttons and scrollbars because their only purpose is to generate events.)

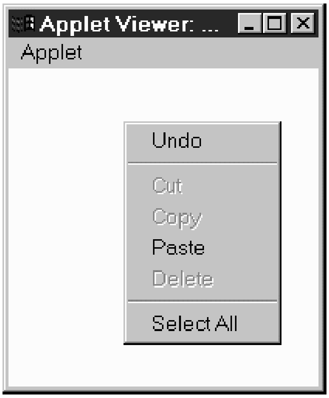


Figure 1–7: A Pop-up menu

1.1.3.1 The Scrollbar class

Most people are familiar with scrollbars. In a word processor or a web browser, when an image or document is too large to fit on the screen, the scrollbar allows the user to move to another area. With Java, the `Scrollbar` performs similarly. Selecting or moving the scrollbar triggers an event that allows the program to process the scrollbar movement and respond accordingly. The details of the `Scrollbar` are covered in Section 11.1. Figure 1-8 shows horizontal and vertical scrollbars.

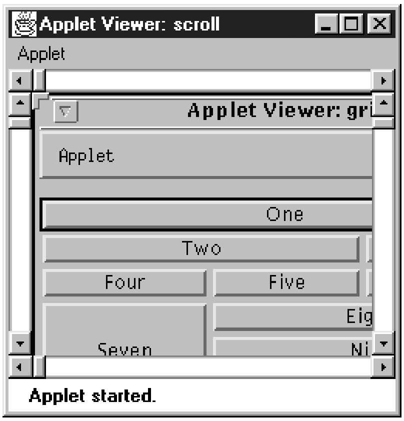


Figure 1–8: Horizontal and vertical scrollbars

Note that a scrollbar is just that. It generates events when the user adjusts it, but the program using the scrollbar is responsible for figuring out what to do with the events, such as displaying a different part of an image or the text, etc. Several of the components we've discussed, like `TextArea` and `List`, have built-in scrollbars, saving you the trouble of writing your own code to do the actual scrolling. Java 1.1 has a new container called a `ScrollPane` that has scrolling built in. By using a scroll pane, you should be able to avoid using scroll bars as a positioning mechanism. An example of `ScrollPane` appears later in this chapter.

1.1.3.2 The Button class

A button is little more than a label that you can click on. Selecting a button triggers an event telling the program to go to work. Section 5.3 explores the `Button` component. Figure 1-9 shows `Button` examples.

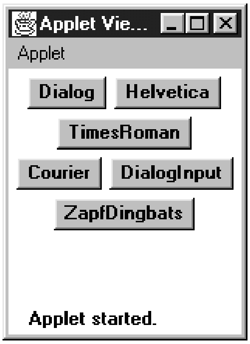


Figure 1–9: Various buttons

The Java Management API includes a fancier button (`ImageButton`) with pictures rather than labels. For the time being, this is a standard extension of Java and not in the Core API. If you don't want to use these extensions, you'll have to implement an image button yourself.

1.1.4 Expansion

1.1.4.1 The Canvas class

The `Canvas` class is just a blank area; it doesn't have any predefined appearance. You can use `Canvas` for drawing images, building new kinds of components, or creating super-components that are aggregates of other components. For example, you can build a picture button by drawing a picture on a `Canvas` and detecting mouse click events within the area of the `Canvas`. `Canvas` is discussed in Section 5.5.

1.2 Peers

Java programs always have the look and feel of the platform they are running on. If you create your program on a UNIX platform and deliver it to Microsoft Windows users, your program will have Motif's look and feel while you're developing it, but users will see Microsoft Windows objects when they use it. Java accomplishes this through a peer architecture, shown in Figure 1-10.

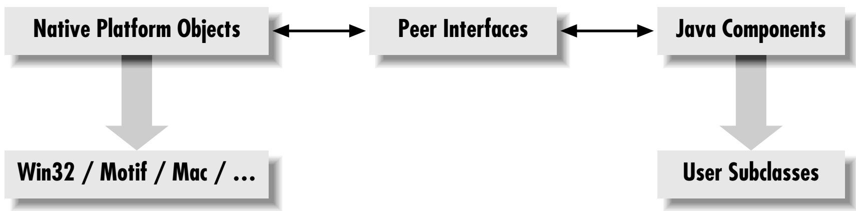


Figure 1–10: Peer architecture

There are several layers of software between your Java program and the actual screen. Let's say you are working with a scrollbar. On your screen, you see the scrollbar that's native to the platform you're using. This system-dependent scrollbar is the "peer" of the Java `Scrollbar` object. The peer scrollbar deals with events like mouse clicks first, passing along whatever it deems necessary to the corresponding Java component. The peer interface defines the relationship between each Java component and its peer; it is what allows a generic component (like a `Scrollbar`) to work with scrollbars on different platforms.

Peers are described in Chapter 15, *Toolkit and Peers*. However, you rarely need to worry about them; interaction between a Java program and a peer takes place behind the scenes. On occasion, you need to make sure that a component's peer exists in order to find out about platform-specific sizes. This process usually involves the `addNotify()` method.

1.3 Layouts

Layouts allow you to format components on the screen in a platform-independent way. Without layouts, you would be forced to place components at explicit locations on the screen, creating obvious problems for programs that need to run on multiple platforms. There's no guarantee that a `TextArea` or a `Scrollbar` or any other component will be the same size on each platform; in fact, you can bet they won't be. In an effort to make your Java creations portable across multiple platforms, Sun created a `LayoutManager` interface that defines methods to reformat the screen based on the current layout and component sizes. Layout managers try to give programs a consistent and reasonable appearance, regardless of the platform, the screen size, or actions the user might take.

The standard JDK provides five classes that implement the `LayoutManager` interface. They are `FlowLayout`, `GridLayout`, `BorderLayout`, `CardLayout`, and `GridBagLayout`. All of these layouts are covered in much greater detail in Chapter 7, *Layouts*. This chapter also discusses how to create complex layouts by combining layout managers and how to write your own `LayoutManager`. The Java 1.1 JDK includes the `LayoutManager2` interface. This interface extends the `LayoutManager` interface for managers that provide constraint-based layouts.

1.3.1 FlowLayout

The `FlowLayout` is the default layout for the `Panel` class, which includes its most famous subclass, `Applet`. When you add components to the screen, they flow left to right (centered within the applet) based upon the order added and the width of the applet. When there are too many components to fit, they "wrap" to a new row, similar to a word processor with word wrap enabled. If you resize an applet, the components' flow will change based upon the new width and height. Figure 1-11 shows an example both before and after resizing. Section 7.2 contains all the `FlowLayout` details.

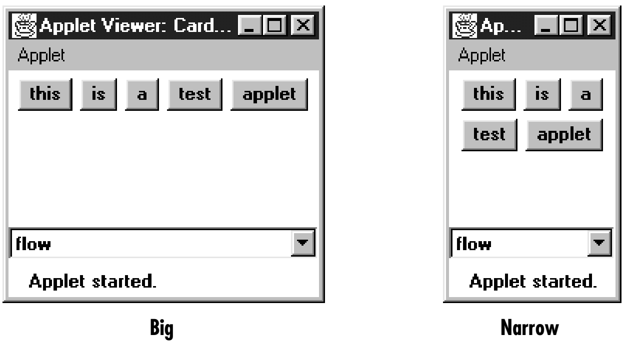


Figure 1–11: A FlowLayout before and after resizing

1.3.2 GridLayout

The `GridLayout` is widely used for arranging components in rows and columns. As with `FlowLayout`, the order in which you add components is relevant. You start at row one, column one, move across the row until it's full, then continue on to the next row. However, unlike `FlowLayout`, the underlying components are resized to fill the row-column area, if possible. `GridLayout` can reposition or resize objects after adding or removing components. Whenever the area is resized, the components within it are resized. Figure 1-12 shows an example before and after resizing. Section 7.4 contains all the details about `GridLayout`.

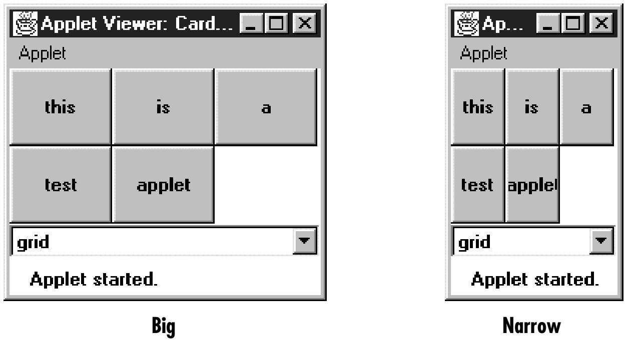


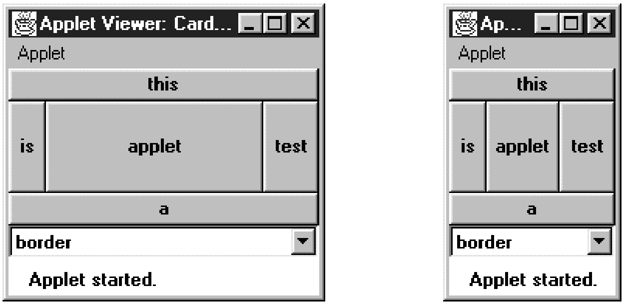
Figure 1–12: A GridLayout before and after resizing

1.3.3 BorderLayout

`BorderLayout` is one of the more unusual layouts provided. It is the default layout for `Window`, along with its children, `Frame` and `Dialog`. `BorderLayout` provides five areas to hold components. These areas are named after the four different borders of the screen, `North`, `South`, `East`, and `West`, with any remaining space going into the `Center` area. When you add a component to the layout, you must specify which area to place it in. The order in which components are added to the screen is not important, although you can have only one component in each area. Figure 1-13 shows a `BorderLayout` that has one button in each area, before and after resizing. Section 7.3 covers the details of the `BorderLayout`.

1.3.4 CardLayout

The `CardLayout` is a bit on the strange side. A `CardLayout` usually manages several components, displaying one of them at a time and hiding the rest. All the components are given the same size. Usually, the `CardLayout` manages a group of `Panels` (or some other container), and each `Panel` contains several components of its own. With a little work, you can use the `CardLayout` to create tabbed dialog boxes or property sheets, which are not currently part of AWT. `CardLayout` lets you assign names to the components it is managing and lets you jump to a component by name. You can also cycle through components in order. Figure 1-11, Figure 1-12, and Figure 1-13 show multiple cards controlled by a single `CardLayout`. Selecting the `Choice` button displays a different card. Section 7.5 discusses the details of `CardLayout`.



Big Narrow

Figure 1–13: A BorderLayout

1.3.5 GridBagLayout

`GridBagLayout` is the most sophisticated and complex of the layouts provided in the development kit. With the `GridBagLayout`, you can organize components in multiple rows and columns, stretch specific rows or columns when space is available, and anchor objects in different corners. You provide all the details of each component through instances of the `GridBagConstraints` class. Figure 1-14 shows an example of a `GridBagLayout`. `GridBagLayout` and `GridBagConstraints` are discussed in Section 7.6 and Section 7.7.

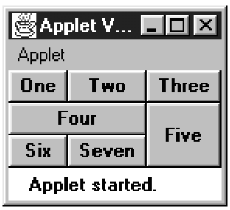


Figure 1–14: A GridBagLayout

1.4 Containers

A `Container` is a type of component that provides a rectangular area within which other components can be organized by a `LayoutManager`. Because `Container` is a subclass of `Component`, a `Container` can go inside another `Container`, which can go inside another `Container`, and so on, like Russian nesting dolls. Subclassing `Container` allows you to encapsulate code for the components within it. This allows you to create reusable higher-level objects easily. Figure 1-15 shows the components in a layout built from several nested containers.

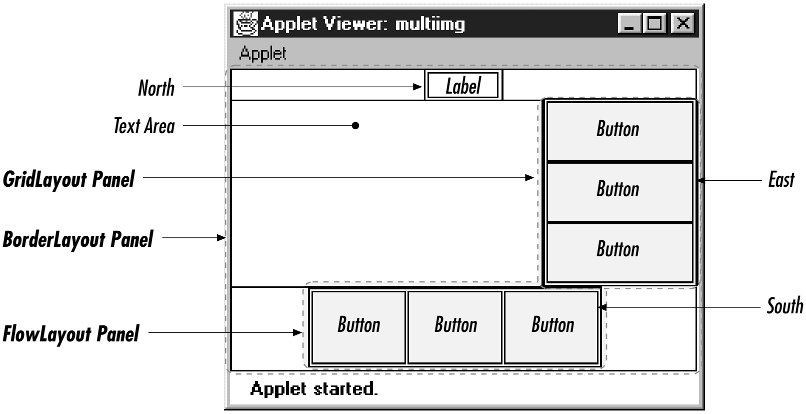


Figure 1–15: Components within containers

1.4.1 Panels

A `Panel` is the basic building block of an applet. It provides a container with no special features. The default layout for a `Panel` is `FlowLayout`. The details of `Panel` are discussed in Section 6.2. Figure 1-16 shows an applet that contains panels within panels within panels.

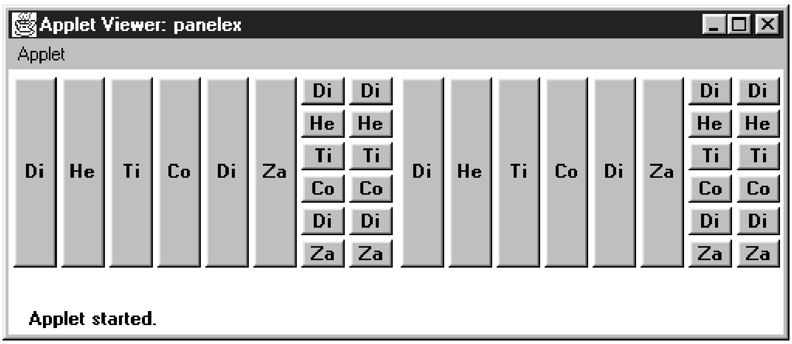


Figure 1–16: A multilevel panel

1.4.2 Windows

A `Window` provides a top-level window on the screen, with no borders or menu bar. It provides a way to implement pop-up messages, among other things. The default layout for a `Window` is `BorderLayout`. Section 6.4 explores the `Window` class in greater detail. Figure 1-17 shows a pop-up message using a `Window` in Microsoft Windows and Motif.

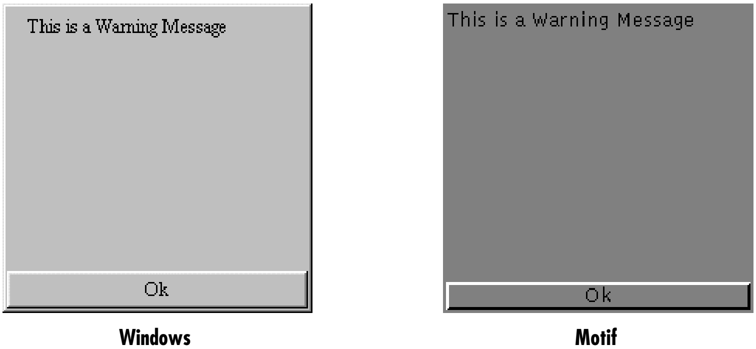


Figure 1–17: Pop-up windows

1.4.3 Frames

A `Frame` is a `Window` with all the window manager's adornments (window title, borders, window minimize/maximize/close functionality) added. It may also include a menu bar. Since `Frame` subclasses `Window`, its default layout is `BorderLayout`. `Frame` provides the basic building block for screen-oriented applications. `Frame` allows you to change the mouse cursor, set an icon image, and have menus. All the details of `Frame` are discussed in Section 6.5. Figure 1-18 shows an example `Frame`.

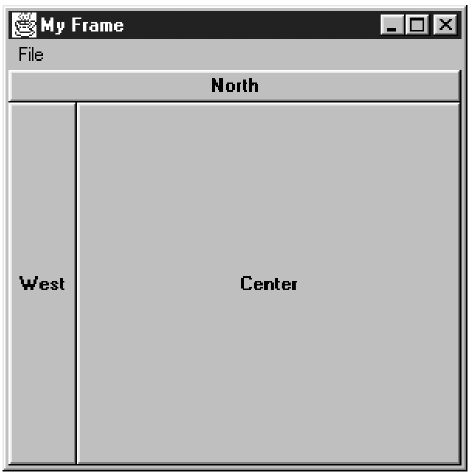


Figure 1–18: A frame

1.4.4 Dialog and FileDialog

A `Dialog` is a `Window` that accepts input from the user. `BorderLayout` is the default layout of `Dialog` because it subclasses `Window`. A `Dialog` is a pop-up used for user interaction; it can be modal to prevent the user from doing anything with the application before responding. A `FileDialog` provides a prebuilt `Dialog` box that interacts with the filesystem. It implements the Open/Save dialog provided by the native windowing system. You will primarily use `FileDialog` with applications since there is no guarantee that an applet can interact with the local filesystem. (Netscape Navigator will throw an exception if you try to use it.) The details of `Dialog` are revealed in Section 6.6, while `FileDialog` is discussed in Section 6.7. Figure 1-19 shows sample `Dialog` and `FileDialog` boxes.

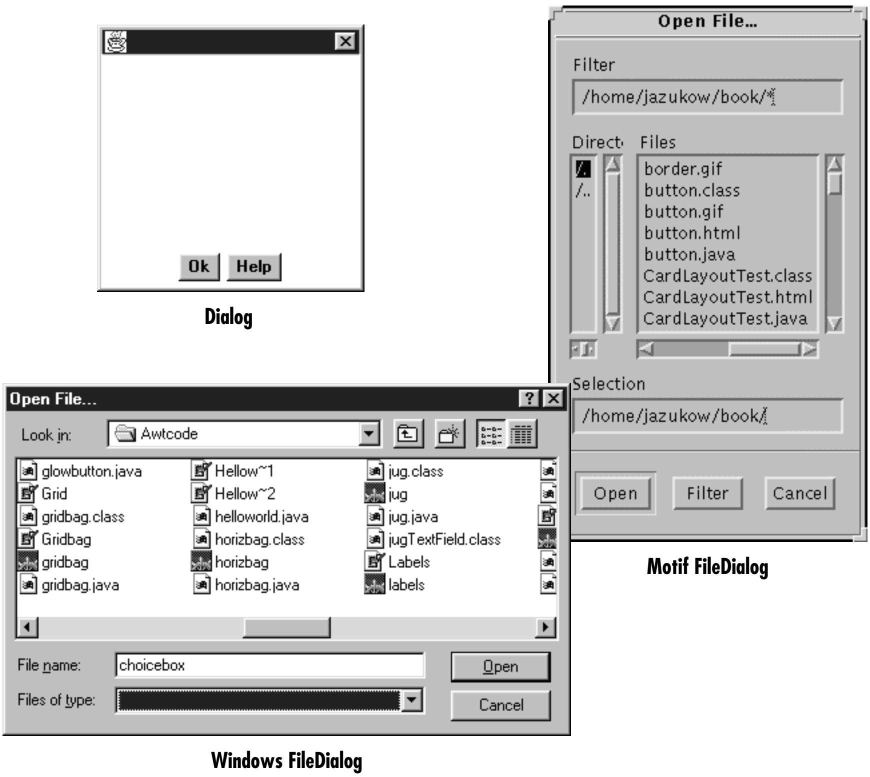


Figure 1–19: Examples of Dialog and FileDialog boxes

1.4.5 ScrollPane

Java 1.1 introduces the `ScrollPane` container. In version 1.0, if you want to have a scrolling area (for example, to display an image that won't fit onto the screen), you create a panel using `BorderLayout` that contains scrollbars on the right and bottom, and display part of the image in the rest of the screen. When the user scrolls, you capture the event, figure out what part of the image to display, and update the screen accordingly. Although this works, its performance is poor, and it's inconvenient. With version 1.1 of Java, you can tell the `ScrollPane` what needs to scroll; it creates the scrollbars and handles all the events automatically. Section 11.4 covers the `ScrollPane`; Figure 1-20 shows a `ScrollPane`. Chapter 11, *Scrolling*, covers the `Adjustable` interface that `Scrollbar` implements and `ScrollPane` utilizes.

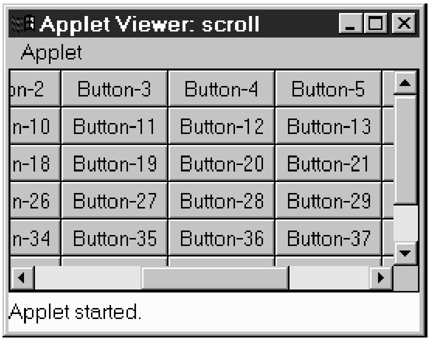


Figure 1–20: A ScrollPane

1.5 And the Rest

Several of the remaining classes within `java.awt` are important to mention here but did not fit well into a general category. The following sections are a grab bag that summarize the remaining classes.

1.5.1 Drawing and Graphics

Java provides numerous primitives for drawing lines, squares, circles, polygons, and images. Figure 1-21 shows a simple drawing. The drawing components of AWT are discussed in Chapter 2, *Simple Graphics*.

The `Font`, `FontMetrics`, `Color`, and `SystemColor` classes provide the ability to alter the displayed output. With the `Font` class, you adjust how displayed text will appear. With `FontMetrics`, you can find out how large the output will be, for the specific system the user is using. You can use the `Color` class to set the color of text and graphics. `SystemColor` is new to Java 1.1; it lets you take advantage of desktop color schemes. These classes are discussed in Chapter 3, *Fonts and Colors*.

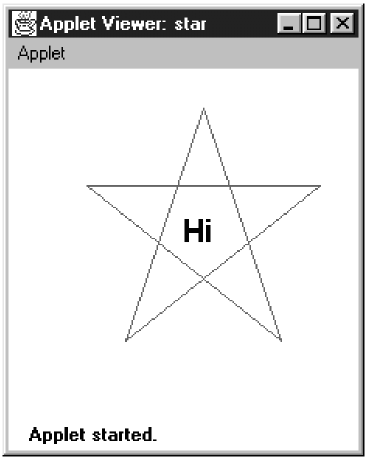


Figure 1–21: A simple drawing

AWT also includes a number of classes that support more complex graphics manipulations: displaying images, generating images in memory, and transforming images. These classes make up the package `java.awt.image`, which is covered in Chapter 12.

1.5.2 Events

Like most windows programming environments, AWT is event driven. When an event occurs (for example, the user presses a key or moves the mouse), the environment generates an event and passes it along to a handler to process the event. If nobody wants to handle the event, the system ignores it. Unlike some windowing environments, you do not have to provide a main loop to catch and process all the events, or an infinite busy-wait loop. AWT does all the event management and passing for you.

Probably the most significant difference between versions 1.0.2 and 1.1 of AWT is the way events work. In older versions of Java, an event is distributed to every component that might conceivably be interested in it, until some component declares that it has handled the event. This event model can still be used in 1.1, but there is also a new event model in which objects listen for particular events. This new model is arguably a little more work for the programmer but promises to be much more efficient, because events are distributed only to objects that want to hear about them. It is also how JavaBeans works.

In this book, examples that are using the older (1.0.2) components use the old event model, unless otherwise indicated. Examples using new components use the new event model. Don't let this mislead you; all components in Java 1.1 support the new event model. The details of `Event` for both version 1.0.2 and 1.1 can be found in Chapter 4, *Events*.

1.5.3 Applets

Although it is not a part of the `java.awt` package, the Core Java API provides a framework for applet development. This includes support for getting parameters from HTML files, changing the web page a browser is displaying, and playing audio files. Chapter 14, *And Then There Were Applets*, describes all the details of the `java.applet` package. Because audio support is part of `java.applet`, portable audio playing is limited to applets. Chapter 14 also shows a nonportable way to play audio in applications. Additional audio capabilities are coming to the Java Core API in the announced extensions.

1.5.4 Clipboards

In Java 1.1, programs can access the system clipboard. This process makes it easier to transfer (cut, copy, and paste) data between various other sources and your Java programs and introduces developers to the concepts involved with JavaBeans. Chapter 16, *Data Transfer*, describes the `java.awt.datatransfer` package.

1.5.5 Printing

Java 1.1 adds the ability to print. Adding printing to an existing program is fairly simple: you don't have to do much beside adding a Print menu button. Chapter 17, *Printing*, describes these capabilities.

1.6 Summary

The `java.awt` package provides a great deal of functionality and flexibility. The package goes well beyond the basics presented in this chapter. Do not be intimidated by the vast libraries available to you in Java. With the help of this book, you should get an excellent grasp of the `java.awt`, `java.awt.image`, `java.awt.datatransfer`, `java.awt.event`, and `java.applet` packages, along with some pieces of the proprietary `sun.awt` and `sun.audio` packages.

Do not feel the need to read this book cover to cover. Pick the section that interests you most, where you feel you do not fully understand something, or where you have an immediate question to be answered and dive right in.

2

In this chapter:
- *Graphics*
- *Point*
- *Dimension*
- *Shape*
- *Rectangle*
- *Polygon*
- *Image*
- *MediaTracker*

Simple Graphics

This chapter digs into the meat of the AWT classes. After completing this chapter, you will be able to draw strings, images, and shapes via the `Graphics` class in your Java programs. We discuss geometry-related classes—`Polygon`, `Rectangle`, `Point`, and `Dimension`, and the `Shape` interface—you will see these throughout the remaining AWT objects. You will also learn several ways to do smooth animation by using double buffering and the `MediaTracker`.

After reading this chapter, you should be able to do simple animation and image manipulation with AWT. For most applications, this should be sufficient. If you want to look at AWT's more advanced graphics capabilities, be sure to take a look at Chapter 12, *Image Processing*.

2.1 Graphics

The `Graphics` class is an abstract class that provides the means to access different graphics devices. It is the class that lets you draw on the screen, display images, and so forth. `Graphics` is an abstract class because working with graphics requires detailed knowledge of the platform on which the program runs. The actual work is done by concrete classes that are closely tied to a particular platform. Your Java Virtual Machine vendor provides the necessary concrete classes for your environment. You never need to worry about the platform-specific classes; once you have a `Graphics` object, you can call all the methods of the `Graphics` class, confident that the platform-specific classes will work correctly wherever your program runs.

You rarely need to create a `Graphics` object yourself; its constructor is protected and is only called by the subclasses that extend `Graphics`. How then do you get a

Graphics object to work with? The sole parameter of the Component.paint() and Component.update() methods is the current graphics context. Therefore, a Graphics object is always available when you override a component's paint() and update() methods. You can ask for the graphics context of a Component by calling Component.getGraphics(). However, many components do not have a drawable graphics context. Canvas and Container objects return a valid Graphics object; whether or not any other component has a drawable graphics context depends on the run-time environment. (The latest versions of Netscape Navigator provide a drawable graphics context for any component, but you shouldn't get used to writing platform-specific code.) This restriction isn't as harsh as it sounds. For most components, a drawable graphics context doesn't make much sense; for example, why would you want to draw on a List? If you want to draw on a component, you probably can't. The notable exception is Button, and that may be fixed in future versions of AWT.

2.1.1 Graphics Methods

Constructors

protected Graphics ()

Because Graphics is an abstract class, it doesn't have a visible constructor. The way to get a Graphics object is to ask for one by calling getGraphics() or to use the one given to you by the Component.paint() or Component.update() method.

The abstract methods of the Graphics class are implemented by some windowing system–specific class. You rarely need to know which subclass of Graphics you are using, but the classes you actually get (if you are using the JDK) are sun.awt.win32.Win32Graphics (JDK1.0), sun.awt.window.WGraphics (JDK1.1), sun.awt.motif.X11Graphics, or sun.awt.macos.MacGraphics.

Pseudo-constructors

In addition to using the graphics contexts given to you by getGraphics() or in Component.paint(), you can get a Graphics object by creating a copy of another Graphics object. Creating new graphics contexts has resource implications. Certain platforms have a limited number of graphics contexts that can be active. For instance, on Windows 95 you cannot have more than four in use at one time. Therefore, it's a good idea to call dispose() as soon as you are done with a Graphics object. Do not rely on the garbage collector to clean up for you.

public abstract Graphics create ()

This method creates a second reference to the graphics context. It is useful for clipping (reducing the drawable area).

public Graphics create (int x, int y, int width, int height)

This method creates a second reference to a subset of the drawing area of the graphics context. The new `Graphics` object covers the rectangle from (`x`, `y`) through (`x+width-1`, `y+height-1`) in the original object. The coordinate space of the new `Graphics` context is translated so that the upper left corner is (0, 0) and the lower right corner is (`width`, `height`). Shifting the coordinate system of the new object makes it easier to work within a portion of the drawing area without using offsets.

Drawing strings

These methods let you draw text strings on the screen. The coordinates refer to the left end of the text's baseline.

public abstract void drawString (String text, int x, int y)

The `drawString()` method draws `text` on the screen in the current font and color, starting at position (`x`, `y`). The starting coordinates specify the left end of the `String`'s baseline.

public void drawChars (char text[], int offset, int length, int x, int y)

The `drawChars()` method creates a `String` from the char array `text` starting at `text[offset]` and continuing for `length` characters. The newly created `String` is then drawn on the screen in the current font and color, starting at position (`x`, `y`). The starting coordinates specify the left end of the `String`'s baseline.

public void drawBytes (byte text[], int offset, int length, int x, int y)

The `drawBytes()` method creates a `String` from the byte array `text` starting at `text[offset]` and continuing for `length` characters. This `String` is then drawn on the screen in the current font and color, starting at position (`x`, `y`). The starting coordinates specify the left end of the `String`'s baseline.

public abstract Font getFont ()

The `getFont()` method returns the current `Font` of the graphics context. See Chapter 3, *Fonts and Colors*, for more on what you can do with fonts. You cannot get meaningful results with `getFont()` until the applet or application is displayed on the screen (generally, not in `init()` of an applet or `main()` of an application).

public abstract void setFont (Font font)

The `setFont()` method changes the current `Font` to `font`. If `font` is not available on the current platform, the system chooses a default. To change the current font to 12 point bold TimesRoman:

```
setFont (new Font ("TimesRoman", Font.BOLD, 12));
```

public FontMetrics getFontMetrics ()

The `getFontMetrics()` method returns the current `FontMetrics` object of the graphics context. You use `FontMetrics` to reveal sizing properties of the current `Font`—for example, how wide the "Hello World" string will be in pixels when displayed on the screen.

public abstract FontMetrics getFontMetrics (Font font)

This version of `getFontMetrics()` returns the `FontMetrics` for the `Font` font instead of the current font. You might use this method to see how much space a new font requires to draw text.

For more information about `Font` and `FontMetrics`, see Chapter 3.

Painting

public abstract Color getColor ()

The `getColor()` method returns the current foreground `Color` of the `Graphics` object. All future drawing operations will use this color. Chapter 3 describes the `Color` class.

public abstract void setColor (Color color)

The `setColor()` method changes the current drawing color to `color`. As you will see in the next chapter, the `Color` class defines some common colors for you. If you can't use one of the predefined colors, you can create a color from its RGB values. To change the current color to red, use any of the following:

```
setColor (Color.red);
setColor (new Color (255, 0, 0));
setColor (new Color (0xff0000));
```

public abstract void clearRect (int x, int y, int width, int height)

The `clearRect()` method sets the rectangular drawing area from (`x`, `y`) to (`x+width-1`, `y+height-1`) to the current background color. Keep in mind that the second pair of parameters is not the opposite corner of the rectangle, but the width and height of the area to clear.

public abstract void clipRect (int x, int y, int width, int height)

The `clipRect()` method reduces the drawing area to the intersection of the current drawing area and the rectangular area from (`x`, `y`) to (`x+width-1`, `y+height-1`). Any future drawing operations outside this clipped area will have no effect. Once you clip a drawing area, you cannot increase its size with `clipRect()`; the drawing area can only get smaller. (However, if the `clipRect()` call is in `paint()`, the size of the drawing area will be reset to its original size on subsequent calls to `paint()`.) If you want the ability to draw to the entire area, you must create a second `Graphics` object that contains a copy of the drawing area before calling `clipRect()` or use `setClip()`. The following code is a simple applet that demonstrates clipping; Figure 2-1 shows the result.

```
import java.awt.*;
public class clipping extends java.applet.Applet {
    public void paint (Graphics g) {
        g.setColor (Color.red);
        Graphics clippedGraphics = g.create();
        clippedGraphics.drawRect (0,0,100,100);
        clippedGraphics.clipRect (25, 25, 50, 50);
        clippedGraphics.drawLine (0,0,100,100);
        clippedGraphics.dispose();
        clippedGraphics=null;
        g.drawLine (0,100,100,0);
    }
}
```

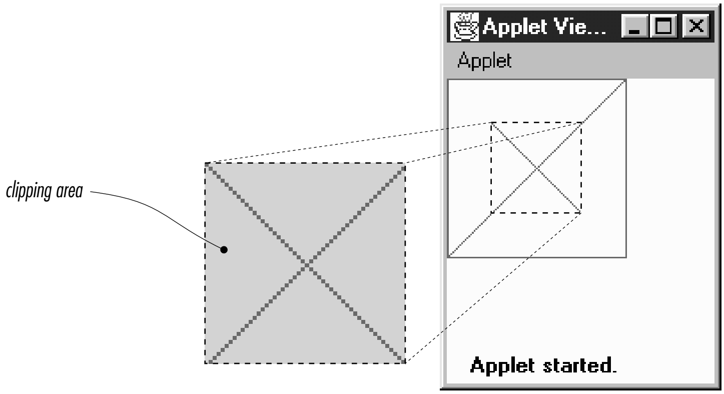


Figure 2–1: Clipping restricts the drawing area

The `paint()` method for this applet starts by setting the foreground color to red. It then creates a copy of the `Graphics` context for clipping, saving the original object so it can draw on the entire screen later. The applet then draws a rectangle, sets the clipping area to a smaller region, and draws a diagonal line across the rectangle from upper left to lower right. Because clipping is in effect, only part of the line is displayed. The applet then discards the clipped `Graphics` object and draws an unclipped line from lower left to upper right using the original object `g`.

public abstract void setClip(int x, int y, int width, int height) ★

This `setClip()` method allows you to change the current clipping area based on the parameters provided. `setClip()` is similar to `clipRect()`, except that it is not limited to shrinking the clipping area. The current drawing area becomes the rectangular area from (`x`, `y`) to (`x+width-1`, `y+height-1`); this area may be larger than the previous drawing area.

public abstract void setClip(Shape clip) ★

This `setClip()` method allows you to change the current clipping area based on the `clip` parameter, which may be any object that implements the `Shape` interface. Unfortunately, practice is not as good as theory, and in practice, `clip` must be a `Rectangle`; if you pass `setClip()` a `Polygon`, it throws an `IllegalArgumentException`.* (The `Shape` interface is discussed later in this chapter.)

public abstract Rectangle getClipBounds () ★
public abstract Rectangle getClipRect () ☆

The `getClipBounds()` methods returns a `Rectangle` that describes the clipping area of a `Graphics` object. The `Rectangle` gives you the (`x`, `y`) coordinates of the top left corner of the clipping area along with its width and height. (`Rectangle` objects are discussed later in this chapter.)

`getClipRect()` is the Java 1.0 name for this method.

public abstract Shape getClip () ★

The `getClip()` method returns a `Shape` that describes the clipping area of a `Graphics` object. That is, it returns the same thing as `getClipBounds()` but as a `Shape`, instead of as a `Rectangle`. By calling `Shape.getBounds()`, you can get the (`x`, `y`) coordinates of the top left corner of the clipping area along with its width and height. In the near future, it is hard to imagine the actual object that `getClip()` returns being anything other than a `Rectangle`.

public abstract void copyArea (int x, int y, int width, int height, int delta_x, int delta_y)

The `copyArea()` method copies the rectangular area from (`x`, `y`) to (`x+width`, `y+height`) to the area with an upper left corner of (`x+delta_x`, `y+delta_y`). The `delta_x` and `delta_y` parameters are not the coordinates of the second point but an offset from the first coordinate pair (`x`, `y`). The area copied may fall outside of the clipping region. This method is often used to tile an area of the graphics context. `copyArea()` does not save the contents of the area copied.

Painting mode

There are two painting or drawing modes for the `Graphics` class: paint (the default) and XOR mode. In paint mode, anything you draw replaces whatever is already on the screen. If you draw a red square, you get a red square, no matter what was underneath; this is what most programmers have learned to expect.

The behavior of XOR mode is rather strange, at least to people accustomed to modern programming environments. XOR mode is short for eXclusive-OR mode.

* It should be simple for Sun to fix this bug; one would expect clipping to a `Polygon` to be the same as clipping to the `Polygon`'s bounding rectangle.

The idea behind XOR mode is that drawing the same object twice returns the screen to its original state. This technique was commonly used for simple animations prior to the development of more sophisticated methods and cheaper hardware.

The side effect of XOR mode is that painting operations don't necessarily get the color you request. Instead of replacing the original pixel with the new value, XOR mode merges the original color, the painting color, and an XOR color (usually the background color) to form a new color. The new color is chosen so that if you repaint the pixel with the same color, you get the original pixel back. For example, if you paint a red square in XOR mode, you get a square of some other color on the screen. Painting the same red square again returns the screen to its original state.

public abstract void setXORMode (Color xorColor)

The `setXORMode()` method changes the drawing mode to XOR mode. In XOR mode, the system uses the `xorColor` color to determine an alternate color for anything drawn such that drawing the same item twice restores the screen to its original condition. The `xorColor` is usually the current background color but can be any color. For each pixel, the new color is determined by an exclusive-or of the old pixel color, the painting color, and the `xorColor`.

For example, if the old pixel is red, the XOR color is blue, and the drawing color is green, the end result would be white. To see why, it is necessary to look at the RGB values of the three colors. Red is (255, 0, 0). Blue is (0, 0, 255). Green is (0, 255, 0). The exclusive-or of these three values is (255, 255, 255), which is white. Drawing another green pixel with a blue XOR color yields red, the pixel's original color, since (255, 255, 255) ^ (0, 0, 255) ^ (0, 255, 0) yields (255, 0, 0).* The following code generates the display shown in Figure 2-2.

```
import java.awt.*;
public class xor extends java.applet.Applet {
    public void init () {
        setBackground (Color.red);
    }
    public void paint (Graphics g) {
        g.setColor (Color.green);
        g.setXORMode (Color.blue);
        g.fillRect (10, 10, 100, 100);
        g.fillRect (10, 60, 100, 100);
    }
}
```

Although it's hard to visualize what color XOR mode will pick, there is one important special case. Let's say that there are only two colors: a background color (the

* ^ is the Java XOR operator.

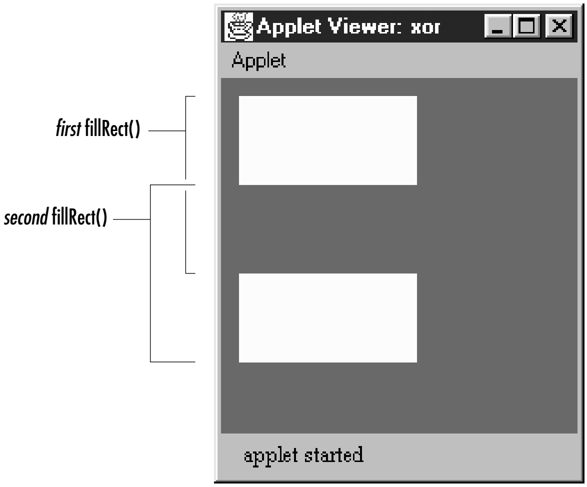


Figure 2–2: Drawing in XOR mode

XOR color) and a foreground color (the painting color). Each pixel must be in one color or the other. Painting "flips" each pixel to the other color. Foreground pixels become background, and vice versa.

public abstract void setPaintMode ()

The `setPaintMode()` method puts the system into paint mode. When in paint mode, any drawing operation replaces whatever is underneath it. Call `setPaintMode()` to return to normal painting when finished with XOR mode.

Drawing shapes

Most of the drawing methods require you to specify a bounding rectangle for the object you want to draw: the location of the object's upper left corner, plus its width and height. The two exceptions are lines and polygons. For lines, you supply two endpoints; for polygons, you provide a set of points.

Versions 1.0.2 and 1.1 of AWT always draw solid lines that are one pixel wide; there is no support for line width or fill patterns. A future version should support lines with variable widths and patterns.

public abstract void drawLine (int x1, int y1, int x2, int y2)

The `drawLine()` method draws a line on the graphics context in the current color from (`x1`, `y1`) to (`x2`, `y2`). If (`x1`, `y1`) and (`x2`, `y2`) are the same point, you will draw a point. There is no method specific to drawing a point. The following code generates the display shown in Figure 2-3.

```
g.drawLine (5, 5, 50, 75);   // line
g.drawLine (5, 75, 5, 75);   // point
g.drawLine (50, 5, 50, 5);   // point
```

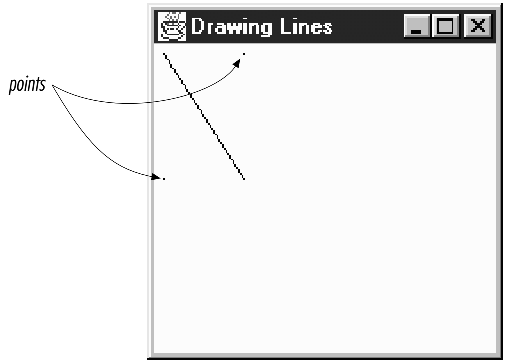


Figure 2–3: Drawing lines and points with drawLine()

public void drawRect (int x, int y, int width, int height)

The `drawRect()` method draws a rectangle on the drawing area in the current color from (`x`, `y`) to (`x+width`, `y+height`). If `width` or `height` is negative, nothing is drawn.

public abstract void fillRect (int x, int y, int width, int height)

The `fillRect()` method draws a filled rectangle on the drawing area in the current color from (`x`, `y`) to (`x+width-1`, `y+height-1`). Notice that the filled rectangle is one pixel smaller to the right and bottom than requested. If `width` or `height` is negative, nothing is drawn.

public abstract void drawRoundRect (int x, int y, int width, int height, int arcWidth, int arcHeight)

The `drawRoundRect()` method draws a rectangle on the drawing area in the current color from (`x`, `y`) to (`x+width`, `y+height`). However, instead of perpendicular corners, the corners are rounded with a horizontal diameter of `arcWidth` and a vertical diameter of `arcHeight`. If `width` or `height` is a negative number, nothing is drawn. If `width`, `height`, `arcWidth`, and `arcHeight` are all equal, you get a circle.

To help you visualize the `arcWidth` and `arcHeight` of a rounded rectangle, Figure 2-4 shows one corner of a rectangle drawn with an `arcWidth` of 20 and a `arcHeight` of 40.

public abstract void fillRoundRect (int x, int y, int width, int height, int arcWidth, int arcHeight)

The `fillRoundRect()` method draws a filled rectangle on the drawing area in the current color from (`x`, `y`) to (`x+width-1`, `y+height-1`). However, instead of having perpendicular corners, the corners are rounded with a horizontal

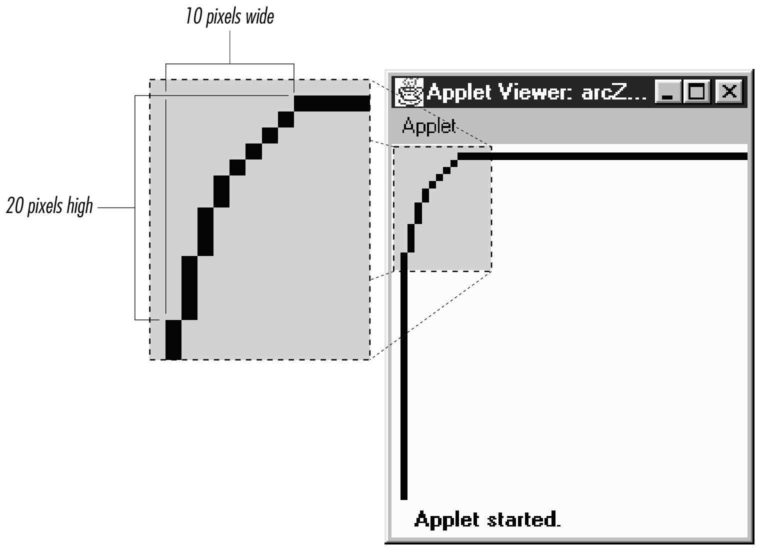


Figure 2–4: Drawing rounded corners

diameter of `arcWidth` and a vertical diameter of `arcHeight` for the four corners. Notice that the filled rectangle is one pixel smaller to the right and bottom than requested. If `width` or `height` is a negative number, nothing is filled. If `width`, `height`, `arcWidth`, and `arcHeight` are all equal, you get a filled circle.

Figure 2-4 shows how AWT generates rounded corners. Figure 2-5 shows the collection of rectangles created by the following code. The rectangles in Figure 2-5 are filled and unfilled, with rounded and square corners.

```
g.drawRect (25, 10, 50, 75);
g.fillRect (25, 110, 50, 75);
g.drawRoundRect (100, 10, 50, 75, 60, 50);
g.fillRoundRect (100, 110, 50, 75, 60, 50);
```

public void draw3DRect (int x, int y, int width, int height, boolean raised)

The `draw3DRect()` method draws a rectangle in the current color from (`x`, `y`) to (`x+width`, `y+height`); a shadow effect makes the rectangle appear to float slightly above or below the screen. The `raised` parameter has an effect only if the current color is not black. If `raised` is `true`, the rectangle looks like a button waiting to be pushed. If `raised` is `false`, the rectangle looks like a depressed button. If `width` or `height` is negative, the shadow appears from another direction.

public void fill3DRect (int x, int y, int width, int height, boolean raised)

The `fill3DRect()` method draws a filled rectangle in the current color from (`x`, `y`) to (`x+width`, `y+height`); a shadow effect makes the rectangle appear to float slightly above or below the screen. The `raised` parameter has an effect

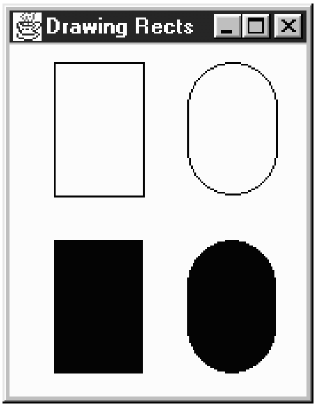


Figure 2–5: Varieties of rectangles

only if the current color is not black. If `raised` is `true`, the rectangle looks like a button waiting to be pushed. If `raised` is `false`, the rectangle looks like a depressed button. To enhance the shadow effect, the depressed area is given a slightly deeper shade of the drawing color. If `width` or `height` is negative, the shadow appears from another direction, and the rectangle isn't filled. (Different platforms could deal with this differently. Try to ensure the parameters have positive values.)

Figure 2-6 shows the collection of three-dimensional rectangles created by the following code. The rectangles in the figure are raised and depressed, filled and unfilled.

```
g.setColor (Color.gray);
g.draw3DRect (25, 10, 50, 75, true);
g.draw3DRect (25, 110, 50, 75, false);
g.fill3DRect (100, 10, 50, 75, true);
g.fill3DRect (100, 110, 50, 75, false);
```

public abstract void drawOval (int x, int y, int width, int height)

The `drawOval()` method draws an oval in the current color within an invisible bounding rectangle from (`x`, `y`) to (`x+width`, `y+height`). You cannot specify the oval's center point and radii. If `width` and `height` are equal, you get a circle. If `width` or `height` is negative, nothing is drawn.

public abstract void fillOval (int x, int y, int width, int height)

The `fillOval()` method draws a filled oval in the current color within an invisible bounding rectangle from (`x`, `y`) to (`x+width-1`, `y+height-1`). You cannot specify the oval's center point and radii. Notice that the filled oval is one pixel smaller to the right and bottom than requested. If `width` or `height` is negative, nothing is drawn.

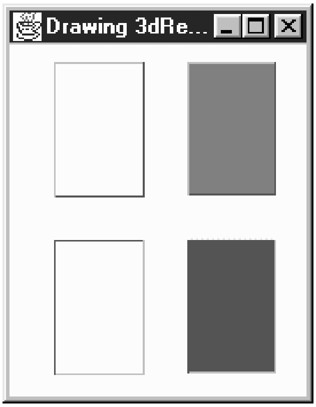


Figure 2–6: Filled and unfilled 3D rectangles

Figure 2-7 shows the collection of ovals, filled and unfilled, that were generated by the following code:

```
g.drawOval (25, 10, 50, 75);
g.fillOval (25, 110, 50, 75);
g.drawOval (100, 10, 50, 50);
g.fillOval (100, 110, 50, 50);
```

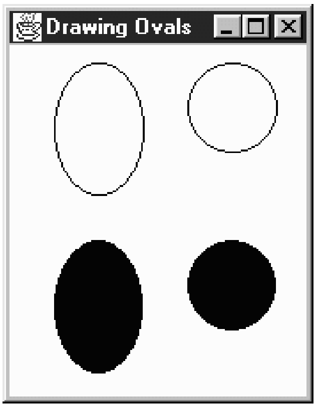


Figure 2–7: Filled and unfilled ovals

public abstract void drawArc (int x, int y, int width, int height, int startAngle, int arcAngle)

The `drawArc()` method draws an arc in the current color within an invisible bounding rectangle from (`x`, `y`) to (`x+width`, `y+height`). The arc starts at `startAngle` degrees and goes to `startAngle` + `arcAngle` degrees. An angle of 0 degrees is at the 3 o'clock position; angles increase counter-clockwise. If arcAngle is negative, drawing is in a clockwise direction. If width and height are equal and arcAngle is 360 degrees, drawArc() draws a circle. If width or height is negative, nothing is drawn.

public abstract void fillArc (int x, int y, int width, int height, int startAngle, int arcAngle)

The fillArc() method draws a filled arc in the current color within an invisible bounding rectangle from (x, y) to (x+width-1, y+height-1). The arc starts at startAngle degrees and goes to startAngle + arcAngle degrees. An angle of 0 degrees is at the 3 o'clock position; angles increase counter-clockwise. If arcAngle is negative, drawing is in a clockwise direction. The arc fills like a pie (to the origin), not from arc endpoint to arc endpoint. This makes creating pie charts easier. If width and height are equal and arcAngle is 360 degrees, fillArc() draws a filled circle. If width or height is negative, nothing is drawn.

Figure 2-8 shows a collection of filled and unfilled arcs that were generated by the following code:

```
g.drawArc (25, 10, 50, 75, 0, 360);
g.fillArc (25, 110, 50, 75, 0, 360);
g.drawArc (100, 10, 50, 75, 45, 215);
g.fillArc (100, 110, 50, 75, 45, 215);
```

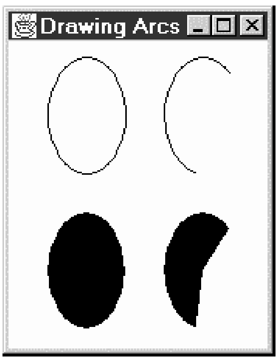


Figure 2–8: Filled and unfilled arcs

public void drawPolygon (Polygon p)

The drawPolygon() method draws a path for the points in polygon p in the current color. Section 2.6 discusses the Polygon class in detail.

The behavior of drawPolygon() changes slightly between Java 1.0.2 and 1.1. With version 1.0.2, if the first and last points of a Polygon are not the same, a call to drawPolygon() results in an open polygon, since the endpoints are not connected for you. Starting with version 1.1, if the first and last points are not the same, the endpoints are connected for you.

public abstract void drawPolygon (int xPoints[], int yPoints[], int numPoints)

The `drawPolygon()` method draws a path of `numPoints` nodes by plucking one element at a time out of `xPoints` and `yPoints` to make each point. The path is drawn in the current color. If either `xPoints` or `yPoints` does not have `numPoints` elements, `drawPolygon()` throws a run-time exception. In 1.0.2, this exception is an `IllegalArgumentException`; in 1.1, it is an `ArrayIndexOutOfBoundsException`. This change shouldn't break older programs, since you are not required to catch run-time exceptions.

public abstract void drawPolyline (int xPoints[], int yPoints[], int numPoints) ★

The `drawPolyline()` method functions like the 1.0 version of `drawPolygon()`. It plays connect the dots with the points in the `xPoints` and `yPoints` arrays and does not connect the endpoints. If either `xPoints` or `yPoints` does not have `numPoints` elements, `drawPolygon()` throws the run-time exception, `ArrayIndexOutOfBoundsException`.

Filling polygons is a complex topic. It is not as easy as filling rectangles or ovals because a polygon may not be closed and its edges may cross. AWT uses an even-odd rule to fill polygons. This algorithm works by counting the number of times each scan line crosses an edge of the polygon. If the total number of crossings to the left of the current point is odd, the point is colored. If it is even, the point is left alone. Figure 2-9 demonstrates this algorithm for a single scan line that intersects the polygon at x values of 25, 75, 125, 175, 225, and 275.

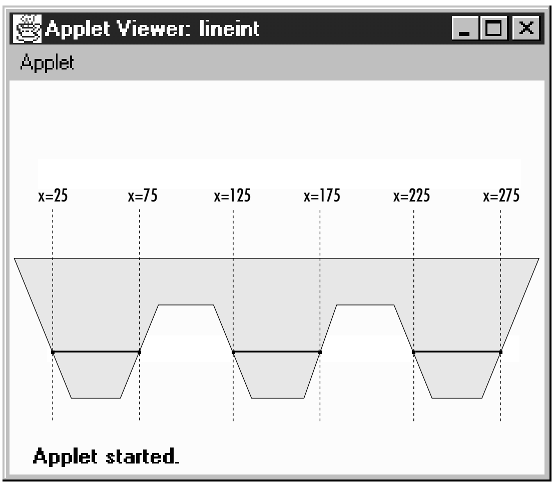


Figure 2–9: Polygon fill algorithm

The scan line starts at the left edge of the screen; at this point there haven't been any crossings, so the pixels are left untouched. The scan line reaches the first crossing when x equals 25. Here, the total number of crossings to the left is one, so the scan line is inside the polygon, and the pixels are colored. At 75, the scan line crosses again; the total number of crossings is two, so coloring stops.

public void fillPolygon (Polygon p)

The `fillPolygon()` method draws a filled polygon for the points in `Polygon p` in the current color. If the polygon is not closed, `fillPolygon()` adds a segment connecting the endpoints. Section 2.6 discusses the `Polygon` class in detail.

public abstract void fillPolygon (int xPoints[], int yPoints[], int nPoints)

The `fillPolygon()` method draws a polygon of `numPoints` nodes by plucking one element at a time out of `xPoints` and `yPoints` to make each point. The polygon is drawn in the current color. If either `xPoints` or `yPoints` does not have `numPoints` elements, `fillPolygon()` throws the run-time exception `IllegalArgumentException`. If the polygon is not closed, `fillPolygon()` adds a segment connecting the endpoints.*

Figure 2-10 shows several polygons created by the following code, containing different versions of `drawPolygon()` and `fillPolygon()`:

```
int[] xPoints[] = {{50, 25, 25, 75, 75},
                   {50, 25, 25, 75, 75},
                   {100, 100, 150, 100, 150, 150, 125, 100, 150},
                   {100, 100, 150, 100, 150, 150, 125, 100, 150}};
int[] yPoints[] = {{10, 35, 85, 85, 35, 10},
                   {110, 135, 185, 185, 135},
                   {85, 35, 35, 85, 85, 35, 10, 35, 85},
                   {185, 135, 135, 185, 185, 135, 110, 135, 185}};
int   nPoints[] = {5, 5, 9, 9};
g.drawPolygon (xPoints[0], yPoints[0], nPoints[0]);
g.fillPolygon (xPoints[1], yPoints[1], nPoints[1]);
g.drawPolygon (new Polygon(xPoints[2], yPoints[2], nPoints[2]));
g.fillPolygon (new Polygon(xPoints[3], yPoints[3], nPoints[3]));
```

Drawing images

An `Image` is a displayable object maintained in memory. To get an image on the screen, you must draw it onto a graphics context, using the `drawImage()` method of the `Graphics` class. For example, within a `paint()` method, you would call `g.drawImage(image, ... , this)` to display some image on the screen. In other situations, you might use the `createImage()` method to generate an offscreen `Graphics` object, then use `drawImage()` to draw an image onto this object, for display later.

* In Java 1.1, this method throws `ArrayIndexOutOfBoundsException`, not `IllegalArgumentException`.

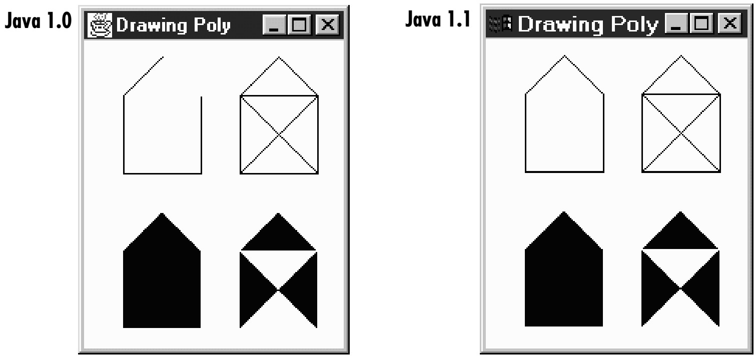


Figure 2–10: Filled and unfilled polygons

This begs the question: where do images come from? We will have more to say about the `Image` class later in this chapter. For now, it's enough to say that you can call `getImage()` to load an image from disk or across the Net. There are versions of `getImage()` in the `Applet` and `Toolkit` classes; the latter is for use in applications. You can also call `createImage()`, a method of the `Component` class, to generate an image in memory.

What about the last argument to `drawImage()`? What is `this` for? The last argument of `drawImage()` is always an image observer—that is, an object that implements the `ImageObserver` interface. This interface is discussed in detail in Chapter 12. For the time being, it's enough to say that the call to `drawImage()` starts a new thread that loads the requested image. An image observer monitors the process of loading an image; the thread that is loading the image notifies the image observer whenever new data has arrived. The `Component` class implements the `ImageObserver` interface; when you're writing a `paint()` method, you're almost certainly overriding some component's `paint()` method; therefore, it's safe to use `this` as the image observer in a call to `drawImage()`. More simply, we could say that any component can serve as an image observer for images that are drawn on it.

public abstract boolean drawImage (Image image, int x, int y, ImageObserver observer)

The `drawImage()` method draws `image` onto the screen with its upper left corner at (`x`, `y`), using `observer` as its `ImageObserver`. Returns `true` if the object is fully drawn, `false` otherwise.

public abstract boolean drawImage (Image image, int x, int y, int width, int height, ImageObserver observer)

The `drawImage()` method draws `image` onto the screen with its upper left corner at (`x`, `y`), using `observer` as its `ImageObserver`. The system scales `image` to fit into a `width` `height` area. The scaling may take time. This method returns `true` if the object is fully drawn, `false` otherwise.

With Java 1.1, you don't need to use drawImage() for scaling; you can prescale the image with the Image.getScaledInstance() method, then use the previous version of drawImage().

public abstract boolean drawImage (Image image, int x, int y, Color backgroundColor, ImageObserver observer)

The drawImage() method draws image onto the screen with its upper left corner at (x, y), using observer as its ImageObserver. backgroundColor is the color of the background seen through the transparent parts of the image. If no part of the image is transparent, you will not see backgroundColor. Returns true if the object is fully drawn, false otherwise.

public abstract boolean drawImage (Image image, int x, int y, int width, int height, Color backgroundColor, ImageObserver observer)

The drawImage() method draws image onto the screen with its upper left corner at (x, y), using observer as its ImageObserver. backgroundColor is the color of the background seen through the transparent parts of the image. The system scales image to fit into a width x height area. The scaling may take time. This method returns true if the image is fully drawn, false otherwise.

With Java 1.1, you can prescale the image with the AreaAveragingScaleFilter or ReplicateScaleFilter described in Chapter 12, then use the previous version of drawImage() to display it.

The following code generated the images in Figure 2-11. The images on the left come from a standard JPEG file. The images on the right come from a file in GIF89a format, in which the white pixel is "transparent." Therefore, the gray background shows through this pair of images.

```
import java.awt.*;
import java.applet.*;
public class drawingImages extends Applet {
    Image i, j;
    public void init () {
        i = getImage (getDocumentBase(), "rosey.jpg");
        j = getImage (getDocumentBase(), "rosey.gif");
    }
    public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this);
        g.drawImage (i, 10, 85, 150, 200, this);
        g.drawImage (j, 270, 10, Color.lightGray, this);
        g.drawImage (j, 270, 85, 150, 200, Color.lightGray, this);
    }
}
```

public abstract boolean drawImage(Image img, int dx1, int dy1, int dx2, int dy2, int sx1, int sy1, int sx2, int sy2, ImageObserver observer) ★

The drawImage() method draws a portion of image onto the screen. It takes the part of the image with corners at (sx1, sy1) and (sx2, sy2); it places this

Figure 2–11: Scaled and unscaled images

rectangular
snippet on the screen with one corner at (`dx1`, `dy1`) and another at (`dx2`, `dy2`), using `observer` as its `ImageObserver`. (Think of `d` for destination location and `s` for source image.) This method returns `true` if the object is fully drawn, `false` otherwise.

`drawImage()` flips the image if source and destination endpoints are not the same corners, crops the image if the destination is smaller than the original size, and scales the image if the destination is larger than the original size. It does not do rotations, only flips (i.e., it can produce a mirror image or an image rotated 180 degrees but not an image rotated 90 or 270 degrees).

public abstract boolean drawImage(Image img, int dx1, int dy1, int dx2, int dy2, int sx1, int sy1, int sx2, int sy2, Color backgroundColor, ImageObserver observer) ★

The `drawImage()` method draws a portion of `image` onto the screen. It takes the part of the image with corners at (`sx1`, `sy1`) and (`sx2`, `sy2`); it places this rectangular snippet on the screen with one corner at (`dx1`, `dy1`) and another at (`dx2`, `dy2`), using `observer` as its `ImageObserver`. (Think of `d` for destination location and `s` for source image.) `backgroundColor` is the color of the background seen through the transparent parts of the image. If no part of the image is transparent, you will not see `backgroundColor`. This method returns `true` if the object is fully drawn, `false` otherwise.

Like the previous version of `drawImage()`, this method flips the image if source and destination endpoints are not the same corners, crops the image if the destination is smaller than the original size, and scales the image if the destination is larger than the original size. It does not do rotations, only flips (i.e., it can produce a mirror image or an image rotated 180 degrees but not an image rotated 90 or 270 degrees).

The following code demonstrates the new `drawImage()` methods in Java 1.1. They allow you to scale, flip, and crop images without the use of image filters. The results are shown in Figure 2-12.

```
// Java 1.1 only
import java.awt.*;
import java.applet.*;
public class drawingImages11 extends Applet {
    Image i, j;
    public void init () {
        i = getImage (getDocumentBase(), "rosey.gif");
    }
    public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this);
        g.drawImage (i, 10, 85,
                     i.getWidth(this)+10, i.getHeight(this)+85,
                     i.getWidth(this), i.getHeight(this), 0, 0, this);
        g.drawImage (i, 270, 10,
                     i.getWidth(this)+270, i.getHeight(this)*2+10, 0, 0,
                     i.getWidth(this), i.getHeight(this), Color.gray, this);
        g.drawImage (i, 10, 170,
                     i.getWidth(this)*2+10, i.getHeight(this)+170, 0,
                     i.getHeight(this)/2, i.getWidth(this)/2, 0, this);
    }
}
```

Miscellaneous methods

public abstract void translate (int x, int y)

The `translate()` method sets how the system translates the coordinate space for you. The point at the (`x`, `y`) coordinates becomes the origin of this graphics context. Any future drawing will be relative to this location. Multiple translations are cumulative. The following code leaves the coordinate system translated by (100, 50).

```
translate (100, 0);
translate (0, 50);
```

Note that each call to `paint()` provides an entirely new `Graphics` context with its origin in the upper left corner. Therefore, don't expect translations to persist from one call to `paint()` to the next.

Figure 2–12: Flipped, mirrored, and cropped images

public abstract void dispose ()

The `dispose()` method frees any system resources used by the `Graphics` context. It's a good idea to call `dispose()` whenever you are finished with a `Graphics` object, rather than waiting for the garbage collector to call it automatically (through `finalize()`). Disposing of the `Graphics` object yourself will help your programs on systems with limited resources. However, you should not dispose the `Graphics` parameter to `Component.paint()` or `Component.update()`.

public void finalize ()

The garbage collector calls `finalize()` when it determines that the `Graphics` object is no longer needed. `finalize()` calls `dispose()`, which frees any resources that the `Graphics` object has used.

public String toString ()

The `toString()` method of `Graphics` returns a string showing the current font and color. However, `Graphics` is an abstract class, and classes that extend `Graphics` usually override `toString()`. For example, on a Windows 95 machine, `sun.awt.win32.Win32Graphics` is the concrete class that extends `Graphics`. The class's `toString()` method displays the current origin of the `Graphics` object, relative to the original coordinate system:

```
sun.awt.win32.Win32Graphics[0,0]
```

2.2 Point

The `Point` class encapsulates x and y coordinates within a single object. It is probably one of the most underused classes within Java. Although there are numerous places within AWT where you would expect to see a `Point`, its appearances are surprisingly rare. Java 1.1 is starting to use `Point` more heavily. The `Point` class is most often used when a method needs to return a pair of coordinates; it lets the method return both x and y as a single object. Unfortunately, `Point` usually is not used when a method requires x and y coordinates as arguments; for example, you would expect the `Graphics` class to have a version of `translate()` that takes a point as an argument, but there isn't one.

The `Point` class does *not* represent a point on the screen. It is not a visual object; there is no `drawPoint()` method.

2.2.1 Point Methods

Variables

The two public variables of `Point` represent a pair of coordinates. They are accessible directly or use the `getLocation()` method. There is no predefined origin for the coordinate space.

public int x

The coordinate that represents the horizontal position.

public int y

The coordinate that represents the vertical position.

Constructors

public Point ()

The first constructor creates an instance of `Point` with an initial x value of 0 and an initial y value of 0.

public Point (int x, int y)

The next constructor creates an instance of `Point` with an initial x value of `x` and an initial y value of `y`.

public Point (Point p)

The last constructor creates an instance of `Point` from another point, the x value of `p.x` and an initial y value of `p.y`.

Locations

public Point getLocation () ★

The `getLocation()` method retrieves the current location of this point as a new `Point`.

public void setLocation (int x, int y) ★
public void move (int x, int y) ☆

The `setLocation()` method changes the point's location to (`x`, `y`).

`move()` is the Java 1.0 name for this method.

public void setLocation (Point p) ★

This `setLocation()` method changes the point's location to (`p.x`, `p.y`).

public void translate (int x, int y)

The `translate()` method moves the point's location by adding the parameters (`x`, `y`) to the corresponding fields of the `Point`. If the original `Point p` is (3, 4) and you call `p.translate(4, -5)`, the new value of `p` is (7, -1).

Miscellaneous methods

public int hashCode ()

The `hashCode()` method returns a hash code for the point. The system calls this method when a `Point` is used as the key for a hash table.

public boolean equals (Object object)

The `equals()` method overrides the `Object.equals()` method to define equality for points. Two `Point` objects are equal if their x and y values are equal.

public String toString ()

The `toString()` method of `Point` displays the current values of the x and y variables. For example:

```
java.awt.Point[x=100,y=200]
```

2.3 Dimension

The `Dimension` class is similar to the `Point` class, except it encapsulates a width and height in a single object. Like `Point`, `Dimension` is somewhat underused; it is used primarily by methods that need to return a width and a height as a single object; for example, `getSize()` returns a `Dimension` object.

2.3.1 Dimension Methods

Variables

A `Dimension` instance has two variables, one for width and one for height. They are accessible directly or through use of the `getSize()` method.

public int width

The width variable represents the size of an object along the x axis (left to right). Width should not be negative; however, there is nothing within the class to prevent this from happening.

public int height

The height variable represents the size of an object along the y axis (top to bottom). Height should not be negative; however, there is nothing within the class to prevent this from happening.

Constructors

public Dimension ()

This constructor creates a `Dimension` instance with a width and height of 0.

public Dimension (Dimension dim)

This constructor creates a copy of `dim`. The initial width is `dim.width`. The initial height is `dim.height`.

public Dimension (int width, int height)

This constructor creates a `Dimension` with an initial width of `width` and an initial height of `height`.

Sizing

public Dimension getSize () ★

The `getSize()` method retrieves the current size as a new `Dimension`, even though the instance variables are public.

public void setSize (int width, int height) ★

The `setSize()` method changes the dimension's size to `width height`.

public void setSize (Dimension d) ★

The `setSize()` method changes the dimension's size to `d.width d.height`.

Miscellaneous methods

public boolean equals (Object object)

The `equals()` method overrides the `Object.equals()` method to define equality for dimensions. Two `Dimension` objects are equal if their width and height values are equal.

public String toString ()

The `toString()` method of `Dimension` returns a string showing the current width and height settings. For example:

```
java.awt.Dimension[width=0,height=0]
```

2.4 Shape

The new `Shape` interface defines a single method; it requires a geometric object to be able to report its bounding box. Currently, the `Rectangle` and `Polygon` classes implement `Shape`; one would expect other geometric classes to implement `Shape` in the future. Although `Component` has the single method defined by the `Shape` interface, it does not implement the interface.

2.4.1 Shape Method

public abstract Rectangle getBounds() ★

The `getBounds()` method returns the shape's bounding `Rectangle`. Once you have the bounding area, you can use methods like `Graphics.copyArea()` to copy the shape.

2.5 Rectangle

The `Rectangle` class encapsulates x and y coordinates and width and height (`Point` and `Dimension` information) within a single object. It is often used by methods that return a rectangular boundary as a single object: for example, `Polygon.getBounds()`, `Component.getBounds()`, and `Graphics.getClipBounds()`. Like `Point`, the `Rectangle` class is not a visual object and does not represent a rectangle on the screen; ironically, `drawRect()` and `fillRect()` don't take `Rectangle` as an argument.

2.5.1 Rectangle Methods

Variables

The four public variables available for `Rectangle` have the same names as the public instance variables of `Point` and `Dimension`. They are all accessible directly or through use of the `getBounds()` method.

public int x

The x coordinate of the upper left corner.

public int y

The y coordinate of the upper left corner.

public int width

The width variable represents the size of the `Rectangle` along the horizontal axis (left to right). Width should not be negative; however, there is nothing within the class to prevent this from happening.

public int height

The height variable represents the size of the `Rectangle` along the vertical axis (top to bottom). Height should not be negative; however, there is nothing within the class to prevent this from happening.

Constructors

The following seven constructors create `Rectangle` objects. When you create a `Rectangle`, you provide the location of the top left corner, along with the `Rectangle`'s width and height. A `Rectangle` located at (0,0) with a width and height of 100 has its bottom right corner at (99, 99). The `Point` (100, 100) lies outside the `Rectangle`, since that would require a width and height of 101.

public Rectangle ()

This `Rectangle` constructor creates a `Rectangle` object in which `x`, y, width, and height are all 0.

public Rectangle (int width, int height)

This `Rectangle` constructor creates a `Rectangle` with (`x`, `y`) coordinates of (0,0) and the specified `width` and `height`. Notice that there is no `Rectangle(int x, int y)` constructor because that would have the same method signature as this one, and the compiler would have no means to differentiate them.

public Rectangle (int x, int y, int width, int height)

The `Rectangle` constructor creates a `Rectangle` object with an initial x coordinate of `x`, y coordinate of `y`, width of `width`, and height of `height`. Height and width should be positive, but the constructor does not check for this.

public Rectangle (Rectangle r)

This `Rectangle` constructor creates a `Rectangle` matching the original. The (`x`, `y`) coordinates are (`r.x`, `r.y`), with a width of `r.width` and a height of `r.height`.

public Rectangle (Point p, Dimension d)

This `Rectangle` constructor creates a `Rectangle` with (`x`, `y`) coordinates of (`p.x`, `p.y`), a width of `d.width`, and a height of `d.height`.

public Rectangle (Point p)

This `Rectangle` constructor creates a `Rectangle` with (`x`, `y`) coordinates of (`p.x`, `p.y`). The width and height are both zero.

public Rectangle (Dimension d)

The last `Rectangle` constructor creates a `Rectangle` with (`x`, `y`) coordinates of (0, 0). The initial `Rectangle` width is `d.width` and height is `d.height`.

Shaping and sizing

public Rectangle getBounds() ★

The `getBounds()` method returns a copy of the original `Rectangle`.

public void setBounds (int x, int y, int width, int height) ★
public void reshape (int x, int y, int width, int height) ☆

The `setBounds()` method changes the origin of the `Rectangle` to (`x`, `y`) and changes the dimensions to `width` by `height`.

`reshape()` is the Java 1.0 name for this method.

public void setBounds (Rectangle r) ★

The `setBounds()` method changes the origin of the `Rectangle` to (`r.x`, `r.y`) and changes the dimensions to `r.width` by `r.height`.

public Point getLocation() ★

The `getLocation()` retrieves the current origin of this rectangle as a `Point`.

public void setLocation (int x, int y) ★
public void move (int x, int y) ☆

The `setLocation()` method changes the origin of the `Rectangle` to (`x`, `y`).

`move()` is the Java 1.0 name for this method.

public void setLocation (Point p) ★

The `setLocation()` method changes the `Rectangle`'s origin to (`p.x`, `p.y`).

public void translate (int x, int y)

The `translate()` method moves the `Rectangle`'s origin by the amount (`x`, `y`). If the original `Rectangle`'s location (r) is (3, 4) and you call `r.translate (4, 5)`, then r's location becomes (7, 9). x and y may be negative. `translate()` has no effect on the `Rectangle`'s width and height.

public Dimension getSize () ★

The `getSize()` method retrieves the current size of the rectangle as a `Dimension`.

public void setSize() (int width, int height) ★
public void resize (int width, int height) ☆

The `setSize()` method changes the `Rectangle`'s dimensions to `width` x `height`.

`resize()` is the Java 1.0 name for this method.

public void setSize() (Dimension d) ★

The `setSize()` method changes the `Rectangle`'s dimensions to `d.width` x `d.height`.

public void grow (int horizontal, int vertical)

The `grow()` method increases the `Rectangle`'s dimensions by adding the amount `horizontal` on the left and the right and adding the amount `vertical` on the top and bottom. Therefore, all four of the rectangle's variables change. If the original location is (`x`, `y`), the new location will be (`x-horizontal`, `y-vertical`) (moving left and up if both values are positive); if the original size is (`width, height`), the new size will be (`width+2*horizontal, height+2*vertical`). Either horizontal or vertical can be negative to decrease the size of the `Rectangle`. The following code demonstrates the changes:

```
import java.awt.Rectangle;
public class rect {
    public static void main (String[] args) {
        Rectangle r = new Rectangle (100, 100, 200, 200);
        System.out.println (r);
        r.grow (50, 75);
        System.out.println (r);
        r.grow (-25, -50);
        System.out.println (r);
    }
}
```

This program produces the following output:

```
java.awt.Rectangle[x=100,y=100,width=200,height=200]
java.awt.Rectangle[x=50,y=25,width=300,height=350]
java.awt.Rectangle[x=75,y=75,width=250,height=250]
```

public void add (int newX, int newY)

The `add()` method incorporates the point (`newX`, `newY`) into the `Rectangle`. If this point is already in the `Rectangle`, there is no change. Otherwise, the size of the `Rectangle` increases to include (`newX`, `newY`) within itself.

public void add (Point p)

This `add()` method incorporates the point (`p.x`, `p.y`) into the `Rectangle`. If this point is already in the `Rectangle`, there is no change. Otherwise, the size of the `Rectangle` increases to include (`p.x`, `p.y`) within itself.

public void add (Rectangle r)

This `add()` method incorporates another `Rectangle r` into this `Rectangle`. This transforms the current rectangle into the union of the two `Rectangles`. This method might be useful in a drawing program that lets you select multiple objects on the screen and create a rectangular area from them.

We will soon encounter a method called `union()` that is almost identical. `add()` and `union()` differ in that `add()` modifies the current `Rectangle`, while `union()` returns a new `Rectangle`. The resulting rectangles are identical.

Intersections

public boolean contains (int x, int y) ★
public boolean inside (int x, int y) ☆

The `contains()` method determines if the point (`x`, `y`) is within this `Rectangle`. If so, `true` is returned. If not, `false` is returned.

`inside()` is the Java 1.0 name for this method.

public boolean contains (Point p) ★

The `contains()` method determines if the point (`p.x`, `p.y`) is within this `Rectangle`. If so, `true` is returned. If not, `false` is returned.

public boolean intersects (Rectangle r)

The `intersects()` method checks whether `Rectangle r` crosses this `Rectangle` at any point. If it does, `true` is returned. If not, `false` is returned.

public Rectangle intersection (Rectangle r)

The `intersection()` method returns a new `Rectangle` consisting of all points that are in both the current `Rectangle` and `Rectangle r`. For example, if `r = new Rectangle (50, 50, 100, 100)` and `r1 = new Rectangle (100, 100, 75, 75)`, then `r.intersection (r1)` is the `Rectangle (100, 100, 50, 50)`, as shown in Figure 2-13.

public Rectangle union (Rectangle r)

The `union()` method combines the current `Rectangle` and `Rectangle r` to form a new `Rectangle`. For example, if `r = new Rectangle (50, 50, 100, 100)` and `r1 = new Rectangle (100, 100, 75, 75)`, then `r.union (r1)` is the `Rectangle (50, 50, 125, 125)`. The original rectangle is unchanged. Figure 2-14 demonstrates the effect of `union()`. Because `fillRect()` fills to `width-1` and `height-1`, the rectangle drawn appears slightly smaller than you would expect. However, that's an artifact of how rectangles are drawn; the returned rectangle contains all the points within both.

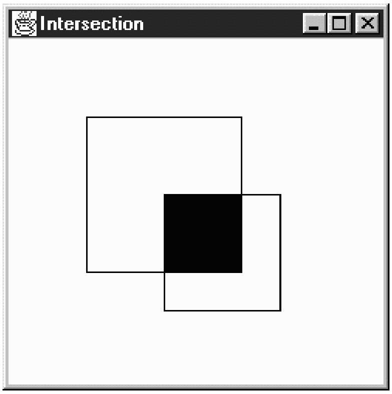


Figure 2–13: Rectangle intersection

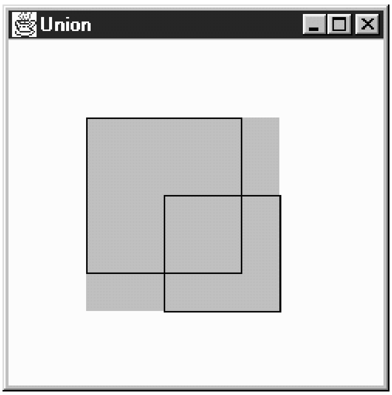


Figure 2–14: Rectangle union

Miscellaneous methods

public boolean isEmpty ()

The `isEmpty()` method checks whether there are any points within the `Rectangle`. If the width and height of the `Rectangle` are both 0 (or less), the `Rectangle` is empty, and this method returns `true`. If either width or height is greater than zero, `isEmpty()` returns `false`. This method could be used to check the results of a call to any method that returns a `Rectangle` object.

public int hashCode ()

The `hashCode()` method returns a hash code for the rectangle. The system calls this method when a `Rectangle` is used as the key for a hash table.

public boolean equals (Object object)

The `equals()` method overrides the `Object`'s `equals()` method to define what equality means for `Rectangle` objects. Two `Rectangle` objects are equal if their `x`, `y`, width, and height values are equal.

public String toString ()

The `toString()` method of `Rectangle` displays the current values of the `x`, `y`, width, and height variables. For example:

```
java.awt.Rectangle[x=100,y=200,width=300,height=400]
```

2.6 Polygon

A `Polygon` is a collection of points used to create a series of line segments. Its primary purpose is to draw arbitrary shapes like triangles or pentagons. If the points are sufficiently close, you can create a curve. To display the `Polygon`, call `drawPolygon()` or `fillPolygon()`.

2.6.1 Polygon Methods

Variables

The collection of points maintained by `Polygon` are stored in three variables:

public int npoints

The `npoints` variable stores the number of points.

public int xpoints[]

The `xpoints` array holds the x component of each point.

public int ypoints[]

The `ypoints` array holds the y component of each point.

You might expect the `Polygon` class to use an array of points, rather than separate arrays of integers. More important, you might expect the instance variables to be private or protected, which would prevent them from being modified directly. Since the three instance variables are public, there is no guarantee that the array sizes are in sync with each other or with `npoints`. To avoid trouble, always use `addPoints()` to modify your polygons, and avoid modifying the instance variables directly.

Constructors

public Polygon ()

This constructor creates an empty `Polygon`.

public Polygon (int xPoints[], int yPoints[], int numPoints)

This constructor creates a `Polygon` that consists of `numPoints` points. Those points are formed from the first `numPoints` elements of the `xPoints` and `yPoints` arrays. If the `xPoints` or `yPoints` arrays are larger than `numPoints`, the additional entries are ignored. If the `xPoints` or `yPoints` arrays do not contain at least `numPoints` elements, the constructor throws the run-time exception `ArrayIndexOutOfBoundsException`.

Miscellaneous methods

public void addPoint (int x, int y)

The `addPoint()` method adds the point (`x`, `y`) to the `Polygon` as its last point. If you alter the `xpoints`, `ypoints`, and `npoints` instance variables directly, `addPoint()` could add the new point at a place other than the end, or it could throw the run-time exception `ArrayIndexOutOfBoundsException` with a message showing the position at which it tried to add the point. Again, for safety, don't modify a `Polygon`'s instance variables yourself; always use `addPoint()`.

public Rectangle getBounds () ★
public Rectangle getBoundingBox () ☆

The `getBounds()` method returns the `Polygon`'s bounding `Rectangle` (i.e., the smallest rectangle that contains all the points within the polygon). Once you have the bounding box, it's easy to use methods like `copyArea()` to copy the `Polygon`.

`getBoundingBox()` is the Java 1.0 name for this method.

public boolean contains (int x, int y) ★
public boolean inside (int x, int y) ☆

The `contains()` method checks to see if the (`x`, `y`) point is within an area that would be filled if the `Polygon` was drawn with `Graphics.fillPolygon()`. A point may be within the bounding rectangle of the polygon, but `contains()` can still return `false` if not within a closed part of the polygon.

`inside()` is the Java 1.0 name for this method.

public boolean contains (Point p) ★

The `contains()` method checks to see if the point `p` is within an area that would be filled if the `Polygon` were drawn with `Graphics.fillPolygon()`.

public void translate (int x, int y) ★

The `translate()` method moves all the `Polygon`'s points by the amount (`x`, `y`). This allows you to alter the location of the `Polygon` by shifting the points.

2.7 Image

An `Image` is a displayable object maintained in memory. AWT has built-in support for reading files in GIF and JPEG format, including GIF89a animation. Netscape Navigator, Internet Explorer, HotJava, and Sun's JDK also understand the XBM image format. Images are loaded from the filesystem or network by the `getImage()` method of either `Component` or `Toolkit`, drawn onto the screen with `drawImage()` from `Graphics`, and manipulated by several objects within the `java.awt.image` package. Figure 2-15 shows an `Image`.

Figure 2–15: An Image

`Image` is an abstract class implemented by many different platform-specific classes. The system that runs your program will provide an appropriate implementation; you do not need to know anything about the platform-specific classes, because the `Image` class completely defines the API for working with images. If you're curious, the platform-specific packages used by the JDK are:

- `sun.awt.win32.Win32Image` on Java 1.0 Windows NT/95 platforms
- `sun.awt.windows.WImage` on Java 1.1 Windows NT/95 platforms
- `sun.awt.motif.X11Image` on UNIX/Motif platforms
- `sun.awt.macos.MacImage` on the Macintosh

This section covers only the `Image` object itself. AWT also includes a package named `java.awt.image` that includes more advanced image processing utilities. The classes in `java.awt.image` are covered in Chapter 12.

2.7.1 Image Methods

Constants

public static final Object UndefinedProperty

In Java 1.0, the sole constant of Image is UndefinedProperty. It is used as a return value from the getProperty() method to indicate that the requested property is unavailable.

Java 1.1 introduces the getScaledInstance() method. The final parameter to the method is a set of hints to tell the method how best to scale the image. The following constants provide possible values for this parameter.

public static final int SCALE_DEFAULT ★

The SCALE_DEFAULT hint should be used alone to tell getScaledInstance() to use the default scaling algorithm.

public static final int SCALE_FAST ★

The SCALE_FAST hint tells getScaledInstance() that speed takes priority over smoothness.

public static final int SCALE_SMOOTH ★

The SCALE_SMOOTH hint tells getScaledInstance() that smoothness takes priority over speed.

public static final int SCALE_REPLICATE ★

The SCALE_REPLICATE hint tells getScaledInstance() to use ReplicateScaleFilter or a reasonable alternative provided by the toolkit. ReplicateScaleFilter is discussed in Chapter 12.

public static final int SCALE_AREA_AVERAGING ★

The SCALE_AREA_AVERAGING hint tells getScaledInstance() to use AreaAveragingScaleFilter or a reasonable alternative provided by the toolkit. AreaAveragingScaleFilter is discussed in Chapter 12.

Constructors

There are no constructors for Image. You get an Image object to work with by using the getImage() method of Applet (in an applet), Toolkit (in an application), or the createImage() method of Component or Toolkit. getImage() uses a separate thread to fetch the image. The thread starts when you call drawImage(), prepareImage(), or any other method that requires image information. getImage() returns immediately. You can also use the MediaTracker class to force an image to load before it is needed. MediaTracker is discussed in the next section.

Characteristics

public abstract int getWidth (ImageObserver observer)

The `getWidth()` method returns the width of the image object. The width may not be available if the image has not started loading; in this case, `getWidth()` returns –1. An image's size is available long before loading is complete, so it is often useful to call `getWidth()` while the image is loading.

public abstract int getHeight (ImageObserver observer)

The `getHeight()` method returns the height of the image object. The height may not be available if the image has not started loading; in this case, the `getHeight()` method returns –1. An image's size is available long before loading is complete, so it is often useful to call `getHeight()` while the image is loading.

Miscellaneous methods

public Image getScaledInstance (int width, int height, int hints) ★

The `getScaledInstance()` method enables you to generate scaled versions of images before they are needed. Prior to Java 1.1, it was necessary to tell the `drawImage()` method to do the scaling. However, this meant that scaling didn't take place until you actually tried to draw the image. Since scaling takes time, drawing the image required more time; the net result was degraded appearance. With Java 1.1, you can generate scaled copies of images before drawing them; then you can use a version of `drawImage()` that does not do scaling, and therefore is much quicker.

The `width` parameter of `getScaledInstance()` is the new width of the image. The `height` parameter is the new height of the image. If either is –1, the scaling retains the aspect ratio of the original image. For instance, if the original image size was 241 by 72 pixels, and `width` and `height` were 100 and –1, the new image size would be 100 by 29 pixels. If both width and height are –1, the `getScaledInstance()` method retains the image's original size. The `hints` parameter is one of the `Image` class constants.

```
Image i = getImage (getDocumentBase(), "rosey.jpg");
Image j = i.getScaledInstance (100, -1, Image.SCALE_FAST);
```

public abstract ImageProducer getSource ()

The `getSource()` method returns the image's producer, which is an object of type `ImageProducer`. This object represents the image's source. Once you have the `ImageProducer`, you can use it to do additional image processing; for example, you could create a modified version of the original image by using a `FilteredImageSource`. Image producers and image filters are covered in Chapter 12.

public abstract Graphics getGraphics ()

The `getGraphics()` method returns the image's graphics context. The method `getGraphics()` works only for `Image` objects created in memory with `Component.createImage (int, int)`. If the image came from a URL or a file (i.e., from `getImage()`), `getGraphics()` throws the run-time exception `ClassCastException`.

public abstract Object getProperty (String name, ImageObserver observer)

The `getProperty()` method interacts with the image's property list. An object representing the requested property `name` will be returned for `observer`. `observer` represents the `Component` on which the image is rendered. If the property `name` exists but is not available yet, `getProperty()` returns `null`. If the property name does not exist, the `getProperty()` method returns the `Image.UndefinedProperty` object.

Each image type has its own property list. A property named `comment` stores a comment `String` from the image's creator. The `CropImageFilter` adds a property named `croprect`. If you ask `getProperty()` for an image's `croprect` property, you get a `Rectangle` that shows how the original image was cropped.

public abstract void flush()

The `flush()` method resets an image to its initial state. Assume you acquire an image over the network with `getImage()`. The first time you display the image, it will be loaded over the network. If you redisplay the image, AWT normally reuses the original image. However, if you call `flush()` before redisplaying the image, AWT fetches the image again from its source. (Images created with `createImage()` aren't affected.) The `flush()` method is useful if you expect images to change while your program is running. The following program demonstrates `flush()`. It reloads and displays the file *flush.gif* every time you click the mouse. If you change the file *flush.gif* and click on the mouse, you will see the new file.

```
import java.awt.*;
public class flushMe extends Frame {
    Image im;
    flushMe () {
        super ("Flushing");
        im = Toolkit.getDefaultToolkit().getImage ("flush.gif");
        resize (175, 225);
    }
    public void paint (Graphics g) {
        g.drawImage (im, 0, 0, 175, 225, this);
    }
    public boolean mouseDown (Event e, int x, int y) {
        im.flush();
        repaint();
        return true;
    }
```

```
        public static void main (String [] args) {
            Frame f = new flushMe ();
            f.show();
        }
    }
```

2.7.2 Simple Animation

Creating simple animation sequences in Java is easy. Load a series of images, then display the images one at a time. Example 2-1 is an application that displays a simple animation sequence. Example 2-2 is an applet that uses a thread to run the application. These programs are far from ideal. If you try them, you'll probably notice some flickering or missing images. We discuss how to fix these problems shortly.

Example 2–1: Animation Application

```
import java.awt.*;
public class Animate extends Frame {
    static Image im[];
    static int numImages = 12;
    static int counter=0;
    Animate () {
        super ("Animate");
    }
    public static void main (String[] args) {
        Frame f = new Animate();
        f.resize (225, 225);
        f.show();
        im = new Image[numImages];
        for (int i=0;i<numImages;i++) {
            im[i] = Toolkit.getDefaultToolkit().getImage ("clock"+i+".jpg");
        }
    }
    public synchronized void paint (Graphics g) {
        g.translate (insets().left, insets().top);
        g.drawImage (im[counter], 0, 0, this);
        counter++;
        if (counter == numImages)
            counter = 0;
        repaint (200);
    }
}
```

This application displays images with the name *clock*n*.jpg*, where *n* is a number between 0 and 11. It fetches the images using the `getImage()` method of the `Toolkit` class—hence, the call to `Toolkit.getDefaultToolkit()`, which gets a `Toolkit` object to work with. The `paint()` method displays the images in sequence, using `drawImage()`. `paint()` ends with a call to `repaint(200)`, which schedules another call to `paint()` in 200 milliseconds.

The AnimateApplet, whose code is shown in Example 2-2, does more or less the same thing. It is able to use the Applet.getImage() method. A more significant difference is that the applet creates a new thread to control the animation. This thread calls sleep(200), followed by repaint(), to display a new image every 200 milliseconds.

Example 2–2: Multithreaded Animation Applet

```
import java.awt.*;
import java.applet.*;
public class AnimateApplet extends Applet implements Runnable {
    static Image im[];
    static int numImages = 12;
    static int counter=0;
    Thread animator;
    public void init () {
        im = new Image[numImages];
        for (int i=0;i<numImages;i++)
            im[i] = getImage (getDocumentBase(), "clock"+i+".jpg");
    }
    public void start() {
        if (animator == null) {
            animator = new Thread (this);
            animator.start ();
        }
    }
    public void stop() {
        if ((animator != null) && (animator.isAlive())) {
            animator.stop();
            animator = null;
        }
    }
    public void run () {
        while (animator != null) {
            try {
                animator.sleep(200);
                repaint ();
                counter++;
                if (counter==numImages)
                    counter=0;
            } catch (Exception e) {
                e.printStackTrace ();
            }
        }
    }
    public void paint (Graphics g) {
        g.drawImage (im[counter], 0, 0, this);
    }
}
```

One quick fix will help the flicker problem in both of these examples. The update() method (which is inherited from the Component class) normally clears the drawing area and calls paint(). In our examples, clearing the drawing area is unnecessary and, worse, results in endless flickering; on slow machines, you'll see update() restore the background color between each image. It's a simple matter to override update() so that it doesn't clear the drawing area first. Add the following method to both of the previous examples:

```
public void update (Graphics g) {
    paint (g);
}
```

Overriding update() helps, but the real solution to our problem is double buffering, which we'll turn to next.

2.7.3 Double Buffering

Double buffering means drawing to an offscreen graphics context and then displaying this graphics context to the screen in a single operation. So far, we have done all our drawing directly on the screen—that is, to the graphics context provided by the paint() method. As your programs grow more complex, paint() gets bigger and bigger, and it takes more time and resources to update the entire drawing area. On a slow machine, the user will see the individual drawing operations take place, which will make your program look slow and clunky. By using the double buffering technique, you can take your time drawing to another graphics context that isn't displayed. When you are ready, you tell the system to display the completely new image at once. Doing so eliminates the possibility of seeing partial screen updates and flickering.

The first thing you need to do is create an image as your drawing canvas. To get an image object, call the createImage() method. createImage() is a method of the Component class, which we will discuss in Chapter 5, *Components*. Since Applet extends Component, you can call createImage() within an applet. When creating an application and extending Frame, createImage() returns null until the Frame's peer exists. To make sure that the peer exists, call addNotify() in the constructor, or make sure you call show() before calling createImage(). Here's the call to the createImage() method that we'll use to get an Image object:

```
Image im = createImage (300, 300); // width and height
```

Once you have an Image object, you have an area you can draw on. But how do you draw on it? There are no drawing methods associated with Image; they're all in the Graphics class. So we need to get a Graphics context from the Image. To do so, call the getGraphics() method of the Image class, and use that Graphics context for your drawing:

```
Graphics buf = im.getGraphics();
```

Now you can do all your drawings with `buf`. To display the drawing, the `paint()` method only needs to call `drawImage(im, . . .)`. Note the hidden connection between the `Graphics` object, `buf`, and the `Image` you are creating, `im`. You draw onto `buf`; then you use `drawImage()` to render the image on the on-screen `Graphics` context within `paint()`.

Another feature of buffering is that you do not have redraw the entire image with each call to `paint()`. The buffered image you're working on remains in memory, and you can add to it at will. If you are drawing directly to the screen, you would have to recreate the entire drawing each time `paint()` is called; remember, `paint()` always hands you a completely new `Graphics` object. Figure 2-16 shows how double buffering works.

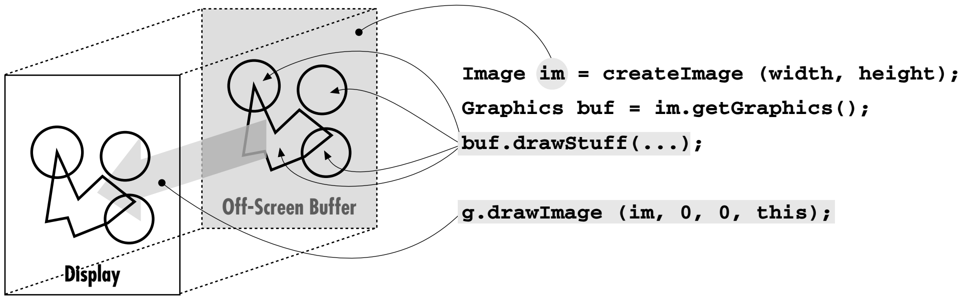


Figure 2–16: Double buffering

Example 2-3 puts it all together for you. It plays a game, with one move drawn to the screen each cycle. We still do the drawing within `paint()`, but we draw into an offscreen buffer; that buffer is copied onto the screen by `g.drawImage(im, 0, 0, this)`. If we were doing a lot of drawing, it would be a good idea to move the drawing operations into a different thread, but that would be overkill for this simple applet.

Example 2–3: Double Buffering—Who Won?

```
import java.awt.*;
import java.applet.*;
public class buffering extends Applet {
    Image im;
    Graphics buf;
    int pass=0;
    public void init () {
        // Create buffer
        im = createImage (size().width, size().height);
        // Get its graphics context
        buf = im.getGraphics();
        // Draw Board Once
```

Example 2–3: Double Buffering—Who Won? (continued)

```
            buf.setColor (Color.red);
            buf.drawLine (  0,  50, 150,  50);
            buf.drawLine (  0, 100, 150, 100);
            buf.drawLine ( 50,   0,  50, 150);
            buf.drawLine (100,   0, 100, 150);
            buf.setColor (Color.black);
        }
        public void paint (Graphics g) {
            // Draw image - changes are written onto buf
            g.drawImage (im, 0, 0, this);
            // Make a move
            switch (pass) {
                case 0:
                    buf.drawLine (50, 50, 100, 100);
                    buf.drawLine (50, 100, 100, 50);
                    break;
                case 1:
                    buf.drawOval (0, 0, 50, 50);
                    break;
                case 2:
                    buf.drawLine (100, 0, 150, 50);
                    buf.drawLine (150, 0, 100, 50);
                    break;
                case 3:
                    buf.drawOval (0, 100, 50, 50);
                    break;
                case 4:
                    buf.drawLine (0, 50, 50, 100);
                    buf.drawLine (0, 100, 50, 50);
                    break;
                case 5:
                    buf.drawOval (100, 50, 50, 50);
                    break;
                case 6:
                    buf.drawLine (50,  0, 100, 50);
                    buf.drawLine (50, 50, 100,  0);
                    break;
                case 7:
                    buf.drawOval (50, 100, 50, 50);
                    break;
                case 8:
                    buf.drawLine (100, 100, 150, 150);
                    buf.drawLine (150, 100, 100, 150);
                    break;
            }
            pass++;
            if (pass <= 9)
                repaint (500);
        }
    }
```

2.8 MediaTracker

The `MediaTracker` class assists in the loading of multimedia objects across the network. Tracking is necessary because Java loads images in separate threads. Calls to `getImage()` return immediately; image loading starts only when you call the method `drawImage()`. `MediaTracker` lets you force images to start loading before you try to display them; it also gives you information about the loading process, so you can wait until an image is fully loaded before displaying it.

Currently, `MediaTracker` can monitor the loading of images, but not audio, movies, or anything else. Future versions are rumored to be able to monitor other media types.

2.8.1 MediaTracker Methods

Constants

The `MediaTracker` class defines four constants that are used as return values from the class's methods. These values serve as status indicators.

public static final int LOADING

The `LOADING` variable indicates that the particular image being checked is still loading.

public static final int ABORTED

The `ABORTED` variable indicates that the loading process for the image being checked aborted. For example, a timeout could have happened during the download. If something `ABORTED` during loading, it is possible to `flush()` the image to force a retry.

public static final int ERRORED

The `ERRORED` variable indicates that an error occurred during the loading process for the image being checked. For instance, the image file might not be available from the server (invalid URL) or the file format could be invalid. If an image has `ERRORED`, retrying it will fail.

public static final int COMPLETE

The `COMPLETE` flag means that the image being checked successfully loaded.

If `COMPLETE`, `ABORTED`, or `ERRORED` is set, the image has stopped loading. If you are checking multiple images, you can OR several of these values together to form a composite. For example, if you are loading several images and want to find out about any malfunctions, call `statusAll()` and check for a return value of `ABORTED | ERRORED`.

Constructors

public MediaTracker (Component component)

The `MediaTracker` constructor creates a new `MediaTracker` object to track images to be rendered onto `component`.

Adding images

The `addImage()` methods add objects for the `MediaTracker` to track. When placing an object under a `MediaTracker`'s control, you must provide an identifier for grouping purposes. When multiple images are grouped together, you can perform operations on the entire group with a single request. For example, you might want to wait until all the images in an animation sequence are loaded before starting the animation; in this case, assigning the same ID to all the images makes good sense. However, when multiple images are grouped together, you cannot check on the status of a single image. The moral is: if you care about the status of individual images, put each into a group by itself.

Folklore has it that the identifier also serves as a loading priority, with a lower ID meaning a higher priority. This is not completely true. Current implementations start loading lower IDs first, but at most, this is implementation-specific functionality for the JDK. Furthermore, although an object with a lower identifier might be told to start loading first, the `MediaTracker` does nothing to ensure that it finishes first.

public synchronized void addImage (Image image, int id, int width, int height)

The `addImage()` method tells the `MediaTracker` instance that it needs to track the loading of `image`. The `id` is used as a grouping. Someone will eventually render the `image` at a scaled size of `width` `height`. If `width` and `height` are both –1, the image will be rendered unscaled. If you forget to notify the `MediaTracker` that the `image` will be scaled and ask the `MediaTracker` to `waitForID (id)`, it is possible that the image may not be fully ready when you try to draw it.

public void addImage (Image image, int id)

The `addImage()` method tells the `MediaTracker` instance that it needs to track the loading of `image`. The `id` is used as a grouping. The `image` will be rendered at its actual size, without scaling.

Removing images

Images that have finished loading are still watched by the `MediaTracker`. The `removeImage()` methods, added in Java 1.1, allow you to remove objects from the `MediaTracker`. Once you no longer care about an image (usually after waiting for it to load), you can remove it from the tracker. Getting rid of loaded images results in better performance because the tracker has fewer objects to check. In Java 1.0, you can't remove an image from `MediaTracker`.

public void removeImage (Image image) ★

The `removeImage()` method tells the `MediaTracker` to remove all instances of `image` from its tracking list.

public void removeImage (Image image, int id) ★

The `removeImage()` method tells the `MediaTracker` to remove all instances of `image` from group `id` of its tracking list.

public void removeImage (Image image, int id, int width, int height) ★

This `removeImage()` method tells the `MediaTracker` to remove all instances of `image` from group `id` and scale `width height` of its tracking list.

Waiting

A handful of methods let you wait for a particular image, image group, all images, or a particular time period. They enable you to be sure that an image has finished trying to load prior to continuing. The fact that an image has finished loading does not imply it has successfully loaded. It is possible that an error condition arose, which caused loading to stop. You should check the status of the image (or group) for actual success.

public void waitForID (int id) throws InterruptedException

The `waitForID()` method blocks the current thread from running until the images added with `id` finish loading. If the wait is interrupted, `waitForID()` throws an `InterruptedException`.

public synchronized boolean waitForID (int id, long ms) throws InterruptedException

The `waitForID()` method blocks the current thread from running until the images added with `id` finish loading or until `ms` milliseconds have passed. If all the images have loaded, `waitForID()` returns `true`; if the timer has expired, it returns `false`, and one or more images in the `id` set have not finished loading. If `ms` is 0, it waits until all images added with `id` have loaded, with no timeout. If the wait is interrupted, `waitForID()` throws an `InterruptedException`.

public void waitForAll () throws InterruptedException

The `waitForAll()` method blocks the current thread from running until all images controlled by this `MediaTracker` finish loading. If the wait is interrupted, `waitForAll()` throws an `InterruptedException`.

public synchronized boolean waitForAll (long ms) throws InterruptedException

The `waitForAll()` method blocks the current thread from running until all images controlled by this `MediaTracker` finish loading or until `ms` milliseconds have passed. If all the images have loaded, `waitForAll()` returns `true`; if the timer has expired, it returns `false`, and one or more images have not finished loading. If `ms` is 0, it waits until all images have loaded, with no timeout. When you interrupt the waiting, `waitForAll()` throws an `InterruptedException`.

Checking status

Several methods are available to check on the status of images loading. None of these methods block, so you can continue working while images are loading.

public boolean checkID (int id)

The `checkID()` method determines if all the images added with the `id` tag have finished loading. The method returns `true` if all images have completed loading (successfully or unsuccessfully). Since this can return `true` on error, you should also use `isErrorID()` to check for errors. If loading has not completed, `checkID()` returns `false`. This method does not force images to start loading.

public synchronized boolean checkID (int id, boolean load)

The `checkID()` method determines if all the images added with the `id` tag have finished loading. If the `load` flag is `true`, any images in the `id` group that have not started loading yet will start. The method returns `true` if all images have completed loading (successfully or unsuccessfully). Since this can return `true` on error, you should also use `isErrorID()` to check for errors. If loading has not completed, `checkID()` returns `false`.

public boolean checkAll ()

The `checkAll()` method determines if all images associated with the `MediaTracker` have finished loading. The method returns `true` if all images have completed loading (successfully or unsuccessfully). Since this can return `true` on error, you should also use `isErrorAny()` to check for errors. If loading has not completed, `checkAll()` returns `false`. This method does not force images to start loading.

public synchronized boolean checkAll (boolean load)

The `checkAll()` method determines if all images associated with the `MediaTracker` have finished loading. If the `load` flag is `true`, any image that has not started loading yet will start. The method returns `true` if all images have completed loading (successfully or unsuccessfully). Since this can return `true` on error, you should also use `isErrorAny()` to check for errors. If loading has not completed, `checkAll()` returns `false`.

public int statusID (int id, boolean load)

The `statusID()` method checks on the load status of the images in the `id` group. If there are multiple images in the group, the results are ORed together. If the `load` flag is `true`, any image in the `id` group that has not started loading yet will start. The return value is some combination of the class constants `LOADING`, `ABORTED`, `ERRORED`, and `COMPLETE`.

public int statusAll (boolean load)

The `statusAll()` method determines the load status of all the images associated with the `MediaTracker`. If this `MediaTracker` is watching multiple images, the results are ORed together. If the `load` flag is `true`, any image that has not started loading yet will start. The return value is some combination of the class constants `LOADING`, `ABORTED`, `ERRORED`, and `COMPLETE`.

public synchronized boolean isErrorID (int id)

The `isErrorId()` method checks whether any media in the `id` group encountered an error while loading. If any image resulted in an error, `isErrorId()` returns `true`; if there were no errors, it returns `false`.

public synchronized boolean isErrorAny ()

The `isErrorAny()` method checks to see if any image associated with the `MediaTracker` encountered an error. If there was an error, the method returns `true`; if none, `false`.

public synchronized Object[] getErrorsID (int id)

The `getErrorsID()` method returns an array of the objects that encountered errors in the group ID during loading. If loading caused no errors, the method returns `null`. The return type is an `Object` array instead of an `Image` array because `MediaTracker` will eventually support additional media types.

public synchronized Object[] getErrorsAny ()

The `getErrorsAny()` method returns an array of all the objects that encountered an error during loading. If there were no errors, the method returns `null`. The return type is an `Object` array instead of an `Image` array because `MediaTracker` will eventually support additional media types.

2.8.2 Using a MediaTracker

The `init()` method improves the `AnimateApplet` from Example 2-2 to ensure that images load before the animation sequence starts. Waiting for images to load is particularly important if there is a slow link between the computer on which the applet is running and the server for the image files. Note that in a few cases, like interlaced GIF files, you might be willing to display an image before it has completely loaded. However, judicious use of `MediaTracker` will give you much more control over your program's behavior.

The new `init()` method creates a `MediaTracker`, puts all the images in the animation sequence under the tracker's control, and then calls `waitForAll()` to wait until the images are loaded. Once the images are loaded, it calls `isErrorsAny()` to make sure that the images loaded successfully.

```
public void init () {
    MediaTracker mt = new MediaTracker (this);
    im = new Image[numImages];
    for (int i=0;i<numImages;i++) {
        im[i] = getImage (getDocumentBase(), "clock"+i+".jpg");
        mt.addImage (im[i], i);
    }
    try {
        mt.waitForAll();
        if (mt.isErrorAny())
            System.out.println ("Error loading images");
    } catch (Exception e) {
        e.printStackTrace ();
    }
}
```

3

In this chapter:
- *Fonts*
- *FontMetrics*
- *Color*
- *SystemColor*
- *Displaying Colors*
- *Using Desktop Colors*

Fonts and Colors

This chapter introduces the `java.awt` classes that are used to work with different fonts and colors. First, we discuss the `Font` class, which determines the font used to display text strings, whether they are drawn directly on the screen (with `drawString()`) or displayed within a component like a text field. The `FontMetrics` class gives you detailed information about a font, which you can use to position text strings intelligently. Next, the `Color` class is used to represent colors and can be used to specify the background color of any object, as well as the foreground color used to display a text string or a shape. Finally, the `SystemColor` class (which is new to Java 1.1) provides access to the desktop color scheme.

3.1 Fonts

An instance of the `Font` class represents a specific font to the system. Within AWT, a font is specified by its name, style, and point size. Each platform that supports Java provides a basic set of fonts; to find the fonts supported on any platform, call `Toolkit.getDefaultToolkit().getFontList()`. This method returns a `String` array of the fonts available. Under Java 1.0, on any platform, the available fonts were: TimesRoman, Helvetica, Courier, Dialog, DialogInput, and ZapfDingbats. For copyright reasons, the list is substantially different in Java 1.1: the available font names are TimesRoman ☆, Serif, Helvetica ☆, SansSerif, Courier ☆, Monospaced, Dialog, and DialogInput. The actual fonts available aren't changing; the deprecated font names are being replaced by non-copyrighted equivalents. Thus, TimesRoman is now Serif, Helvetica is now SansSerif, and Courier is Monospaced. The ZapfDingbats font name has been dropped completely because the characters in this font have official Unicode mappings in the range \u2700 to \u27ff.

NOTE If you desire non-Latin font support with Java 1.1, use the Unicode mappings for the characters. The actual font used is specified in a set of *font.properties* files in the *lib* subdirectory under *java.home*. These localized font files allow you to remap the "Serif", "SansSerif", and "Monospaced" names to different fonts.

The font's `style` is passed with the help of the class variables `Font.PLAIN`, `Font.BOLD`, and `Font.ITALIC`. The combination `Font.BOLD | Font.ITALIC` specifies bold italics.

A font's `size` is represented as an integer. This integer is commonly thought of as a point size; although that's not strictly correct, this book follows common usage and talks about font sizes in points.

It is possible to add additional font names to the system by setting properties. For example, putting the line below in the properties file or a resource file (resource files are new to Java 1.1) defines the name "AvantGarde" as an alias for the font SansSerif:

```
awt.font.avantgarde=SansSerif
```

With this line in the properties file, a Java program can use "AvantGarde" as a font name; when this font is selected, AWT uses the font SansSerif for display. The property name must be all lowercase. Note that we haven't actually added a new font to the system; we've only created a new name for an old font. See the discussion of `getFont()` and `decode()` for more on font properties.

3.1.1 The Font Class

Constants

There are four styles for displaying fonts in Java: plain, bold, italic, and bold italic. Three class constants are used to represent font styles:

public static final int BOLD

The `BOLD` constant represents a boldface font.

public static final int ITALIC

The `ITALIC` constant represents an italic font.

public static final int PLAIN

The `PLAIN` constant represents a plain or normal font.

The combination `BOLD | ITALIC` represents a bold italic font. `PLAIN` combined with either `BOLD` or `ITALIC` represents bold or italic, respectively.

There is no style for underlined text. If you want underlining, you have to do it manually, with the help of `FontMetrics`.

NOTE If you are using Microsoft's SDK, the `com.ms.awt.FontX` class includes direct support for underlined, strike through (line through middle), and outline fonts.

Variables

Three protected variables access the font setting. They are initially set through the `Font` constructor. To read these variables, use the `Font` class's "get" methods.

protected String name

The name of the font.

protected int size

The size of the font.

protected int style

The style of the font. The style is some logical combination of the constants listed previously.

Constructors

public Font (String name, int style, int size)

There is a single constructor for `Font`. It requires a `name`, `style`, and `size`. `name` represents the name of the font to create, case insensitive.

```
setFont (new Font ("TimesRoman", Font.BOLD | Font.ITALIC, 20));
```

Characteristics

public String getName ()

The `getName()` method returns the font's logical name. This is the name passed to the constructor for the specific instance of the `Font`. Remember that system properties can be used to alias font names, so the name used in the constructor isn't necessarily the actual name of a font on the system.

public String getFamily ()

The `getFamily()` method returns the actual name of the font that is being used to display characters. If the font has been aliased to another font, the `getFamily()` method returns the name of the platform-specific font, not the alias. For example, if the constructor was `new Font ("AvantGarde", Font.PLAIN, 10)` and the `awt.font.avantgarde=Helvetica` property is set, then `getName()` returns AvantGarde, and `getFamily()` returns Helvetica. If nobody set the property, both methods return AvantGarde, and the system uses the default font (since AvantGarde is a nonstandard font).

public int getStyle ()

The `getStyle()` method returns the current style of the font as an integer. Compare this value with the constants `Font.BOLD`, `Font.PLAIN`, and `Font.ITALIC` to see which style is meant. It is easier to use the `isPlain()`, `isBold()`, and `isItalic()` methods to find out the current style. `getStyle()` is more useful if you want to copy the style of some font when creating another.

public int getSize ()

The `getSize()` method retrieves the point size of the font, as set by the size parameter in the constructor. The actual displayed size may be different.

public FontPeer getPeer () ★

The `getPeer()` method retrieves the platform-specific peer object. The object `FontPeer` is a platform-specific subclass of `sun.awt.PlatformFont`. For example, on a Windows 95 platform, this would be an instance of `sun.awt.windows.WFontPeer`.

Styles

public boolean isPlain ()

The `isPlain()` method returns `true` if the current font is neither bold nor italic. Otherwise, it returns `false`.

public boolean isBold ()

The `isBold()` method returns `true` if the current font is either bold or bold and italic. Otherwise, it returns `false`.

public boolean isItalic ()

The `isItalic()` method returns `true` if the current font is either italic or bold and italic. Otherwise, it returns `false`.

Font properties

Earlier, you saw how to use system properties to add aliases for fonts. In addition to adding aliases, you can use system properties to specify which fonts your program will use when it runs. This allows your users to customize their environments to their liking; your program reads the font settings at run-time, rather than using hard-coded settings. The format of the settings in a properties file is:

```
propname=fontname-style-size
```

where `propname` is the name of the property being set, `fontname` is any valid font name (including aliases), `style` is `plain`, `bold`, `italic`, or `bolditalic`, and `size` represents the desired size for the font. `style` and `size` default to `plain` and 12 points. Order is important; the font's style must always precede its size.

For example, let's say you have three areas on your screen: one for menus, one for labels, and one for input. In the system properties, you allow users to set three properties: `myPackage.myClass.menuFont`, `myPackage.myClass.labelFont`, and `myPackage.myClass.inputFont`. One user sets two:

```
myPackage.myClass.menuFont=TimesRoman-italic-24
myPackage.myClass.inputFont=Helvetica
```

The user has specified a Times font for menus and Helvetica for other input. The property names are up to the developer. The program uses `getFont()` to read the properties and set the fonts accordingly.

NOTE The location of the system properties file depends on the run-time environment and version you are using. Normally, the file goes into a subdirectory of the installation directory, or for environments where users have home directories, in a subdirectory for the user. Sun's HotJava, JDK, and *appletviewer* tools use the *properties* file in the *.hotjava* directory.

Most browsers do not permit modifying properties, so there is no file.

Java 1.1 adds the idea of "resource files," which are syntactically similar to properties files. Resource files are then placed on the server or within a directory found in the `CLASSPATH`. Updating the properties file is no longer recommended.

---

public static Font getFont (String name)

The `getFont()` method gets the font specified by the system property `name`. If `name` is not a valid system property, `null` is returned. This method is implemented by a call to the next version of `getFont()`, with the `defaultFont` parameter set to `null`.

Assuming the properties defined in the previous example, if you call the `getFont()` method with `name` set to `myPackage.myClass.menuFont`, the return value is a 24-point, italic, TimesRoman `Font` object. If called with `name` set to `myPackage.myClass.inputFont`, `getFont()` returns a 12-point, plain Helvetica `Font` object. If called with `myPackage.myClass.labelFont` as `name`, `getFont()` returns `null` because this user did not set the property `myPackage.myClass.labelFont`.

public static Font getFont (String name, Font defaultFont)

The `getFont()` method gets the font specified by the system property `name`. If `name` is not a valid system property, this version of `getFont()` returns the `Font` specified by `defaultFont`. This version allows you to provide defaults in the event the user does not wish to provide his own font settings.

public static Font decode (String name) ★

The `decode()` method provides an explicit means to decipher font property settings, regardless of where the setting comes from. (The `getFont()` method can decipher settings, but only if they're in the system properties file.) In particular, you can use `decode()` to look up font settings in a resource file. The format of `name` is the same as that used by `getFont()`. If the contents of `name` are invalid, a 12-point plain font is returned. To perform the equivalent of `getFont("myPackage.myClass.menuFont")` without using system properties, see the following example. For a more extensive example using resource files, see Appendix A.

```
// Java 1.1 only
InputStream is = instance.getClass().getResourceAsStream("propfile");
Properties p = new Properties();
try {
    p.load (is);
    Font f = Font.decode(p.getProperty("myPackage.myClass.menuFont"));
} catch (IOException e) {
    System.out.println ("error loading props...");
}
```

Miscellaneous methods

public int hashCode ()

The `hashCode()` method returns a hash code for the font. This hash code is used whenever a `Font` object is used as the key in a `Hashtable`.

public boolean equals (Object o)

The `equals()` method overrides the `equals()` method of `Object` to define equality for `Font` objects. Two `Font` objects are equal if their size, style, and name are equal. The following example demonstrates why this is necessary.

```
Font a = new Font ("TimesRoman", Font.PLAIN, 10);
Font b = new Font ("TimesRoman", Font.PLAIN, 10);
// displays false since the objects are different objects
System.out.println (a == b);
// displays true since the objects have equivalent settings
System.out.println (a.equals (b));
```

public String toString ()

The `toString()` method of `Font` returns a string showing the current family, name, style, and size settings. For example:

```
java.awt.Font[family=TimesRoman,name=TimesRoman,style=bolditalic,size=20]
```

3.2 FontMetrics

The abstract `FontMetrics` class provides the tools for calculating the actual width and height of text when displayed on the screen. You can use the results to position objects around text or to provide special effects like shadows and underlining.

Like the `Graphics` class, `FontMetrics` is abstract. The run-time Java platform provides a concrete implementation of `FontMetrics`. You don't have to worry about the actual class; it is guaranteed to implement all the methods of `FontMetrics`. In case you're curious, on a Windows 95 platform, either the class `sun.awt.win32.Win32FontMetrics` (JDK1.0) or the class `sun.awt.windows.WFontMetrics` (JDK1.1) extends `FontMetrics`. On a UNIX/Motif platform, the class is `sun.awt.motif.X11FontMetrics`. With the Macintosh, the class is `sun.awt.macos.MacFontMetrics`. If you're not using the JDK, the class names may be different, but the principle still applies: you don't have to worry about the concrete class.

3.2.1 The FontMetrics Class

Variables

protected Font font

The font whose metrics are contained in this `FontMetrics` object; use the `getFont()` method to get the value.

Constructors

protected FontMetrics (Font font)

There is no visible constructor for `FontMetrics`. Since the class is abstract, you cannot create a `FontMetrics` object. The way to get the `FontMetrics` for a font is to ask for it. Through the current graphics context, call the method `getGraphics().getFontMetrics()` to retrieve the `FontMetrics` for the current font. If a graphics context isn't available, you can get a `FontMetrics` object from the default `Toolkit` by calling the method `Toolkit.getDefaultToolkit().getFontMetrics (aFontObject)`.

Font height

Four variables describe the height of a font: leading (pronounced like the metal), ascent, descent, and height. Leading is the amount of space required between lines of the same font. Ascent is the space above the baseline required by the tallest character in the font. Descent is the space required below the baseline by the lowest descender (the "tail" of a character like "y"). Height is the total of the three: ascent, baseline, and descent. Figure 3-1 shows these values graphically.

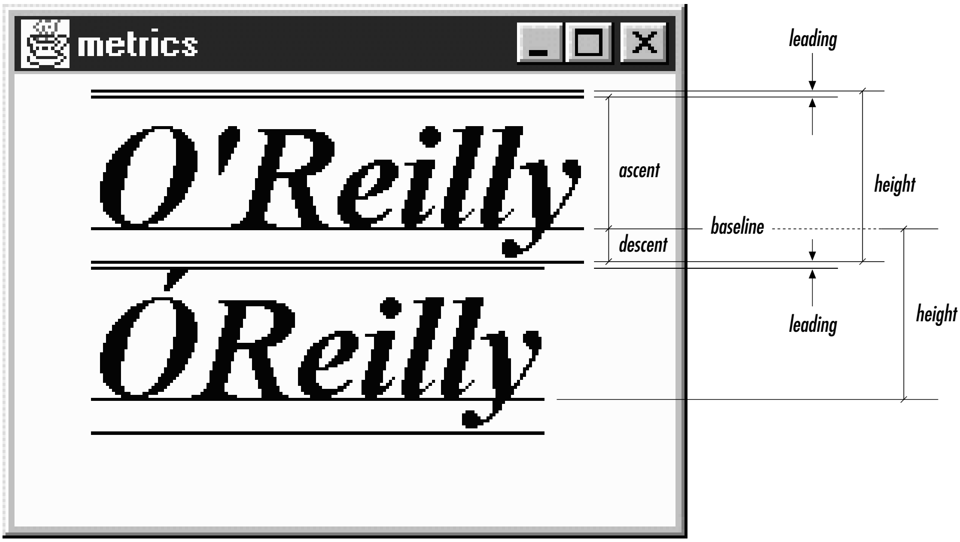


Figure 3–1: Font height metrics

If that were the entire story, it would be simple. Unfortunately, it isn't. Some special characters (for example, capitals with umlauts or accents) are taller than the "tallest" character in the font; so Java defines a value called `maxAscent` to account for these. Similarly, some characters descend below the "greatest" descent, so Java defines a `maxDescent` to handle these cases.

NOTE It seems that on Windows and Macintosh platforms there is no difference between the return values of `getMaxAscent()` and `getAscent()`, or between `getMaxDescent()` and `getDescent()`. On UNIX platforms, they sometimes differ. For developing truly portable applications, the `max` methods should be used where necessary.

---

public int getLeading ()

The `getLeading()` method retrieves the leading required for the `FontMetrics` of the font. The units for this measurement are pixels.

public int getAscent ()

The `getAscent()` method retrieves the space above the baseline required for the tallest character in the font. The units for this measurement are pixels. You cannot get the ascent value for a specific character.

public int getMaxAscent ()

`getMaxAscent()` retrieves the height above the baseline for the character that's really the tallest character in the font, taking into account accents, umlauts, tildes, and other special marks. The units for this measurement are pixels. If you are using only ordinary ASCII characters below 128 (i.e., the English language character set), `getMaxAscent()` is not necessary.

If you're using `getMaxAscent()`, avoid `getHeight()`; `getHeight()` is based on `getAscent()` and doesn't account for extra space.

For some fonts and platforms, `getAscent()` may include the space for the diacritical marks.

public int getDescent ()

The `getDescent()` method retrieves the space below the baseline required for the deepest character for the font. The units for this measurement are pixels. You cannot get the descent value for a specific character.

public int getMaxDescent ()
public int getMaxDecent ()

Some fonts may have special characters that extend farther below the baseline than the value returned by `getDescent()`. `getMaxDescent()` returns the real maximum descent for the font, in pixels. In most cases, you can still use the `getDescent()` method; visually, it is okay for an occasional character to extend into the space between lines. However, if it is absolutely, positively necessary that the descent space does not overlap with the next line's ascent requirements, use `getMaxDescent()` and avoid `getDescent()` and `getHeight()`.

An early beta release of the AWT API included the method `getMaxDecent()`. It is left for compatibility with early beta code. Avoid using it; it is identical to `getMaxDescent()` in every way except spelling. Unfortunately, it is not flagged as deprecated.

public int getHeight ()

The `getHeight()` method returns the sum of `getDescent()`, `getAscent()`, and `getLeading()`. In most cases, this will be the distance between successive baselines when you are displaying multiple lines of text. The height of a font in pixels is not necessarily the size of a font in points.

Don't use `getHeight()` if you are displaying characters with accents, umlauts, and other marks that increase the character's height. In this case, compute the height yourself using the `getMaxAscent()` method. Likewise, you shouldn't use the method `getHeight()` if you are using `getMaxDescent()` instead of `getDescent()`.

Character width

In the horizontal dimension, positioning characters is relatively simple: you don't have to worry about ascenders and descenders, you only have to worry about how far ahead to draw the next character after you have drawn the current one. The "how far" is called the *advance width* of a character. For most cases, the advance width is the actual width plus the intercharacter space. However, it's not a good idea to think in these terms; in many cases, the intercharacter space is actually negative (i.e., the bounding boxes for two adjacent characters overlap). For example, consider an italic font. The top right corner of one character probably extends beyond the character's advance width, overlapping the next character's bounding box. (To see this, look back at Figure 3-1; in particular, look at the *ll* in *O'Reilly*.) If you think purely in terms of the advance width (the amount to move horizontally after drawing a character), you won't run into trouble. Obviously, the advance width depends on the character, unless you're using a fixed width font.

public int charWidth (char character)

This version of the `charWidth()` method returns the advance width of the given `character` in pixels.

public int charWidth (int character)

The `charWidth()` method returns the advance width of the given `character` in pixels. Note that the argument has type `int` rather than `char`. This version is useful when overriding the `Component.keyDown()` method, which gets the integer value of the character pressed as a parameter. With the `KeyEvent` class, you should use the previous version with its `getKeyChar()` method.

public int stringWidth (String string)

The `stringWidth()` method calculates the advance width of the entire `string` in pixels. Among other things, you can use the results to underline or center text within an area of the screen. Example 3-1 and Figure 3-2 show an example that centers several text strings (taken from the command-line arguments) in a `Frame`.

Example 3–1: Centering Text in a Frame

```
import java.awt.*;
public class Center extends Frame {
    static String text[];
    private Dimension dim;
    static public void main (String args[]) {
        if (args.length == 0) {
            System.err.println ("Usage: java Center <some text>");
            return;
        }
        text = args;
        Center f = new Center();
        f.show();
    }
    public void addNotify() {
        super.addNotify();
        int maxWidth = 0;
        FontMetrics fm = getToolkit().getFontMetrics(getFont());
        for (int i=0;i<text.length;i++) {
            maxWidth = Math.max (maxWidth, fm.stringWidth(text[i]));
        }
        Insets inset = insets();
        dim = new Dimension (maxWidth + inset.left + inset.right,
            text.length*fm.getHeight() + inset.top + inset.bottom);
        resize (dim);
    }
    public void paint (Graphics g) {
        g.translate(insets().left, insets().top);
        FontMetrics fm = g.getFontMetrics();
        for (int i=0;i<text.length;i++) {
            int x,y;
            x = (size().width - fm.stringWidth(text[i]))/2;
            y = (i+1)*fm.getHeight()-1;
            g.drawString (text[i], x, y);
        }

    }
}
```

This application extends the `Frame` class. It stores its command-line arguments in the `String` array `text[]`. The `addNotify()` method sizes the frame appropriately. It computes the size needed to display the arguments and resizes the `Frame` accordingly. To compute the width, it takes the longest `stringWidth()` and adds the left and right insets. To compute the height, it takes the current font's height,

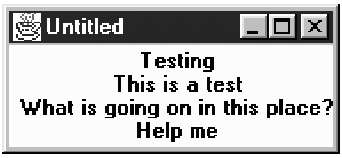


Figure 3–2: Centering text in a frame

multiplies it by the number of lines to display, and adds insets. Then it is up to the `paint()` method to use `stringWidth()` and `getHeight()` to figure out where to put each string.

public int charsWidth (char data[], int offset, int length)

The `charsWidth()` method allows you to calculate the advance width of the char array `data`, without first converting `data` to a `String` and calling the `stringWidth()` method. The `offset` specifies the element of `data` to start with; `length` specifies the number of elements to use. The first element of the array has an `offset` of zero. If `offset` or `length` is invalid, `charsWidth()` throws the run-time exception `ArrayIndexOutOfBoundsException`.

public int bytesWidth (byte data[], int offset, int length)

The `bytesWidth()` method allows you to calculate the advance width of the byte array `data`, without first converting `data` to a `String` and calling the `stringWidth()` method. The `offset` specifies the element of `data` to start with; `length` specifies the number of elements to use. The first element of the array has an `offset` of zero. If `offset` or `length` is invalid, `bytesWidth()` throws the run-time exception `ArrayIndexOutOfBoundsException`.

public int[] getWidths ()

The `getWidths()` method returns an integer array of the advance widths of the first 255 characters in the `FontMetrics` font. `getWidths()` is very useful if you are continually looking up the widths of ASCII characters. Obtaining the widths as an array and looking up individual character widths yourself results in less method invocation overhead than making many calls to `charWidth()`.

public int getMaxAdvance ()

The `getMaxAdvance()` method returns the advance pixel width of the widest character in the font. This allows you to reserve enough space for characters before you know what they are. If you know you are going to display only ASCII characters, you are better off calculating the maximum value returned from `getWidths()`. When unable to determine the width in advance, the method `getMaxAdvance()` returns –1.

Miscellaneous methods

public Font getFont ()

The `getFont()` method returns the specific font for this `FontMetrics` instance.

public String toString ()

The `toString()` method of `FontMetrics` returns a string displaying the current font, ascent, descent, and height. For example:

```
sun.awt.win32.Win32FontMetrics[font=java.awt.Font[family=TimesRoman,
name=TimesRoman,style=bolditalic,size=20]ascent=17, descent=6, height=24]
```

Because this is an abstract class, the concrete implementation could return something different.

3.2.2 Font Display Example

Example 3-2 displays all the available fonts in the different styles at 12 points. The code uses the `FontMetrics` methods to ensure that there is enough space for each line. Figure 3-3 shows the results, using the Java 1.0 font names, on several platforms.

Example 3–2: Font Display

```
import java.awt.*;
public class Display extends Frame {
    static String[] fonts;
    private Dimension dim;
    Display () {
        super ("Font Display");
        fonts = Toolkit.getDefaultToolkit().getFontList();
    }
    public void addNotify() {
        Font f;
        super.addNotify();
        int height   = 0;
        int maxWidth = 0;
        final int vMargin  = 5, hMargin = 5;
        for (int i=0;i<fonts.length;i++) {
            f = new Font (fonts[i], Font.PLAIN, 12);
            height += getHeight (f);
            f = new Font (fonts[i], Font.BOLD, 12);
            height += getHeight (f);
            f = new Font (fonts[i], Font.ITALIC, 12);
            height += getHeight (f);
            f = new Font (fonts[i], Font.BOLD | Font.ITALIC, 12);
            height += getHeight (f);
            maxWidth = Math.max (maxWidth, getWidth (f, fonts[i] + " BOLDITALIC"));
        }
        Insets inset = insets();
        dim = new Dimension (maxWidth + inset.left + inset.right + hMargin,
                        height + inset.top + inset.bottom + vMargin);
```

Example 3–2: Font Display (continued)

```
        resize (dim);
    }
    static public void main (String args[]) {
        Display f = new Display();
        f.show();
    }
    private int getHeight (Font f) {
        FontMetrics fm = Toolkit.getDefaultToolkit().getFontMetrics(f);
        return fm.getHeight();
    }
    private int getWidth (Font f, String s) {
        FontMetrics fm = Toolkit.getDefaultToolkit().getFontMetrics(f);
        return fm.stringWidth(s);
    }
    public void paint (Graphics g) {
        int x = 0;
        int y = 0;
        g.translate(insets().left, insets().top);
        for (int i=0;i<fonts.length;i++) {
            Font plain = new Font (fonts[i], Font.PLAIN, 12);
            Font bold = new Font (fonts[i], Font.BOLD, 12);
            Font italic = new Font (fonts[i], Font.ITALIC, 12);
            Font bolditalic = new Font (fonts[i], Font.BOLD | Font.ITALIC, 12);
            g.setFont (plain);
            y += getHeight (plain);
            g.drawString (fonts[i] + " PLAIN", x, y);
            g.setFont (bold);
            y += getHeight (bold);
            g.drawString (fonts[i] + " BOLD", x, y);
            g.setFont (italic);
            y += getHeight (italic);
            g.drawString (fonts[i] + " ITALIC", x, y);
            g.setFont (bolditalic);
            y += getHeight (bolditalic);
            g.drawString (fonts[i] + " BOLDITALIC", x, y);
        }
        resize (dim);
    }
}
```

3.3 Color

Not so long ago, color was a luxury; these days, color is a requirement. A program that uses only black and white seems hopelessly old fashioned. AWT's `Color` class lets you define and work with `Color` objects. When we discuss the `Component` class (see Chapter 5, *Components*), you will see how to use these color objects, and our discussion of the `SystemColor` subclass (new to Java 1.1; discussed later in this chapter) shows you how to control the colors that are painted on the screen.

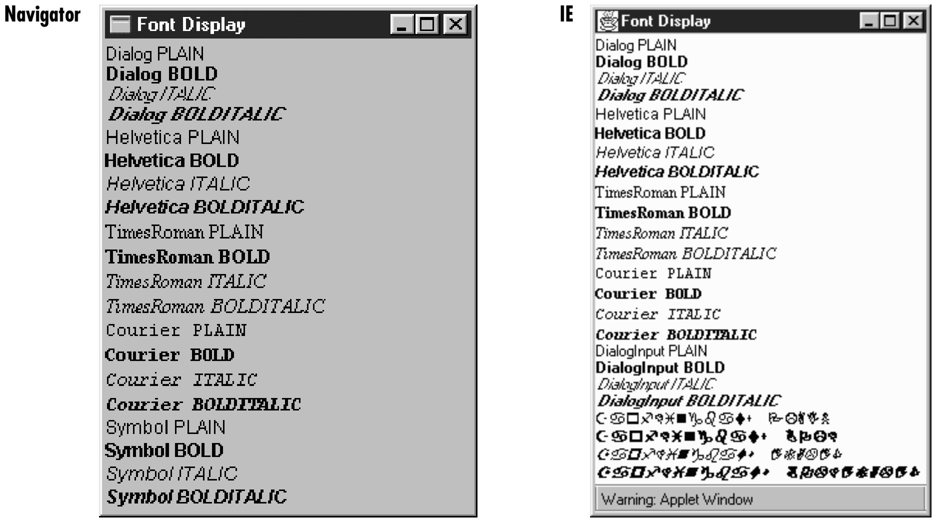


Figure 3–3: Fonts available with the Netscape Navigator 3.0 and Internet Explorer 3.0

A few words of warning: while colors give you the opportunity to make visually pleasing applications, they also let you do things that are incredibly ugly. Resist the urge to go overboard with your use of color; it's easy to make something hideous when you are trying to use every color in the palette. Also, realize that colors are fundamentally platform dependent, and in a very messy way. Java lets you use the same `Color` objects on any platform, but it can't guarantee that every display will treat the color the same way; the result depends on everything from your software to the age of your monitor. What looks pink on one monitor may be red on another. Furthermore, when running in an environment with a limited palette, AWT picks the available color that is closest to what you requested. If you really care about appearance, there is no substitute for testing.

3.3.1 Color Methods

Constants

The `Color` class has predefined constants (all of type `public static final Color`) for frequently used colors. These constants, their RGB values, and their HSB values (hue, saturation, brightness) are given in Table 3-1.

Table 3–1: Comparison of RGB and HSB Colors

Color	Red	Green	Blue	Hue	Saturation	Brightness
black	0	0	0	0	0	0
blue	0	0	255	.666667	1	1
cyan	0	255	255	.5	1	1
darkGray	64	64	64	0	0	.25098
gray	128	128	128	0	0	.501961
green	0	255	0	.333333	1	1
lightGray	192	192	192	0	0	.752941
magenta	255	0	255	.833333	1	1
orange	255	200	0	.130719	1	1
pink	255	175	175	0	.313726	1
red	255	0	0	0	1	1
white	255	255	255	0	0	1
yellow	255	255	0	.166667	1	1

These constants are used like any other class variable: for example, `Color.red` is a constant `Color` object representing the color red. Many other color constants are defined in the `SystemColor` class.

Constructors

When you're not using a predefined constant, you create `Color` objects by specifying the color's red, green, and blue components. Depending on which constructor you use, you can specify the components as integers between 0 and 255 (most intense) or as floating point intensities between 0.0 and 1.0 (most intense). The result is a 24-bit quantity that represents a color. The remaining 8 bits are used to represent transparency: that is, if the color is painted on top of something, does whatever was underneath show through? The `Color` class doesn't let you work with the transparency bits; all `Color` objects are opaque. However, you can use transparency when working with images; this topic is covered in Chapter 12, *Image Processing*.

public Color (int red, int green, int blue)

This constructor is the most commonly used. You provide the specific `red`, `green`, and `blue` values for the color. Valid values for `red`, `green`, and `blue` are between 0 and 255. The constructor examines only the low-order byte of the integer and ignores anything outside the range, including the sign bit.

public Color (int rgb)

This constructor allows you to combine all three variables in one parameter, `rgb`. Bits 16–23 represent the red component, and bits 8–15 represent the green component. Bits 0–7 represent the blue component. Bits 24–31 are ignored. Going from three bytes to one integer is fairly easy:

```
(((red & 0xFF) << 16 ) | ((green & 0xFF) << 8) | ((blue & 0xFF) << 0))
```

public Color (float red, float green, float blue)

This final constructor allows you to provide floating point values between 0.0 and 1.0 for each of `red`, `green`, and `blue`. Values outside of this range yield unpredictable results.

Settings

public int getRed ()

The `getRed()` method retrieves the current setting for the red component of the color.

public int getGreen ()

The `getGreen()` method retrieves the current setting for the green component of the color.

public int getBlue ()

The `getBlue()` method retrieves the current setting for the blue component of the color.

public int getRGB ()

The `getRGB()` method retrieves the current settings for red, green, and blue in one combined value. Bits 16–23 represent the red component. Bits 8–15 represent the green component. Bits 0–7 represent the blue component. Bits 24–31 are the transparency bits; they are always `0xff` (opaque) when using the default RGB `ColorModel`.

public Color brighter ()

The `brighter()` method creates a new `Color` that is somewhat brighter than the current color. This method is useful if you want to highlight something on the screen.

NOTE Black does not get any brighter.

public Color darker ()

The `darker()` method returns a new `Color` that is somewhat darker than the current color. This method is useful if you are trying to de-emphasize an object on the screen. If you are creating your own `Component`, you can use a `darker()` `Color` to mark it inactive.

Color properties

`Color` properties are very similar to `Font` properties. You can use system properties (or resource files) to allow users to select colors for your programs. The settings have the form `0xRRGGBB`, where `RR` is the red component of the color, `GG` represents the green component, and `BB` represents the blue component. `0x` indicates that the number is in hexadecimal. If you (or your user) are comfortable using decimal values for colors (0x112233 is 1122867 in decimal), you can, but then it is harder to see the values of the different components.

NOTE The location of the system properties file depends on the run-time environment and version you are using. Ordinarily, the file will go into a subdirectory of the installation directory or, for environment's where users have home directories, in a subdirectory for the user. Sun's HotJava, JDK, and *appletviewer* tools use the *properties* file in the *.hotjava* directory.

Most browsers do not permit modifying properties, so there is no file.

Java 1.1 adds the idea of "resource files," which are syntactically similar to properties files. Resource files are then placed on the server or within a directory found in the `CLASSPATH`. Updating the properties file is no longer recommended.

For example, consider a screen that uses four colors: one each for the foreground, the background, inactive components, and highlighted text. In the system properties file, you allow users to select colors by setting the following properties:

```
myPackage.myClass.foreground
myPackage.myClass.background
myPackage.myClass.inactive
myPackage.myClass.highlight
```

One particular user set two:

```
myPackage.myClass.foreground=0xff00ff        #magenta
myPackage.myClass.background=0xe0e0e0        #light gray
```

These lines tell the program to use magenta as the foreground color and light gray for the background. The program will use its default colors for inactive components and highlighted text.

public static Color getColor (String name)

The `getColor()` method gets the color specified by the system property `name`. If `name` is not a valid system property, `getColor()` returns `null`. If the property value does not convert to an integer, `getColor()` returns `null`.

For the properties listed above, if you call `getColor()` with `name` set to the property `myPackage.myClass.foreground`, it returns a magenta `Color` object. If called with `name` set to `myPackage.myClass.inactive`, `getColor()` returns `null`.

public static Color getColor (String name, Color defaultColor)

The `getColor()` method gets the color specified by the system property `name`. This version of the `getColor()` method returns `defaultColor` if `name` is not a valid system property or the property's value does not convert to an integer.

For the previous example, if `getColor()` is called with `name` set to `myPackage.myClass.inactive`, the `getColor()` method returns the value of `defaultColor`. This allows you to provide defaults for properties the user doesn't wish to set explicitly.

public static Color getColor (String name, int defaultColor)

This `getColor()` method gets the color specified by the system property `name`. This version of the `getColor()` method returns `defaultColor` if `name` is not a valid system property or the property's value does not convert to an integer. The default color is specified as an integer in which bits 16–23 represent the red component, 8–15 represent the green component, and 0–7 represent the blue component. Bits 24–31 are ignored. If the property value does not convert to an integer, `defaultColor` is returned.

public static Color decode (String name) ★

The `decode()` method provides an explicit means to decipher color property settings, regardless of where the setting comes from. (The `getColor()` method can decipher settings but only if they're in the system properties file.) In particular, you can use `decode()` to look up color settings in a resource file. The format of `name` is the same as that used by `getColor()`. If the contents of `name` do not translate to a 24-bit integer, the `NumberFormatException` run-time exception is thrown. To perform the equivalent of `getColor("myPackage.myClass.foreground")`, without using system properties, see the following example. For a more extensive example using resource files, see Appendix A.

```
// Java 1.1 only
InputStream is = instance.getClass().getResourceAsStream("propfile");
Properties p = new Properties();
try {
    p.load (is);
    Color c = Color.decode(p.getProperty("myPackage.myClass.foreground"));
} catch (IOException e) {
```

```
        System.out.println ("error loading props...");
    }
```

Hue, saturation, and brightness

So far, the methods we have seen work with a color's red, green, and blue components. There are many other ways to represent colors. This group of methods allows you to work in terms of the HSB (hue, saturation, brightness) model. Hue represents the base color to work with: working through the colors of the rainbow, red is represented by numbers immediately above 0; magenta is represented by numbers below 1; white is 0; and black is 1. Saturation represents the color's purity, ranging from completely unsaturated (either white or black depending upon brightness) to totally saturated (just the base color present). Brightness is the desired level of luminance, ranging from black (0) to the maximum amount determined by the saturation level.

public static float[] RGBtoHSB (int red, int green, int blue, float[] hsbvalues)

The `RGBtoHSB()` method allows you to convert a specific `red`, `green`, `blue` value to the hue, saturation, and brightness equivalent. `RGBtoHSB()` returns the results in two different ways: the parameter `hsbvalues` and the method's return value. The values of these are the same. If you do not want to pass an `hsbvalues` array parameter, pass `null`. In both the parameter and the return value, the three components are placed in the array as follows:

`hsbvalues[0]`	*contains hue*
`hsbvalues[1]`	*contains saturation*
`hsbvalues[2]`	*contains brightness*

public static Color getHSBColor (float hue, float saturation, float brightness)

The `getHSBColor()` method creates a `Color` object by using `hue`, `saturation`, and `brightness` instead of `red`, `green`, and `blue` values.

public static int HSBtoRGB (float hue, float saturation, float brightness)

The `HSBtoRGB()` method converts a specific `hue`, `saturation`, and `brightness` to a `Color` and returns the `red`, `green`, and `blue` values as an integer. As with the constructor, bits 16–23 represent the red component, 8–15 represent the green component, and 0–7 represent the blue component. Bits 24–31 are ignored.

Miscellaneous methods

public int hashCode ()

The `hashCode()` method returns a hash code for the color. The hash code is used whenever a color is used as a key in a `Hashtable`.

public boolean equals (Object o)

The `equals()` method overrides the `equals()` method of the `Object` to define equality for `Color` objects. Two `Color` objects are equivalent if their `red`, `green`, and `blue` values are equal.

public String toString ()

The `toString()` method of `Color` returns a string showing the color's red, green, and blue settings. For example `System.out.println (Color.orange)` would result in the following:

```
java.awt.Color[r=255,g=200,b=0]
```

3.4 SystemColor

In Java 1.1, AWT provides access to desktop color schemes, or *themes*. To give you an idea of how these themes work, with the Windows Standard scheme for the Windows 95 desktop, buttons have a gray background with black text. If you use the control panel to change to a High Contrast Black scheme, the button's background becomes black and the text white. Prior to 1.1, Java didn't know anything about desktop colors: all color values were hard coded. If you asked for a particular shade of gray, you got that shade, and that was it; applets and applications had no knowledge of the desktop color scheme in effect, and therefore, wouldn't change in response to changes in the color scheme.

Starting with Java 1.1, you can write programs that react to changes in the color scheme: for example, a button's color will change automatically when you use the control panel to change the color scheme. To do so, you use a large number of constants that are defined in the `SystemColor` class. Although these constants are `public static final`, they actually have a very strange behavior. Your program is not allowed to modify them (like any other constant). However, their initial values are loaded at run-time, and their values may change, corresponding to changes in the color scheme. This has one important consequence for programmers: you should not use `equals()` to compare a `SystemColor` with a "regular" `Color`; use the `getRGB()` methods of the colors you are comparing to ensure that you compare the current color value.* Section 3.6 contains a usage example.

---

* The omission of an `equals()` method that can properly compare a `SystemColor` with a `Color` is unfortunate.

Because `SystemColor` is a subclass of `Color`, you can use a `SystemColor` anywhere you can use a `Color` object. You will never create your own `SystemColor` objects; there is no public constructor. The only objects in this class are the twenty or so `SystemColor` constants.

3.4.1 SystemColor Methods

Constants

There are two sets of constants within `SystemColor`. The first set provides names for indices into the internal system color lookup table; you will probably never need to use these. All of them have corresponding constants in the second set, except `SystemColor.NUM_COLORS`, which tells you how many `SystemColor` constants are in the second set.

public final static int ACTIVE_CAPTION ★
public final static int ACTIVE_CAPTION_BORDER ★
public final static int ACTIVE_CAPTION_TEXT ★
public final static int CONTROL ★
public final static int CONTROL_DK_SHADOW ★
public final static int CONTROL_HIGHLIGHT ★
public final static int CONTROL_LT_HIGHLIGHT ★
public final static int CONTROL_SHADOW ★
public final static int CONTROL_TEXT ★
public final static int DESKTOP ★
public final static int INACTIVE_CAPTION ★
public final static int INACTIVE_CAPTION_BORDER ★
public final static int INACTIVE_CAPTION_TEXT ★
public final static int INFO ★
public final static int INFO_TEXT ★
public final static int MENU ★
public final static int MENU_TEXT ★
public final static int NUM_COLORS ★
public final static int SCROLLBAR ★
public final static int TEXT ★
public final static int TEXT_HIGHLIGHT ★
public final static int TEXT_HIGHLIGHT_TEXT ★
public final static int TEXT_INACTIVE_TEXT ★
public final static int TEXT_TEXT ★
public final static int WINDOW ★

public final static int WINDOW_BORDER ★
public final static int WINDOW_TEXT ★

The second set of constants is the set of `SystemColors` you use when creating `Component` objects, to ensure they appear similar to other objects in the user's desktop environment. By using these symbolic constants, you can create new objects that are well integrated into the user's desktop environment, making it easier for the user to work with your program.

public final static SystemColor activeCaption ★
The `activeCaption` color represents the background color for the active window's title area. This is automatically set for you when you use `Frame`.

public final static SystemColor activeCaptionBorder ★
The `activeCaptionBorder` color represents the border color for the active window.

public final static SystemColor activeCaptionText ★
The `activeCaptionText` color represents the text color to use for the active window's title.

public final static SystemColor control ★
The `control` color represents the background color for the different components. If you are creating your own `Component` by subclassing `Canvas`, this should be the background color of the new object.

public final static SystemColor controlDkShadow ★
The `controlDkShadow` color represents a dark shadow color to be used with `control` and `controlShadow` to simulate a three-dimensional appearance. Ordinarily, when not depressed, the `controlDkShadow` should be used for the object's bottom and right edges. When depressed, `controlDkShadow` should be used for the top and left edges.

public final static SystemColor controlHighlight ★
The `controlHighlight` color represents an emphasis color for use in an area or an item of a custom component.

public final static SystemColor controlLtHighlight ★
The `controlLtHighlight` color represents a lighter emphasis color for use in an area or an item of a custom component.

public final static SystemColor controlShadow ★
The `controlShadow` color represents a light shadow color to be used with `control` and `controlDkShadow` to simulate a three-dimensional appearance. Ordinarily, when not depressed, the `controlShadow` should be used for the top and left edges. When depressed, `controlShadow` should be used for the bottom and right edges.

public final static SystemColor controlText ★

The `controlText` color represents the text color of a component. Before drawing any text in your own components, you should change the color to `controlText` with a statement like this:

```
g.setColor(SystemColor.controlText);
```

public final static SystemColor desktop ★

The `desktop` color represents the background color of the desktop workspace.

public final static SystemColor inactiveCaption ★

The `inactiveCaption` color represents the background color for an inactive window's title area.

public final static SystemColor inactiveCaptionBorder ★

The `inactiveCaptionBorder` color represents the border color for an inactive window.

public final static SystemColor inactiveCaptionText ★

The `inactiveCaptionText` color represents the text color to use for each inactive window's title.

public final static SystemColor info ★

The `info` color represents the background color for mouse-over help text. When a mouse dwells over an object, any pop-up help text should be displayed in an area of this color. In the Microsoft Windows world, these are also called "tool tips."

public final static SystemColor infoText ★

The `infoText` color represents the text color for mouse-over help text.

public final static SystemColor menu ★

The `menu` color represents the background color of deselected `MenuItem`-like objects. When the menu is selected, the `textHighlight` color is normally the background color.

public final static SystemColor menuText ★

The `menuText` color represents the color of the text on deselected `MenuItem`-like objects. When a menu is selected, the `textHighlightText` color is normally the text color. If the menu happens to be inactive, `textInactiveText` would be used.

public final static SystemColor scrollbar ★

The `scrollbar` color represents the background color for scrollbars. This color is used by default with `Scrollbar`, `ScrollPane`, `TextArea`, and `List` objects.

public final static SystemColor textHighlight ★

The `textHighlight` color represents the background color of highlighted text; for example, it is used for the selected area of a `TextField` or a selected `MenuItem`.

public final static SystemColor textHighlightText ★

The `textHighlightText` color represents the text color of highlighted text.

public final static SystemColor textInactiveText ★

The `textInactiveText` color represents the text color of an inactive component.

public final static SystemColor textText ★

The `textText` color represents the color of text in `TextComponent` objects.

public final static SystemColor window ★

The `window` color represents the background color of the window's display area. For an applet, this would be the display area specified by the `WIDTH` and `HEIGHT` values of the `<APPLET>` tag (`setBackground(SystemColor.window)`), although you would probably use it more for the background of a `Frame`.

public final static SystemColor windowBorder ★

The `windowBorder` color represents the color of the borders around a window. With AWT, instances of `Window` do not have borders, but instances of `Frame` and `Dialog` do.

public final static SystemColor windowText ★

The `windowText` color represents the color of the text drawn within the window.

NOTE Every platform does not fully support every system color. However, on platforms that do not provide natural values for some constants, Java selects reasonable alternate colors.

If you are going to be working only with Java's prefabricated components (`Button`, `List`, etc.), you don't have to worry about system colors; the component's default colors will be set appropriately. You are most likely to use system colors if you are creating your own components. In this case, you will use system colors to make your component emulate the behavior of other components; for example, you will use `controlText` as the color for drawing text, `activeCaption` as the background for the caption of an active window, and so on.

Constructors

There are no public constructors for `SystemColor`. If you need to create a new color, use the `Color` class described previously.

Miscellaneous methods

public int getRGB ()

The `getRGB()` method retrieves the current settings for red, green, and blue in one combined value, like `Color`. However, since the color value is dynamic, `getRGB()` needs to look up the value in an internal table. Therefore, `SystemColor` overrides `Color.getRGB()`.

public String toString ()

The `toString()` method of `SystemColor` returns a string showing the system color's index into its internal table. For example, the following string is returned by `SystemColor.text.toString()`:

```
java.awt.SystemColor[i=12]
```

3.5 Displaying Colors

Example 3-3 displays the predefined colors on the screen in a series of filled rectangles. When you press a mouse button, they appear brighter. When you press a key, they appear darker. (Event handling is fully explained in Chapter 4, *Events*.) Figure 3-4 shows the results, although it doesn't look very impressive in black and white.

Example 3–3: Color Display

```
import java.awt.*;
public class ColorDisplay extends Frame {
    int width, height;
    static Color colors[] =
                {Color.black, Color.blue, Color.cyan, Color.darkGray,
                Color.gray, Color.green, Color.lightGray, Color.magenta,
                Color.orange, Color.pink, Color.red, Color.white,
                Color.yellow};
    ColorDisplay () {
        super ("ColorDisplay");
        setBackground (Color.white);
    }
    static public void main (String args[]) {
        ColorDisplay f = new ColorDisplay();
        f.resize (300,300);
        f.show();
    }
    public void paint (Graphics g) {
        g.translate (insets().left, insets().top);
        if (width == 0) {
```

Example 3–3: Color Display (continued)

```
                Insets inset = insets();
                width  = (size().width - inset.right - inset.left) / 3;
                height = (size().height - inset.top - inset.bottom) / 5;
            }
            for (int i = 0; i < 3; i++) {
                for (int j = 0; j < 5; j++) {
                    if ((i == 2) && (j >= 3)) break;
                    g.setColor (colors[i*5+j]);
                    g.fillRect (i*width, j*height, width, height);
                }
            }
        }
        public boolean keyDown (Event e, int c) {
            for (int i=0;i<colors.length;i++)
                colors[i] = colors[i].darker();
            repaint();
            return true;
        }
        public boolean mouseDown (Event e, int x, int y) {
            for (int i=0;i<colors.length;i++)
                colors[i] = colors[i].brighter();
            repaint();
            return true;
        }
    }
```

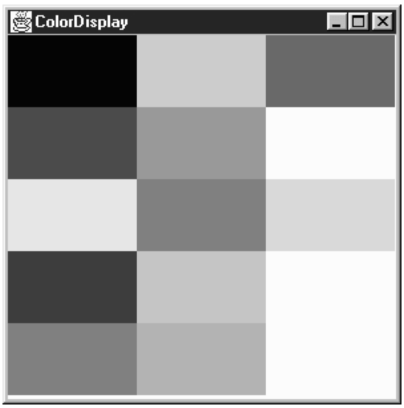


Figure 3–4: A color display

3.6 Using Desktop Colors

Example 3-4 demonstrates how to use the desktop color constants introduced in Java 1.1. If you run this example under an earlier release, an uncatchable class verifier error will occur.

NOTE Notice that the border lines are drawn from `0` to `width-1` or `height-1`. This is to draw lines of length `width` and `height`, respectively.

Example 3–4: Desktop Color Usage

```
// Java 1.1 only
import java.awt.*;
public class TextBox3D extends Canvas {
    String text;
    public TextBox3D (String s, int width, int height) {
        super();
        text=s;
        setSize(width, height);
    }
    public synchronized void paint (Graphics g) {
        FontMetrics fm = g.getFontMetrics();
        Dimension size=getSize();
        int x = (size.width - fm.stringWidth(text))/2;
        int y = (size.height - fm.getHeight())/2;
        g.setColor (SystemColor.control);
        g.fillRect (0, 0, size.width, size.height);
        g.setColor (SystemColor.controlShadow);
        g.drawLine (0, 0, 0, size.height-1);
        g.drawLine (0, 0, size.width-1, 0);
        g.setColor (SystemColor.controlDkShadow);
        g.drawLine (0, size.height-1, size.width-1, size.height-1);
        g.drawLine (size.width-1, 0, size.width-1, size.height-1);
        g.setColor (SystemColor.controlText);
        g.drawString (text, x, y);
    }
}
```

4

In this chapter:

- *Java 1.0 Event Model*
- *The Event Class*
- *The Java 1.1 Event Model*

Events

This chapter covers Java's event-driven programming model. Unlike procedural programs, windows-based programs require an event-driven model in which the underlying environment tells your program when something happens. For example, when the user clicks on the mouse, the environment generates an event that it sends to the program. The program must then figure out what the mouse click means and act accordingly.

This chapter covers two different event models, or ways of handling events. In Java 1.0.2 and earlier, events were passed to all components that could possibly have an interest in them. Events themselves were encapsulated in a single `Event` class. Java 1.1 implements a "delegation" model, in which events are distributed only to objects that have been registered to receive the event. While this is somewhat more complex, it is much more efficient and also more flexible, because it allows any object to receive the events generated by a component. In turn, this means that you can separate the user interface itself from the event-handling code.

In the Java 1.1 event model, all event functionality is contained in a new package, `java.awt.event`. Within this package, subclasses of the abstract class `AWTEvent` represent different kinds of events. The package also includes a number of `EventListener` interfaces that are implemented by classes that want to receive different kinds of events; they define the methods that are called when events of the appropriate type occur. A number of adapter classes are also included; they correspond to the `EventListener` interfaces and provide null implementations of the methods in the corresponding listener. The adapter classes aren't essential but provide a convenient shortcut for developers; rather than declaring that your class implements a particular `EventListener` interface, you can declare that your class extends the appropriate adapter.

The old and new event models are incompatible. Although Java 1.1 supports both, you should not use both models in the same program.

4.1 Java 1.0 Event Model

The event model used in versions 1.0 through 1.0.2 of Java is fairly simple. Upon receiving a user-initiated event, like a mouse click, the system generates an instance of the `Event` class and passes it along to the program. The program identifies the event's target (i.e., the component in which the event occurred) and asks that component to handle the event. If the target can't handle this event, an attempt is made to find a component that can, and the process repeats. That is all there is to it. Most of the work takes place behind the scenes; you don't have to worry about identifying potential targets or delivering events, except in a few special circumstances. Most Java programs only need to provide methods that deal with the specific events they care about.

4.1.1 Identifying the Target

All events occur within a Java `Component`. The program decides which component gets the event by starting at the outermost level and working in. In Figure 4-1, assume that the user clicks at the location (156, 70) within the enclosing `Frame`'s coordinate space. This action results in a call to the `Frame`'s `deliverEvent()` method, which determines which component within the frame should receive the event and calls that component's `deliverEvent()` method. In this case, the process continues until it reaches the `Button` labeled Blood, which occupies the rectangular space from (135, 60) to (181, 80). Blood doesn't contain any internal components, so it must be the component for which the event is intended. Therefore, an action event is delivered to Blood, with its coordinates translated to fit within the button's coordinate space—that is, the button receives an action event with the coordinates (21, 10). If the user clicked at the location (47, 96) within the Frame's coordinate space, the `Frame` itself would be the target of the event because there is no other component at this location.

To reach Blood, the event follows the component/container hierarchy shown in Figure 4-2.

4.1.2 Dealing With Events

Once `deliverEvent()` identifies a target, it calls that target's `handleEvent()` method (in this case, the `handleEvent()` method of Blood) to deliver the event for processing. If Blood has not overridden `handleEvent()`, its default implementation would call Blood's `action()` method. If Blood has not overridden `action()`, its default implementation (which is inherited from `Component`) is executed and

Figure 4–1: deliverEvent

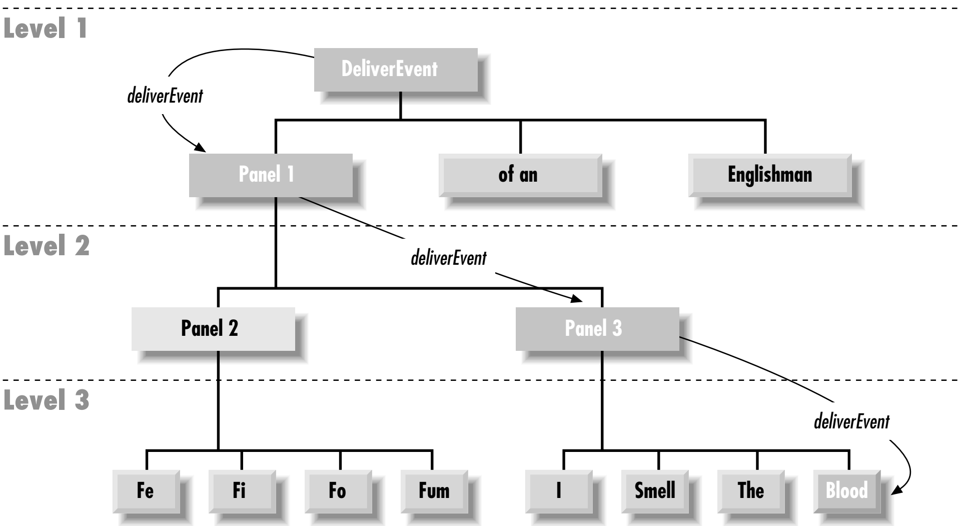


Figure 4–2: deliverEvent screen model

does nothing. For your program to respond to the event, you would have to provide your own implementation of `action()` or `handleEvent()`.

`handleEvent()` plays a particularly important role in the overall scheme. It is really a dispatcher, which looks at the type of event and calls an appropriate method to do the actual work: `action()` for action events, `mouseUp()` for mouse up events, and so on. Table 4-1 shows the event-handler methods you would have to override when using the default `handleEvent()` implementation. If you create your own `handleEvent()`, either to handle an event without a default handler or to process events differently, it is best to leave these naming conventions in place. Whenever you override an event-handler method, it is a good idea to call the overridden method to ensure that you don't lose any functionality. All of the event handler methods return a boolean, which determines whether there is any further event processing; this is described in the next section, "Passing the Buck."

Table 4–1: Event Types and Event Handlers

Event Type	Event Handler
MOUSE_ENTER	mouseEnter()
MOUSE_EXIT	mouseExit()
MOUSE_MOVE	mouseMove()
MOUSE_DRAG	mouseDrag()
MOUSE_DOWN	mouseDown()
MOUSE_UP	mouseUp()
KEY_PRESS	keyDown()
KEY_ACTION	keyDown()
KEY_RELEASE	keyUp()
KEY_ACTION_RELEASE	keyUp()
GOT_FOCUS	gotFocus()
LOST_FOCUS	lostFocus()
ACTION_EVENT	action()

4.1.3 Passing the Buck

In actuality, `deliverEvent()` does not call `handleEvent()` directly. It calls the `postEvent()` method of the target component. In turn, `postEvent()` manages the calls to `handleEvent()`. `postEvent()` provides this additional level of indirection to monitor the return value of `handleEvent()`. If the event handler returns `true`, the handler has dealt with the event completely. All processing has been completed, and the system can move on to the next event. If the event handler returns `false`, the handler has not completely processed the event, and `postEvent()` will contact the component's `Container` to finish processing the event. Using the screen in Figure 4-1 as the basis, Example 4-1 traces the calls through `deliverEvent()`, `postEvent()`, and `handleEvent()`. The action starts when the user clicks on the Blood button at coordinates (156, 70). In short, Java dives into the depths of the screen's component hierarchy to find the target of the event (by way of the method `deliverEvent()`). Once it locates the target, it tries to find something to deal with the event by working its way back out (by way of `postEvent()`, `handleEvent()`, and the convenience methods). As you can see, there's a lot of overhead, even in this relatively simple example. When we discuss the Java 1.1 event model, you will see that it has much less overhead, primarily because it doesn't need to go looking for a component to process each event.

Example 4–1: The deliverEvent, postEvent, and handleEvent Methods

```
DeliverEvent.deliverEvent (Event e) called
    DeliverEvent.locate (e.x, e.y)
    Finds Panel1
    Translate Event Coordinates for Panel1
    Panel1.deliverEvent (Event e)
        Panel1.locate (e.x, e.y)
        Finds Panel3
        Translate Event Coordinates for Panel3
        Panel3.deliverEvent (Event e)
            Panel3.locate (e.x, e.y)
            Finds Blood
            Translate Event Coordinates for Blood
            Blood.deliverEvent (Event e)
                Blood.postEvent (Event e)
                    Blood.handleEvent (Event e)
                        Blood.mouseDown   (Event e, e.x, e.y)
                            returns false
                        return false
                    Get parent Container Panel3
                    Translate Event Coordinates for Panel3
                    Panel3.postEvent (Event e)
                        Panel3.handleEvent (Event e)
                            Component.mouseDown (Event e, e.x, e.y)
                                returns false
                            return false
                        Get parent Container Panel1
                        Translate Event Coordinates for Panel1
                        Panel1.postEvent (Event e)
                            Panel1.handleEvent (Event e)
                                Component.action (Event e, e.x, e.y)
                                    return false
                                return false
                            Get parent Container DeliverEvent
                            Translate Event Coordinates for DeliverEvent
                            DeliverEvent.postEvent (Event e)
                                DeliverEvent.handleEvent
                                    DeliverEvent.action (Event e, e.x, e.y)
                                        return true
                                    return true
                                return true
                            return true
                        return true
                    return true
                return true
            return true
        return true
    return true
```

4.1.4 Overriding handleEvent()

In many programs, you only need to override convenience methods like `action()` and `mouseUp()`; you usually don't need to override `handleEvent()`, which is the high level event handler that calls the convenience methods. However, convenience methods don't exist for all event types. To act upon an event that doesn't have a convenience method (for example, `LIST_SELECT`), you need to override `handleEvent()` itself. Unfortunately, this presents a problem. Unlike the convenience methods, for which the default versions don't take any action, `handleEvent()` does quite a lot: as we've seen, it's the dispatcher that calls the convenience methods. Therefore, when you override `handleEvent()`, either you should reimplement all the features of the method you are overriding (a very bad idea), or you must make sure that the original `handleEvent()`is still executed to ensure that the remaining events get handled properly. The simplest way for you to do this is for your new `handleEvent()` method to act on any events that it is interested in and return `true` if it has handled those events completely. If the incoming event is not an event that your `handleEvent()` is interested in, you should call `super.handleEvent()` and return its return value. The following code shows how you might override `handleEvent()` to deal with a `LIST_SELECT` event:

```
public boolean handleEvent (Event e) {
    if (e.id == Event.LIST_SELECT) {   // take care of LIST_SELECT
        System.out.println ("Selected item: " + e.arg);
        return true;    // LIST_SELECT handled completely; no further action
    } else {   // make sure we call the overridden method to ensure
               // that other events are handled correctly
        return super.handleEvent (e);
    }
}
```

4.1.5 Basic Event Handlers

The convenience event handlers like `mouseDown()`, `keyUp()`, and `lostFocus()` are all implemented by the `Component` class. The default versions of these methods do nothing and return `false`. Because these methods do nothing by default, when overriding them you do not have to ensure that the overridden method gets called. This simplifies the programming task, since your method only needs to return `false` if it has not completely processed the event. However, if you start to subclass nonstandard components (for example, if someone has created a fancy `AudioButton`, and you're subclassing that, rather than the standard `Button`), you probably should explicitly call the overridden method. For example, if you are overriding `mouseDown()`, you should include a call to `super.mouseDown()`, just as we called `super.handleEvent()` in the previous example. This call is "good housekeeping"; most of the time, your program will work without it. However, your program will break as soon as someone changes the behavior of the AudioButton and adds some feature to its mouseDown() method. Calling the super class's event handler helps you write "bulletproof" code.

The code below overrides the mouseDown() method. I'm assuming that we're extending a standard component, rather than extending some custom component, and can therefore dispense with the call to super.mouseDown().

```
public boolean mouseDown (Event e, int x, int y) {
    System.out.println ("Coordinates: " + x + "-" + y);
    if ((x > 100) || (y < 100))
        return false;    // we're not interested in this event; pass it on
    else                 // we're interested;
        ...              // this is where event-specific processing goes
        return true;     // no further event processing
}
```

Here's a debugging hint: when overriding an event handler, make sure that the parameter types are correct—remember that each convenience method has different parameters. If your overriding method has parameters that don't match the original method, the program will still compile correctly. However, it won't work. Because the parameters don't match, your new method simply overloads the original, rather than overriding it. As a result, your method will never be called.

4.2 The Event Class

An instance of the Event class is a platform-independent representation that encapsulates the specifics of an event that happens within the Java 1.0 model. It contains everything you need to know about an event: who, what, when, where, and why the event happened. Note that the Event class is not used in the Java 1.1 event model; instead, Java 1.1 has an AWTEvent class, with subclasses for different event types.

When an event occurs, you decide whether or not to process the event. If you decide against reacting, the event passes through your program quickly without anything happening. If you decide to handle the event, you must deal with it quickly so the system can process the next event. If handling the event requires a lot of work, you should move the event-handling code into its own thread. That way, the system can process the next event while you go off and process the first. If you do not multithread your event processing, the system becomes slow and unresponsive and could lose events. A slow and unresponsive program frustrates users and may convince them to find another solution for their problems.

4.2.1 Variables

`Event` contains ten instance variables that offer all the specific information for a particular event.

Instance variables

public Object arg

The `arg` field contains some data regarding the event, to be interpreted by the recipient. For example, if the user presses Return within a `TextField`, an `Event` with an `id` of `ACTION_EVENT` is generated with the `TextField` as the `target` and the string within it as the `arg`. See a description of each specific event to find out what its `arg` means.

public int clickCount

The `clickCount` field allows you to check for double clicking of the mouse. This field is relevant only for `MOUSE_DOWN` events. There is no way to specify the time delta used to determine how quick a double-click needs to be, nor is there a maximum value for `clickCount`. If a user quickly clicks the mouse four times, `clickCount` is four. Only the passage of a system-specific time delta will reset the value so that the next `MOUSE_DOWN` is the first click. The incrementing of `clickCount` does not care which mouse button is pressed.

public Event evt

The `evt` field does not appear to be used anywhere but is available if you wish to pass around a linked list of events. Then your program can handle this event and tell the system to deal with the next one (as demonstrated in the following code), or you can process the entire chain yourself.

```
public boolean mouseDown (Event e, int x, int y) {
    System.out.println ("Coordinates: " + x + "-" + y);
    if (e.evt != null)
        postEvent (e.evt);
    return true;
}
```

public int id

The `id` field of `Event` contains the identifier of the event. The system-generated events are the following `Event` constants:

```
WINDOW_DESTROY       MOUSE_ENTER
WINDOW_EXPOSE        MOUSE_EXIT
WINDOW_ICONIFY       MOUSE_DRAG
WINDOW_DEICONIFY     SCROLL_LINE_UP
```

KEY_PRESS	SCROLL_LINE_DOWN
KEY_RELEASE	SCROLL_PAGE_UP
KEY_ACTION	SCROLL_PAGE_DOWN
KEY_ACTION_RELEASE	SCROLL_ABSOLUTE
MOUSE_DOWN	LIST_SELECT
MOUSE_UP	LIST_DESELECT
MOUSE_MOVE	ACTION_EVENT

As a user, you can create your own event types and store your own unique event ID here. In Java 1.0, there is no formal way to prevent conflicts between your events and system events, but using a negative IO is a good ad-hoc method. It is up to you to check all the user events generated in your program in order to avoid conflicts among user events.

public int key

For keyboard-related events, the `key` field contains the integer representation of the keyboard element that caused the event. Constants are available for the keypad keys. To examine `key` as a character, just cast it to a `char`. For nonkeyboard-related events, the value is zero.

pubic int modifiers

The `modifiers` field shows the state of the modifier keys when the event happened. A flag is set for each modifier key pressed by the user when the event happened. Modifier keys are Shift, Control, Alt, and Meta. Since the middle and right mouse key are indicated in a Java event by a modifier key, one reason to use the `modifiers` field is to determine which mouse button triggered an event. See Section 4.2.4 for an example.

public Object target

The `target` field contains a reference to the object that is the cause of the event. For example, if the user selects a button, the button is the target of the event. If the user moves the mouse into a `Frame`, the `Frame` is the target. The `target` indicates where the event happened, not the component that is dealing with it.

public long when

The `when` field contains the time of the event in milliseconds. The following code converts this `long` value to a `Date` to examine its contents:

```
Date d = new Date (e.when);
```

public int x
public int y

The `x` and `y` fields show the coordinates where the event happened. The coordinates are always relative to the top left corner of the target of the event and get translated based on the top left corner of the container as the event gets passed through the containing components. (See the previous Section 4.1.1 for an example of this translation.) It is possible for either or both of these to be outside the coordinate space of the applet (e.g., if user quickly moves the mouse outside the applet).

4.2.2 Constants

Numerous constants are provided with the `Event` class. Several designate which event happened (the why). Others are available to help in determining the function key a user pressed (the what). And yet more are available to make your life easier.

When the system generates an event, it calls a handler method for it. To deal with the event, you have to override the appropriate method. The different event type sections describe which methods you override.

Key constants

These constants are set when a user presses a key. Most of them correspond to function and keypad keys; since such keys are generally used to invoke an action from the program or the system, Java calls them *action keys* and causes them to generate a different `Event` type (`KEY_ACTION`) from regular alphanumeric keys (`KEY_PRESS`).

Table 4-2 shows the constants used to represent keys and the event type that uses each constant. The values, which are all declared `public static final int`, appear in the `key` variable of the event instance. A few keys represent ASCII characters that have string equivalents such as `\n`. Black stars (★) mark the constants that are new in Java 1.1; they can be used with the 1.0 event model, provided that you are running Java 1.1. Java 1.1 events use a different set of key constants defined in the `KeyEvent` class.

Table 4–2: Constants for Keys in Java 1.0

Constant	Event Type	Constant	Event Type
HOME	KEY_ACTION	F9	KEY_ACTION
END	KEY_ACTION	F10	KEY_ACTION
PGUP	KEY_ACTION	F11	KEY_ACTION
PGDN	KEY_ACTION	F12	KEY_ACTION
UP	KEY_ACTION	PRINT_SCREEN★	KEY_ACTION
DOWN	KEY_ACTION	SCROLL_LOCK★	KEY_ACTION
LEFT	KEY_ACTION	CAPS_LOCK★	KEY_ACTION
RIGHT	KEY_ACTION	NUM_LOCK★	KEY_ACTION
F1	KEY_ACTION	PAUSE★	KEY_ACTION

Table 4–2: Constants for Keys in Java 1.0 (continued)

Constant	Event Type	Constant	Event Type
F2	KEY_ACTION	INSERT★	KEY_ACTION
F3	KEY_ACTION	ENTER (\n)★	KEY_PRESS
F4	KEY_ACTION	BACK_SPACE (\b)★	KEY_PRESS
F5	KEY_ACTION	TAB (\t)★	KEY_PRESS
F6	KEY_ACTION	ESCAPE★	KEY_PRESS
F7	KEY_ACTION	DELETE★	KEY_PRESS
F8	KEY_ACTION		

Modifiers

Modifiers are keys like Shift, Control, Alt, or Meta. When a user presses any key or mouse button that generates an `Event`, the `modifiers` field of the `Event` instance is set. You can check whether any modifier key was pressed by ANDing its constant with the `modifiers` field. If multiple modifier keys were down at the time the event occurred, the constants for the different modifiers are ORed together in the field.

```
public static final int ALT_MASK
public static final int CTRL_MASK
public static final int META_MASK
public static final int SHIFT_MASK
```

When reporting a mouse event, the system automatically sets the `modifiers` field. Since Java is advertised as supporting the single-button mouse model, all buttons generate the same mouse events, and the system uses the `modifiers` field to differentiate between mouse buttons. That way, a user with a one- or two-button mouse can simulate a three-button mouse by clicking on his mouse while holding down a modifier key. Table 4-3 lists the mouse modifier keys; an applet in Section 4.2.4 demonstrates how to differentiate between mouse buttons.

Table 4–3: Mouse Button Modifier Keys

Mouse Button	Modifier Key
Left mouse button	None
Middle mouse button	ALT_MASK
Right mouse button	META_MASK

For example, if you have a three-button mouse, and click the right button, Java generates some kind of mouse event with the `META_MASK` set in the `modifiers` field. If you have a one-button mouse, you can generate the same event by clicking the mouse while depressing the Meta key.

NOTE If you have a multibutton mouse and do an Alt+right mouse or Meta+left mouse, the results are platform specific. You should get a mouse event with two masks set.

Key events

The component peers deliver separate key events when a user presses and releases nearly any key. `KEY_ACTION` and `KEY_ACTION_RELEASE` are for the function and arrow keys, while `KEY_PRESS` and `KEY_RELEASE` are for the remaining control and alphanumeric keys.

public static final int KEY_ACTION

The peers deliver the `KEY_ACTION` event when the user presses a function or keypad key. The default `Component.handleEvent()` method calls the `keyDown()` method for this event. If the user holds down the key, this event is generated multiple times. If you are using the 1.1 event model, the interface method `KeyListener.keyPressed()` handles this event.

public static final int KEY_ACTION_RELEASE

The peers deliver the `KEY_ACTION_RELEASE` event when the user releases a function or keypad key. The default `handleEvent()` method for `Component` calls the `keyUp()` method for this event. If you are using the 1.1 event model, the `KeyListener.keyReleased()` interface method handles this event.

public static final int KEY_PRESS

The peers deliver the `KEY_PRESS` event when the user presses an ordinary key. The default `Component.handleEvent()` method calls the `keyDown()` method for this event. Holding down the key causes multiple `KEY_PRESS` events to be generated. If you are using the 1.1 event model, the interface method `KeyListener.keyPressed()` handles this event.

public static final int KEY_RELEASE

The peers deliver `KEY_RELEASE` events when the user releases an ordinary key. The default `handleEvent()` method for `Component` calls the `keyUp()` method for this event. If you are using the 1.1 event model, the interface method `KeyListener.keyReleased()` handles this event.

NOTE If you want to capture arrow and keypad keys under the X Window System, make sure the key codes are set up properly, using the *xmodmap* command.

NOTE Some platforms generate events for the modifier keys by themselves, whereas other platforms require modifier keys to be pressed with another key. For example, on a Windows 95 platform, if Ctrl+A is pressed, you would expect one `KEY_PRESS` and one `KEY_RELEASE`. However, there is a second `KEY_RELEASE` for the Control key. Under Motif, you get only a single `KEY_RELEASE`.

Window events

Window events happen only for components that are children of `Window`. Several of these events are available only on certain platforms. Like other event types, the `id` variable holds the value of the specific event instance.

public static final int WINDOW_DESTROY

The peers deliver the `WINDOW_DESTROY` event whenever the system tells a window to destroy itself. This is usually done when the user selects the window manager's Close or Quit window menu option. By default, `Frame` instances do not deal with this event, and you must remember to catch it yourself. If you are using the 1.1 event model, the `WindowListener.windowClosing()` interface method handles this event.

public static final int WINDOW_EXPOSE

The peers deliver the `WINDOW_EXPOSE` event whenever all or part of a window becomes visible. To find out what part of the window has become uncovered, use the `getClipRect()` method (or `getClipBounds()` in Java version 1.1) of the `Graphics` parameter to the `paint()` method. If you are using the 1.1 event model, the `WindowListener.windowOpening()` interface method most closely corresponds to the handling of this event.

public static final int WINDOW_ICONIFY

The peers deliver the `WINDOW_ICONIFY` event when the user iconifies the window. If you are using the 1.1 event model, the interface method `WindowListener.windowIconified()` handles this event.

public static final int WINDOW_DEICONIFY

The peers deliver the `WINDOW_DEICONIFY` event when the user de-iconifies the window. If you are using the 1.1 event model, the interface method `WindowListener.windowDeiconified()` handles this event.

public static final int WINDOW_MOVED

The `WINDOW_MOVED` event signifies that the user has moved the window. If you are using the 1.1 event model, the `ComponentListener.componentMoved()` interface method handles this event.

Mouse events

The component peers deliver mouse events when a user presses or releases a mouse button. Events are also delivered whenever the mouse moves. In order to be platform independent, Java pretends that all mice have a single button. If you press the second or third button, Java generates a regular mouse event but sets the event's `modifers` field with a flag that indicates which button was pressed. If you press the left button, no `modifiers` flags are set. Pressing the center button sets the `ALT_MASK` flag; pressing the right button sets the `META_MASK` flag. Therefore, you can determine which mouse button was pressed by looking at the `Event.modifiers` attribute. Furthermore, users with a one-button or two-button mouse can generate the same events by pressing a mouse button while holding down the Alt or Meta keys.

NOTE Early releases of Java (1.0.2 and earlier) only propagated mouse events from `Canvas` and `Container` objects. With the 1.1 event model, the events that different components process are better defined.

---

public static final int MOUSE_DOWN

The peers deliver the `MOUSE_DOWN` event when the user presses any mouse button. This action must occur over a component that passes along the `MOUSE_DOWN` event. The default `Component.handleEvent()` method calls the `mouseDown()` method for this event. If you are using the 1.1 event model, the `MouseListener.mousePressed()` interface method handles this event.

public static final int MOUSE_UP

The peers deliver the `MOUSE_UP` event when the user releases the mouse button. This action must occur over a component that passes along the `MOUSE_UP` event. The default `handleEvent()` method for `Component` calls the `mouseUp()` method for this event. If you are using the 1.1 event model, the interface method `MouseListener.mouseReleased()` handles this event.

public static final int MOUSE_MOVE

The peers deliver the `MOUSE_MOVE` event whenever the user moves the mouse over any part of the applet. This can happen many, many times more than you want to track, so make sure you really want to do something with this event before trying to capture it. (You can also capture `MOUSE_MOVE` events and without losing much, choose to deal with only every third or fourth movement.) The default handleEvent() method calls the mouseMove() method for the event. If you are using the 1.1 event model, the interface method MouseMotionListener.mouseMoved() handles this event.

public static final int MOUSE_DRAG

The peers deliver the MOUSE_DRAG event whenever the user moves the mouse over any part of the applet with a mouse button depressed. The default method handleEvent() calls the mouseDrag() method for the event. If you are using the 1.1 event model, the interface method MouseMotionListener.mouseDragged() handles this event.

public static final int MOUSE_ENTER

The peers deliver the MOUSE_ENTER event whenever the cursor enters a component. The default handleEvent() method calls the mouseEnter() method for the event. If you are using the 1.1 event model, the interface method MouseListener.mouseEntered() handles this event.

public static final int MOUSE_EXIT

The peers deliver the MOUSE_EXIT event whenever the cursor leaves a component. The default handleEvent() method calls the mouseExit() method for the event. If you are using the 1.1 event model, the interface method MouseListener.mouseExited() handles this event.

Scrolling events

The peers deliver scrolling events for the Scrollbar component. The objects that have a built-in scrollbar (like List, ScrollPane, and TextArea) do not generate these events. No default methods are called for any of the scrolling events. They must be dealt with in the handleEvent() method of the Container or a subclass of the Scrollbar. You can determine which particular event occurred by checking the id variable of the event, and find out the new position of the thumb by looking at the arg variable or calling getValue() on the scrollbar. See also the description of the AdjustmentListener interface later in this chapter.

public static final int SCROLL_LINE_UP

The scrollbar peers deliver the SCROLL_LINE_UP event when the user presses the arrow pointing up for the vertical scrollbar or the arrow pointing left for the horizontal scrollbar. This decreases the scrollbar setting by one back toward the minimum value. If you are using the 1.1 event model, the interface method AdjustmentListener.adjustmentValueChanged() handles this event.

public static final int SCROLL_LINE_DOWN

The peers deliver the `SCROLL_LINE_DOWN` event when the user presses the arrow pointing down for the vertical scrollbar or the arrow pointing right for the horizontal scrollbar. This increases the scrollbar setting by one toward the maximum value. If you are using the 1.1 event model, the interface method `AdjustmentListener.adjustmentValueChanged()` handles this event.

public static final int SCROLL_PAGE_UP

The peers deliver the `SCROLL_PAGE_UP` event when the user presses the mouse with the cursor in the area between the slider and the decrease arrow. This decreases the scrollbar setting by the paging increment, which defaults to 10, back toward the minimum value. If you are using the 1.1 event model, the interface method `AdjustmentListener.adjustmentValueChanged()` handles this event.

public static final int SCROLL_PAGE_DOWN

The peers deliver the `SCROLL_PAGE_DOWN` event when the user presses the mouse with the cursor in the area between the slider and the increase arrow. This increases the scrollbar setting by the paging increment, which defaults to 10, toward the maximum value. If you are using the 1.1 event model, the interface method `AdjustmentListener.adjustmentValueChanged()` handles this event.

public static final int SCROLL_ABSOLUTE

The peers deliver the `SCROLL_ABSOLUTE` event when the user drags the slider part of the scrollbar. There is no set time period or distance between multiple `SCROLL_ABSOLUTE` events. If you are using the Java version 1.1 event model, the `AdjustmentListener.adjustmentValueChanged()` interface method handles this event.

public static final int SCROLL_BEGIN ★

The `SCROLL_BEGIN` event is not delivered by peers, but you may wish to use it to signify when a user drags the slider at the beginning of a series of `SCROLL_ABSOLUTE` events. `SCROLL_END`, described next, would then be used to signify the end of the series.

public static final int SCROLL_END ★

The `SCROLL_END` event is not delivered by peers, but you may wish to use it to signify when a user drags the slider at the end of a series of `SCROLL_ABSOLUTE` events. `SCROLL_BEGIN`, described previously, would have been used to signify the beginning of the series.

List events

Two events specific to the `List` class are passed along by the peers. They signify when the user has selected or deselected a specific choice in the `List`. It is not ordinarily necessary to capture these events, because the peers deliver the `ACTION_EVENT` when the user double-clicks on a specific item in the `List` and it is this `ACTION_EVENT` that triggers something to happen. However, if there is reason to do something when the user has just single-clicked on a choice, these events may be useful. An example of how they would prove useful is if you are displaying a list of filenames with the ability to preview files before loading. Single selection would preview, double-click would load, and deselect would stop previewing.

No default methods are called for any of the list events. They must be dealt with in the `handleEvent()` method of the `Container` of the `List` or a subclass of the `List`. You can determine which particular event occurred by checking the `id` variable of the event.

public static final int LIST_SELECT

The peers deliver the `LIST_SELECT` event when the user selects an item in a `List`. If you are using the 1.1 event model, the interface method `ItemListener.itemStateChanged()` handles this event.

public static final int LIST_DESELECT

The peers deliver the `LIST_DESELECT` event when an item in a `List` has been deselected. This is generated only if the `List` permits multiple selections. If you are using the 1.1 event model, the `ItemListener.itemStateChanged()` interface method handles this event.

Focus events

The peers deliver focus events when a component gains (`GOT_FOCUS`) or loses (`LOST_FOCUS`) the input focus. No default methods are called for the focus events. They must be dealt with in the `handleEvent()` method of the `Container` of the component or a subclass of the component. You can determine which particular event occurred by checking the `id` variable of the event.

NOTE Early releases of Java (1.0.2 and before) did not propagate focus events on all platforms. This is fixed in release 1.1 of Java. Still, you should avoid capturing focus events if you want to write portable 1.0 code.

---

public static final int GOT_FOCUS

The peers deliver the `GOT_FOCUS` event when a component gets the input focus. If you are using the 1.1 event model, the `FocusListener.focusGained()` interface method handles this event.

public static final int LOST_FOCUS

The peers deliver the `LOST_FOCUS` event when a component loses the input focus. If you are using the 1.1 event model, the `FocusListener.focusLost()` interface method handles this event.

FileDialog events

The `FileDialog` events are another set of nonportable events. Ordinarily, the `FileDialog` events are completely dealt with by the system, and you never see them. Refer to Chapter 6, *Containers* for exactly how to work with the `FileDialog` object. If you decide to create a generic `FileDialog` object, you can use these events to indicate file loading and saving. These constants would be used in the `id` variable of the specific event instance:

public static final int LOAD_FILE
public static final int SAVE_FILE

Miscellaneous events

`ACTION_EVENT` is probably the event you deal with most frequently. It is generated when the user performs the desired action for a specific component type (e.g., when a user selects a button or toggles a checkbox). This constant would be found in the `id` variable of the specific event instance.

public static final int ACTION_EVENT

The circumstances that lead to the peers delivering the `ACTION_EVENT` event depend upon the component that is the target of the event and the user's platform. Although the event can be passed along differently on different platforms, users will be accustomed to how the peers work on their specific platforms and will not care that it is different on the other platforms. For example, a Java 1.0 `List` component on a Microsoft Windows platform allows the user to select an item by pressing the first letter of the choice, whereupon the `List` tries to find an item that starts with the letter. The X Window System `List` component does not provide this capability. It works like a normal X `List`, where the user must scroll to locate the item and then select it.

When the `ACTION_EVENT` is generated, the `arg` variable of the specific `Event` instance is set based upon the component type. In Chapters 5–11, which describe Java's GUI components, the description of each component contains an "Events" subsection that describes the value of the event's `arg` field. If you are using the 1.1 event model, the `ActionListener.actionPerformed()` and `ItemListener.itemStateChanged()` interface methods handle this event, depending upon the component type.

4.2.3 Event Methods

Constructors

Ordinarily, the peers deliver all your events for you. However, if you are creating your own components or want to communicate across threads, it may be necessary to create your own events. You can also create your own events to notify your component's container of application-specific occurrences. For example, if you were implementing your own tab sequencing for text fields, you could create a "next text field" event to tell your container to move to the next text field. Once you create the event, you send it through the system using the `Component.postEvent()` method.

public Event (Object target, long when, int id, int x, int y, int key, int modifiers, Object arg)

The first version of the constructor is the most complete and is what the other two call. It initializes all the fields of the `Event` to the parameters passed and sets `clickCount` to 0. See the descriptions of the instance variables Section 4.2.1 for the meanings of the arguments.

public Event (Object target, long when, int id, int x, int y, int key, int modifiers)

The second constructor version calls the first with `arg` set to null.

public Event (Object target, int id, Object arg)

The final version calls the first constructor with the `when`, `x`, `y`, `key`, and `modifiers` parameters set to 0.

Modifier methods

The modifier methods check to see if the different modifier mask values are set. They report the state of each modifier key at the moment an event occurred. It is possible for multiple masks to be set if multiple modifiers are pressed when the event occurs.

There is no `altDown()` method; to check whether the Alt key is pressed you must directly compare the event's `modifiers` against the `Event.ALT_MASK` constant. The `metaDown()` method is helpful when dealing with mouse events to see if the user pressed the right mouse button.

public boolean shiftDown ()

The `shiftDown()` method returns `true` if the Shift key was pressed and `false` otherwise. There is no way to differentiate left and right shift keys.

public boolean controlDown ()

The `controlDown()` method returns `true` if the Control key was pressed and `false` otherwise.

public boolean metaDown ()

The `metaDown()` method returns `true` if the Meta key was pressed and `false` otherwise.

Miscellaneous methods

public void translate (int x, int y)

The `translate()` method translates the x and y coordinates of the `Event` instance by `x` and `y`. The system does this so that the coordinates of the event are relative to the component receiving the event, rather than the container of the component. The system takes care of all this for you when passing the event through the containment hierarchy (not the object hierarchy), so you do not have to bother with translating them yourself. Figure 4-3 shows how this method would change the location of an event from a container down to an internal component.

protected String paramString ()

When you call the `toString()` method of `Event`, the `paramString()` method is called in turn to build the string to display. In the event you subclass `Event` to add additional information, instead of having to provide a whole new `toString()` method, you need only add the new information to the string already generated by `paramString()`. Assuming the new information is `foo`, this would result in the following method declaration:

```
protected String paramString() {
    return super.paramString() + ",foo=" + foo;
}
```

public String toString ()

The `toString()` method of `Event` returns a string with numerous components. The only variables that will always be in the output will be the event ID and the x and y coordinates. The others will be present if necessary (i.e., non-null): key (as the integer corresponding to a keyboard event), shift when `shiftDown()` is true; control, when `controlDown()` is true; meta, when `metaDown()` is true; target (if it was a `Component`); and arg (the value depends on the target and ID). `toString()` does not display all pieces of the `Event` information. An event when moving a `Scrollbar` might result in the following:

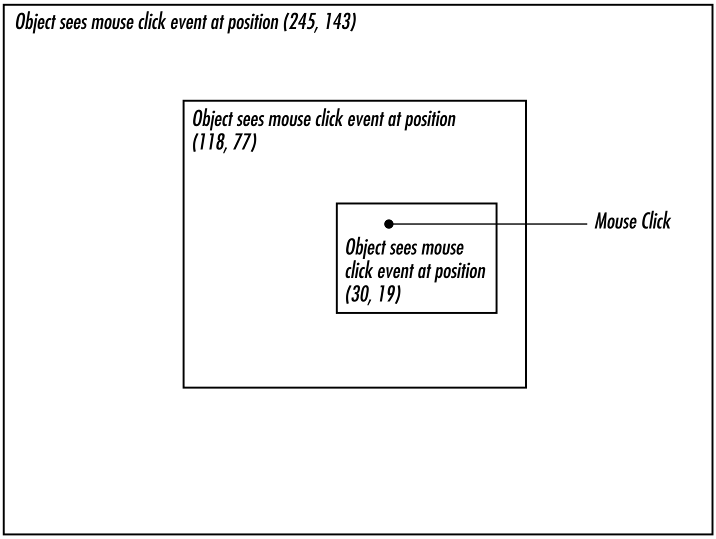


Figure 4–3: Translating an event's location relative to a component

```
java.awt.Event[id=602,x=374,y=110,target=java.awt.Scrollbar[374,
110,15x50,val=1,vis=true,min=0,max=255,vert],arg=1]
```

4.2.4 Working With Mouse Buttons in Java 1.0

As stated earlier, the modifiers component of Event can be used to differentiate the different mouse buttons. If the user has a multibutton mouse, the modifiers field is set automatically to indicate which button was pressed. If the user does not own a multibutton mouse, he or she can press the mouse button in combination with the Alt or Meta keys to simulate a three-button mouse. Example 4-2 is a sample program called mouseEvent that displays the mouse button selected.

Example 4–2: Differentiating Mouse Buttons in Java 1.0

```
import java.awt.*;
import java.applet.*;
public class mouseEvent extends Applet {
    String theString = "Press a Mouse Key";
    public synchronized void setString (String s) {
        theString = s;
    }
    public synchronized String getString () {
        return theString;
    }
    public synchronized void paint (Graphics g) {
        g.drawString (theString, 20, 20);
    }
    public boolean mouseDown (Event e, int x, int y) {
        if (e.modifiers == Event.META_MASK) {
```

Example 4–2: Differentiating Mouse Buttons in Java 1.0 (continued)

```
            setString ("Right Button Pressed");
        } else if (e.modifiers == Event.ALT_MASK) {
            setString ("Middle Button Pressed");
        } else {
            setString ("Left Button Pressed");
        }
        repaint ();
        return true;
    }
    public boolean mouseUp (Event e, int x, int y) {
        setString ("Press a Mouse Key");
        repaint ();
        return true;
    }
}
```

Unfortunately, this technique does not always work. With certain components on some platforms, the peer captures the mouse event and does not pass it along; for example, on Windows, the display-edit menu of a `TextField` appears when you select the right mouse button. Be cautious about relying on multiple mouse buttons; better yet, if you want to ensure absolute portability, stick to a single button.

4.2.5 Comprehensive Event List

Unfortunately, there are many platform-specific differences in the way event handling works. It's not clear whether these differences are bugs or whether vendors think they are somehow improving their product by introducing portability problems. We hope that as Java matures, different platforms will gradually come into synch. Until that happens, you might want your programs to assume the lowest common denominator. If you are willing to take the risk, you can program for a specific browser or platform, but should be aware of the possibility of changes.

Appendix C, *Platform-Specific Event Handling*, includes a table that shows which components pass along which events by default in the most popular environments. This table was developed using an interactive program called `compList`, which generates a list of supported events for each component. You can find `compList` on this book's Web site, http://www.ora.com/catalog/javawt. If you want to check the behavior of some new platform, or a newer version of one of the platforms in Appendix C, feel free to use `compList`. It does require a little bit of work on your part. You have to click, toggle, type, and mouse over every object. Hopefully, as Java matures, this program will become unnecessary.

4.3 The Java 1.1 Event Model

Now it's time to discuss the new event model that is implemented by the 1.1 release of the JDK. Although this model can seem much more complex (it does have many more pieces), it is really much simpler and more efficient. The new event model does away with the process of searching for components that are interested in an event—`deliverEvent()`, `postEvent()`, `handleEvent()`—and all that. The new model requires objects be registered to receive events. Then, only those objects that are registered are told when the event actually happens.

This new model is called "delegation"; it implements the `Observer-Observable` design pattern with events. It is important in many respects. In addition to being much more efficient, it allows for a much cleaner separation between GUI components and event handling. It is important that any object, not just a `Component`, can receive events. Therefore, you can separate your event-handling code from your GUI code. One set of classes can implement the user interface; another set of classes can respond to the events generated by the interface. This means that if you have designed a good interface, you can reuse it in different applications by changing the event processing. The delegation model is essential to JavaBeans, which allows interaction between Java and other platforms, like OpenDoc or ActiveX. To allow such interaction, it was essential to separate the source of an event from the recipient.*

The delegation model has several other important ramifications. First, event handlers no longer need to worry about whether or not they have completely dealt with an event; they do what they need to, and return. Second, events can be broadcast to multiple recipients; any number of classes can be registered to receive an event. In the old model, broadcasting was possible only in a very limited sense, if at all. An event handler could declare that it hadn't completely processed an event, thus letting its container receive the event when it was done, or an event handler could generate a new event and deliver it to some other component. In any case, developers had to plan how to deliver events to other recipients. In Java 1.1, that's no longer necessary. An event will be delivered to every object that is registered as a listener for that event, regardless of what other objects do with the event. Any listener can mark an event "consumed," so it will be ignored by the peer or (if they care) other listeners.

Finally, the 1.1 event model includes the idea of an event queue. Instead of having to override `handleEvent()` to see all events, you can peek into the system's event queue by using the `EventQueue` class. The details of this class are discussed at the end of this chapter.

---

* For more information about JavaBeans, see http://splash.javasoft.com/beans/.

In Java 1.1, each component is an event *source* that can generate certain types of events, which are all subclasses of `AWTEvent`. Objects that are interested in an event are called *listeners*. Each event type corresponds to a listener interface that specifies the methods that are called when the event occurs. To receive an event, an object must implement the appropriate listener interface and must be registered with the event's source, by a call to an "add listener" method of the component that generates the event. Who calls the "add listener" method can vary; it is probably the best design for the component to register any listeners for the events that it generates, but it is also possible for the event handler to register itself, or for some third object to handle registration (for example, one object could call the constructor for a component, then call the constructor for an event handler, then register the event handler as a listener for the component's events).

This sounds complicated, but it really isn't that bad. It will help to think in concrete terms. A `TextField` object can generate action events, which in Java 1.1 are of the class `ActionEvent`. Let's say we have an object of class `TextActionHandler` that is called `myHandler` that is interested in receiving action events from a text field named `inputBuffer`. This means that our object must implement the `ActionListener` interface, and this in turn, means that it must include an `actionPerformed()` method, which is called when an action event occurs. Now, we have to register our object's interest in action events generated by `inputBuffer`; to do so, we need a call to `inputBuffer.addActionListener(myHandler)`. This call would probably be made by the object that is creating the `TextField` but could also be made by our event handler itself. The code might be as simple as this:

```
...
public void init(){
    ...
    inputBuffer = new TextField();
    myHandler = new TextActionHandler();
    inputBuffer.addActionListener(myHandler); // register the handler for the
                                              // buffer's events
    add (inputBuffer);  // add the input buffer to the display
    ...
}
```

Once our object has been registered, `myHandler.actionPerformed()` will be called whenever a user does anything in the text field that generates an action event, like typing a carriage return. In a way, `actionPerformed()` is very similar to the `action()` method of the old event model—except that it is not tied to the `Component` hierarchy; it is part of an interface that can be implemented by any object that cares about events.

Of course, there are many other kinds of events. Figure 4-4 shows the event hierarchy for Java 1.1. Figure 4-5 shows the different listener interfaces, which are all subinterfaces of EventListener, along with the related adapter classes.

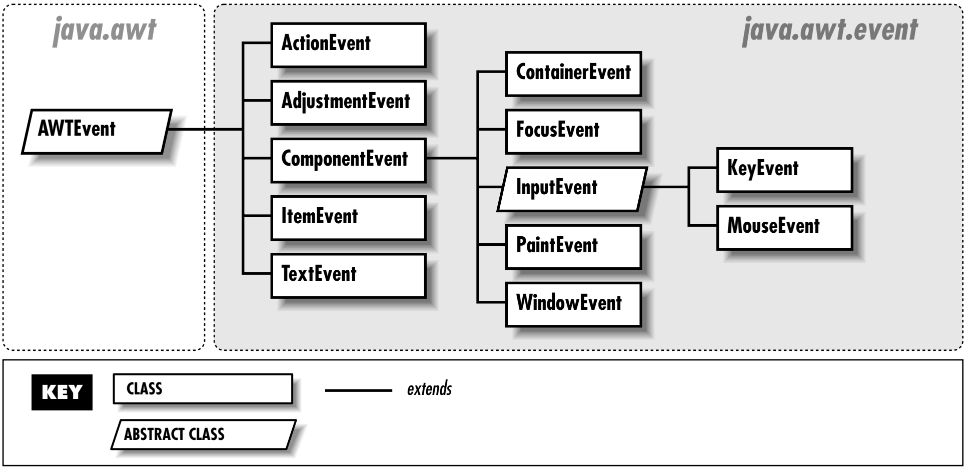


Figure 4–4: AWTEvent class hierarchy

Some of the listener interfaces are constructed to deal with multiple events. For instance, the MouseListener interface declares five methods to handle different kinds of mouse events: mouse down, mouse up, click (both down and up), mouse enter, and mouse exit. Strictly speaking, this means that an object interested in mouse events must implement MouseListener and must therefore implement five methods to deal with all possible mouse actions. This sounds like a waste of the programmer's effort; most of the time, you're only interested in one or two of these events. Why should you have to implement all five methods? Fortunately, you don't. The java.awt.event package also includes a set of *adapter classes*, which are shorthands that make it easier to write event handlers. The adapter class for any listener interface provides a null implementation of all the methods in that interface. For example, the MouseAdapter class provides stub implementations of the methods mouseEntered(), mouseExited(), mousePressed(), mouseReleased(), and mouseClicked(). If you want to write an event-handling class that deals with mouse clicks only, you can declare that your class extends MouseAdapter. It then inherits all five of these methods, and your only programming task is to override the single method you care about: mouseClicked().

A particularly convenient way to use the adapters is to write an anonymous inner class. For example, the following code deals with the MOUSE_PRESSED event without creating a separate listener class:

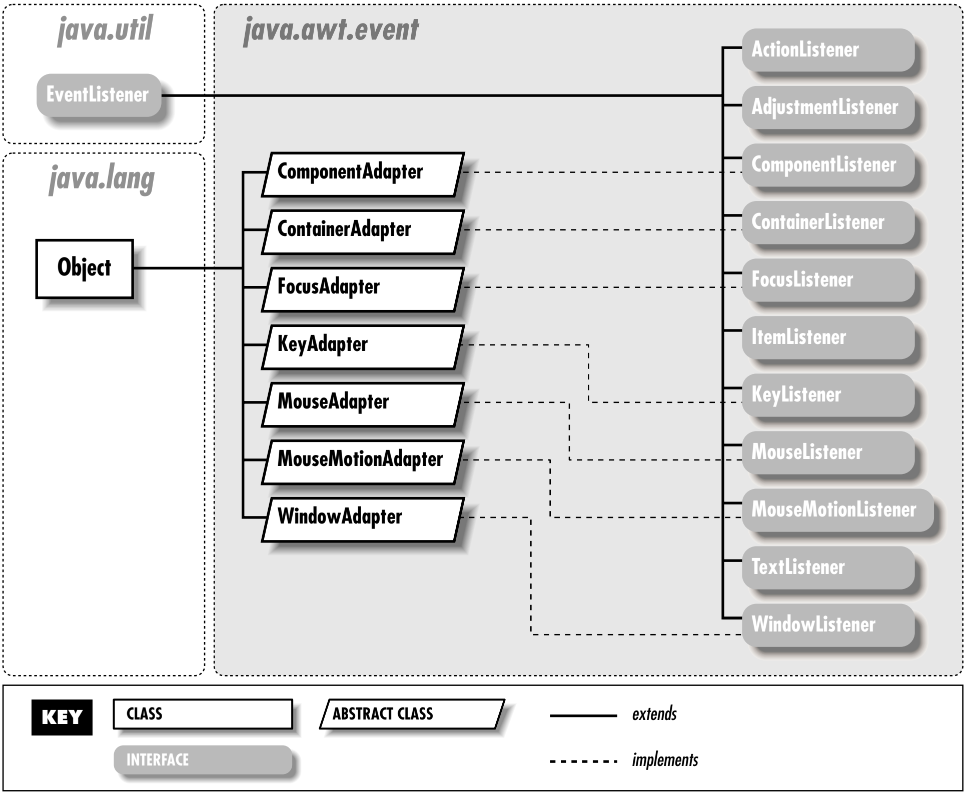


Figure 4–5: AWT EventListener and Adapter class hierarchies

```
addMouseListener (new MouseAdapter()   {
  public void mousePressed (MouseEvent e)  {
    // do what's needed to handle the event
    System.out.println ("Clicked at: " + e.getPoint());
  }
});
```

This code creates a `MouseAdapter`, overrides its `mousePressed()` method, and registers the resulting unnamed object as a listener for mouse events. Its `mousePressed()` method is called when `MOUSE_PRESSED` events occur. You can also use the adapter classes to implement something similar to a callback. For example, you could override `mousePressed()` to call one of your own methods, which would then be called whenever a `MOUSE_PRESSED` event occurs.

There are adapter classes for most of the listener interfaces; the only exceptions are the listener interfaces that contain only one method (for example, there's no `ActionAdapter` to go with `ActionListener`). When the listener interface contains only one method, an adapter class is superfluous. Event handlers may as well implement the listener interface directly, because they will have to override the only method in the interface; creating a dummy class with the interface method stubbed out doesn't accomplish anything. The different adapter classes are discussed with their related `EventListener` interfaces.

With all these adapter classes, listener interfaces, and event classes, it's easy to get confused. Here's a quick summary of the different pieces involved and the roles they play:

- Components generate `AWTEvents` when something happens. Different subclasses of `AWTEvent` represent different kinds of events. For example, mouse events are represented by the `MouseEvent` class. Each component can generate certain subclasses of `AWTEvent`.
- Event handlers are registered to receive events by calls to an "add listener" method in the component that generates the event. There is a different "add listener" method for every kind of `AWTEvent` the component can generate; for example, to declare your interest in a mouse event, you call the component's `addMouseListener()` method.
- Every event type has a corresponding listener interface that defines the methods that are called when that event occurs. To be able to receive events, an event handler must therefore implement the appropriate listener interface. For example, `MouseListener` defines the methods that are called when mouse events occur. If you create a class that calls `addMouseListener()`, that class had better implement the `MouseListener` interface.
- Most event types also have an adapter class. For example, `MouseEvents` have a `MouseAdapter` class. The adapter class implements the corresponding listener interface but provides a `stub` implementation of each method (i.e., the method just returns without taking any action). Adapter classes are shorthand for programs that only need a few of the methods in the listener interface. For example, instead of implementing all five methods of the `MouseListener` interface, a class can extend the `MouseAdapter` class and override the one or two methods that it is interested in.

4.3.1 Using the 1.1 Event Model

Before jumping in and describing all the different pieces in detail, we will look at a simple applet that uses the Java 1.1 event model. Example 4-3 is equivalent to Example 4-2, except that it uses the new event model; when you press a mouse button, it just tells you what button you pressed. Notice how the new class, `mouseEvent11`, separates the user interface from the actual work. The class mouseEvent11 implements a very simple user interface. The class UpDownCatcher handles the events, figures out what to do, and calls some methods in mouseEvent11 to communicate the results. I added a simple interface that is called GetSetString to define the communications between the user interface and the event handler; strictly speaking, this isn't necessary, but it's a good programming practice.

Example 4–3: Handling Mouse Events in Java 1.1

```
// Java 1.1 only
import java.awt.*;
import java.awt.event.*;
import java.applet.*;
interface GetSetString {
    public void setString (String s);
    public String getString ();
}
```

The UpDownCatcher class is responsible for handling events generated by the user interface. It extends MouseAdapter so that it needs to implement only the MouseListener methods that we care about (such as mousePressed() and mouseReleased()).

```
class UpDownCatcher extends MouseAdapter {
    GetSetString gss;
    public UpDownCatcher (GetSetString s) {
        gss = s;
    }
```

The constructor simply saves a reference to the class that is using this handler.

```
    public void mousePressed (MouseEvent e) {
        int mods = e.getModifiers();
        if ((mods & MouseEvent.BUTTON3_MASK) != 0) {
            gss.setString ("Right Button Pressed");
        } else if ((mods & MouseEvent.BUTTON2_MASK) != 0) {
            gss.setString ("Middle Button Pressed");
        } else {
            gss.setString ("Left Button Pressed");
        }
        e.getComponent().repaint();
    }
```

The mousePressed method overrides one of the methods of the MouseAdapter class. The method mousePressed() is called whenever a user presses any mouse button. This method figures out which button on a three-button mouse was pressed and calls the setString() method in the user interface to inform the user of the result.

```
        public void mouseReleased (MouseEvent e) {
            gss.setString ("Press a Mouse Key");
            e.getComponent().repaint();
        }
    }
```

The mouseReleased method overrides another of the methods of the MouseAdapter class. When the user releases the mouse button, it calls setString() to restore the user interface to the original message.

```
    public class mouseEvent11 extends Applet implements GetSetString {
        private String theString = "Press a Mouse Key";
        public synchronized void setString (String s) {
            theString = s;
        }
        public synchronized String getString () {
            return theString;
        }
        public synchronized void paint (Graphics g) {
            g.drawString (theString, 20, 20);
        }
        public void init () {
            addMouseListener (new UpDownCatcher(this));
        }
    }
```

mouseEvent11 is a very simple applet that implements our user interface. All it does is draw the desired string on the screen; the event handler tells it what string to draw. The init() method creates an instance of the event handler, which is UpDownCatcher, and registers it as interested in mouse events.

Because the user interface and the event processing are in separate classes, it would be easy to use this user interface for another purpose. You would have to replace only the UpDownCatcher class with something else—perhaps a more complex class that reported when the mouse entered and exited the area.

4.3.2 AWTEvent and Its Children

Under the 1.1 delegation event model, all system events are instances of AWTEvent or its subclasses. The model provides two sets of event types. The first set are fairly raw events, such as those indicating when a component gets focus, a key is pressed, or the mouse is moved. These events exist in ComponentEvent and its subclasses, along with some new events previously available only by overriding non-event-related methods. In addition, higher-level event types (for example, selecting a button) are encapsulated in other subclasses of AWTEvent that are not children of ComponentEvent.

4.3.2.1 AWTEvent

Variables

protected int id ★

The `id` field of `AWTEvent` is protected and is accessible through the `getID()` method. It serves as the identifier of the event type, such as the `ACTION_PERFORMED` type of `ActionEvent` or the `MOUSE_MOVE` type of `Event`. With the delegation event model, it is usually not necessary to look at the event `id` unless you are looking in the event queue; just register the appropriate event listener.

Constants The constants of `AWTEvent` are used in conjunction with the internal method `Component.eventEnabled()`. They are used to help the program determine what style of event handling (true/false-containment or listening-delegation) the program uses and which events a component processes. If you want to process 1.1 events without providing a listener, you need to set the mask for the type of event you want to receive. Look in Chapter 5, *Components,* for more information on the use of these constants:

public final static long ACTION_EVENT_MASK ★
public final static long ADJUSTMENT_EVENT_MASK ★
public final static long COMPONENT_EVENT_MASK ★
public final static long CONTAINER_EVENT_MASK ★
public final static long FOCUS_EVENT_MASK ★
public final static long ITEM_EVENT_MASK ★
public final static long KEY_EVENT_MASK ★
public final static long MOUSE_EVENT_MASK ★
public final static long MOUSE_MOTION_EVENT_MASK ★
public final static long TEXT_EVENT_MASK ★
public final static long WINDOW_EVENT_MASK ★

In addition to the mask constants, the constant `RESERVED_ID_MAX` is the largest event ID reserved for "official" events. You may use ID numbers greater than this value to create your own events, without risk of conflicting with standard events.

public final static long RESERVED_ID_MAX ★

Constructors Since `AWTEvent` is an abstract class, you cannot call the constructors directly. They are automatically called when an instance of a child class is created.

public AWTEvent(Event event) ★

The first constructor creates an `AWTEvent` from the parameters of a 1.0 `Event`. The `event.target` and `event.id` are passed along to the second constructor.

public AWTEvent(Object source, int id) ★

This constructor creates an `AWTEvent` with the given `source`; the source is the object generating the event. The `id` field serves as the identifier of the event type. It is protected and is accessible through the `getID()` method. With the delegation event model, it is usually not necessary to look at the event `id` unless you are looking in the event queue or in the `processEvent()` method of a component; just register the appropriate event listener.

Methods

public int getID() ★

The `getID()` method returns the `id` from the constructor, thus identifying the event type.

protected void consume() ★

The `consume()` method is called to tell an event that it has been handled. An event that has been marked "consumed" is still delivered to the source component's peer and to all other registered listeners. However, the peer will ignore the event; other listeners may also choose to ignore it, but that's up to them. It isn't possible for a listener to "unconsume" an event that has already been marked "consumed."

Noncomponent events cannot be consumed. Only keyboard and mouse event types can be flagged as consumed. Marking an event "consumed" is useful if you are capturing keyboard input and need to reject a character; if you call `consume()`, the key event never makes it to the peer, and the keystroke isn't displayed. In Java 1.0, you would achieve the same effect by writing an event handler (e.g., `keyDown()`) that returns `true`.

You can assume that an event won't be delivered to the peer until all listeners have had a chance to consume it. However, you should not make any other assumptions about the order in which listeners are called.

protected boolean isConsumed() ★

The `isConsumed()` method returns whether the event has been consumed. If the event has been consumed, either by default or through `consume()`, this method returns `true`; otherwise, it returns `false`.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. Since you are most frequently dealing with children of `AWTEvent`, the children need only to override `paramString()` to add their specific information.

public String toString() ★

The `toString()` method of `AWTEvent` returns a string with the name of the event, specific information about the event, and the source. In the method `MouseAdapter.mouseReleased()`, printing the parameter would result in something like the following:

```
java.awt.event.MouseEvent[MOUSE_RELEASED,(69,107),mods=0,clickCount=1] on panel1
```

4.3.2.2 ComponentEvent

Constants

public final static int COMPONENT_FIRST ★
public final static int COMPONENT_LAST ★

The `COMPONENT_FIRST` and `COMPONENT_LAST` constants hold the endpoints of the range of identifiers for `ComponentEvent` types.

public final static int COMPONENT_HIDDEN ★

The `COMPONENT_HIDDEN` constant identifies component events that occur because a component was hidden. The interface method `ComponentListener.componentHidden()` handles this event.

public final static int COMPONENT_MOVED ★

The `COMPONENT_MOVED` constant identifies component events that occur because a component has moved. The `ComponentListener.componentMoved()` interface method handles this event.

public final static int COMPONENT_RESIZED ★

The `COMPONENT_RESIZED` constant identifies component events that occur because a component has changed size. The interface method `ComponentListener.componentResized()` handles this event.

public final static int COMPONENT_SHOWN ★

The `COMPONENT_SHOWN` constant identifies component events that occur because a component has been shown (i.e., made visible). The interface method `ComponentListener.componentShown()` handles this event.

Constructors

public ComponentEvent(Component source, int id) ★

This constructor creates a `ComponentEvent` with the given `source`; the source is the object generating the event. The `id` field identifies the event type. If system generated, the `id` will be one of the last four constants above. However, nothing stops you from creating your own `id` for your event types.

Methods

public Component getComponent() ★

The `getComponent()` method returns the source of the event—that is, the component initiating the event.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `ComponentEvent` level, `paramString()` adds a string containing the event `id` (if available) and the bounding rectangle for the `source` (if appropriate). For example:

```
java.awt.event.ComponentEvent[COMPONENT_RESIZED (0, 0, 100x100)] on button0
```

4.3.2.3 ContainerEvent

The `ContainerEvent` class includes events that result from specific container operations.

Constants

public final static int CONTAINER_FIRST ★
public final static int CONTAINER_LAST ★

The `CONTAINER_FIRST` and `CONTAINER_LAST` constants hold the endpoints of the range of identifiers for `ContainerEvent` types.

public final static int COMPONENT_ADDED ★

The `COMPONENT_ADDED` constant identifies container events that occur because a component has been added to the container. The interface method `ContainerListener.componentAdded()` handles this event. Listening for this event is useful if a common listener should be attached to all components added to a container.

public final static int COMPONENT_REMOVED ★

The `COMPONENT_REMOVED` constant identifies container events that occur because a component has been removed from the container. The interface method `ContainerListener.componentRemoved()` handles this event.

Constructors

public ContainerEvent(Container source, int id, Component child) ★

The constructor creates a `ContainerEvent` with the given `source` (the container generating the event), to which the given `child` has been added or removed. The `id` field serves as the identifier of the event type. If system generated, the `id` will be one of the constants described previously. However, nothing stops you from creating your own `id` for your event types.

Methods

public Container getContainer() ★

The `getContainer()` method returns the container that generated the event.

public Component getComponent() ★

The `getComponent()` method returns the component that was added to or removed from the container.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is in turn called to build the string to display. At the `ContainerEvent` level, `paramString()` adds a string containing the event `id` (if available) along with the name of the child.

4.3.2.4 FocusEvent

The `FocusEvent` class contains the events that are generated when a component gets or loses focus. These may be either temporary or permanent focus changes. A temporary focus change is the result of something else happening, like a window appearing in front of you. Once the window is removed, focus is restored. A permanent focus change is usually the result of focus traversal, using the keyboard or the mouse: for example, you clicked in a text field to type in it, or used Tab to move to the next component. More programmatically, permanent focus changes are the result of calls to `Component.requestFocus()`.

Constants

public final static int FOCUS_FIRST ★
public final static int FOCUS_LAST ★

The `FOCUS_FIRST` and `FOCUS_LAST` constants hold the endpoints of the range of identifiers for `FocusEvent` types.

public final static int FOCUS_GAINED ★

The `FOCUS_GAINED` constant identifies focus events that occur because a component gains input focus. The `FocusListener.focusGained()` interface method handles this event.

public final static int FOCUS_LOST ★

The `FOCUS_LOST` constant identifies focus events that occur because a component loses input focus. The `FocusListener.focusLost()` interface method handles this event.

Constructors

public FocusEvent(Component source, int id, boolean temporary) ★

This constructor creates a `FocusEvent` with the given `source`; the source is the object generating the event. The `id` field serves as the identifier of the event type. If system generated, the `id` will be one of the two constants described previously. However, nothing stops you from creating your own `id` for your event types. The `temporary` parameter is `true` if this event represents a temporary focus change.

public FocusEvent(Component source, int id) ★

This constructor creates a `FocusEvent` by calling the first constructor with the `temporary` parameter set to `false`; that is, it creates an event for a permanent focus change.

Methods

public boolean isTemporary() ★

The `isTemporary()` method returns `true` if the focus event describes a temporary focus change, `false` if the event describes a permanent focus change. Once set by the constructor, the setting is permanent.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is in turn called to build the string to display. At the `FocusEvent` level, `paramString()` adds a string showing the event `id` (if available) and whether or not it is temporary.

4.3.2.5 WindowEvent

The `WindowEvent` class encapsulates the window-oriented events.

Constants

public final static int WINDOW_FIRST ★
public final static int WINDOW_LAST ★

The `WINDOW_FIRST` and `WINDOW_LAST` constants hold the endpoints of the range of identifiers for `WindowEvent` types.

public final static int WINDOW_ICONIFIED ★

The `WINDOW_ICONIFIED` constant identifies window events that occur because the user iconifies a window. The `WindowListener.windowIconified()` interface method handles this event.

public final static int WINDOW_DEICONIFIED ★

The WINDOW_DEICONIFIED constant identifies window events that occur because the user de-iconifies a window. The interface method WindowListener.windowDeiconified() handles this event.

public final static int WINDOW_OPENED ★

The WINDOW_OPENED constant identifies window events that occur the first time a Frame or Dialog is made visible with show(). The interface method WindowListener.windowOpened() handles this event.

public final static int WINDOW_CLOSING ★

The WINDOW_CLOSING constant identifies window events that occur because the user wants to close a window. This is similar to the familiar event Event.WINDOW_DESTROY dealt with under 1.0 with frames. The WindowListener.windowClosing() interface method handles this event.

public final static int WINDOW_CLOSED ★

The WINDOW_CLOSED constant identifies window events that occur because a Frame or Dialog has finally closed, after hide() or destroy(). This comes after WINDOW_CLOSING, which happens when the user wants the window to close. The WindowListener.windowClosed() interface method handles this event.

NOTE If there is a call to System.exit() in the windowClosing() listener, the window will not be around to call windowClosed(), nor will other listeners know.

---

public final static int WINDOW_ACTIVATED ★

The WINDOW_ACTIVATED constant identifies window events that occur because the user brings the window to the front, either after showing the window, deiconifying, or removing whatever was in front. The interface method WindowListener.windowActivated() handles this event.

public final static int WINDOW_DEACTIVATED ★

The WINDOW_DEACTIVATED constant identifies window events that occur because the user makes another window the active window. The interface method WindowListener.windowDeactivated() handles this event.

Constructors

public WindowEvent(Window source, int id) ★

This constructor creates a WindowEvent with the given source; the source is the object generating the event. The id field serves as the identifier of the event type. If system generated, the id will be one of the seven constants described previously. However, nothing stops you from creating your own id for your event types.

Methods

public Window getWindow() ★

The `getWindow()` method returns the `Window` that generated the event.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is in turn called to build the string to display. At the `WindowEvent` level, `paramString()` adds a string containing the event `id` (if available). In a call to `windowClosing()`, printing the parameter would yield:

```
java.awt.event.WindowEvent[WINDOW_CLOSING] on frame0
```

4.3.2.6 PaintEvent

The `PaintEvent` class encapsulates the paint-oriented events. There is no corresponding `PaintListener` class, so you cannot listen for these events. To process them, override the `paint()` and `update()` routines of `Component`. The `PaintEvent` class exists to ensure that events are serialized properly through the event queue.

Constants

public final static int PAINT_FIRST ★
public final static int PAINT_LAST ★

The `PAINT_FIRST` and `PAINT_LAST` constants hold the endpoints of the range of identifiers for `PaintEvent` types.

public final static int PAINT ★

The `PAINT` constant identifies paint events that occur because a component needs to be repainted. Override the `Component.paint()` method to handle this event.

public final static int UPDATE ★

The `UPDATE` constant identifies paint events that occur because a component needs to be updated before painting. This usually refreshes the display. Override the `Component.update()` method to handle this event.

Constructors

public PaintEvent(Component source, int id, Rectangle updateRect) ★

This constructor creates a `PaintEvent` with the given `source`. The source is the object whose display needs to be updated. The `id` field identifies the event type. If system generated, the `id` will be one of the two constants described previously. However, nothing stops you from creating your own `id` for your event types. `updateRect` represents the rectangular area of `source` that needs to be updated.

Methods

public Rectangle getUpdateRect()

The `getUpdateRect()` method returns the rectangular area within the `PaintEvent`'s source component that needs repainting. This area is set by either the constructor or the `setUpdateRect()` method.

public void setUpdateRect(Rectangle updateRect)

The `setUpdateRect()` method changes the area of the `PaintEvent`'s source component that needs repainting.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `PaintEvent` level, `paramString()` adds a string containing the event `id` (if available) along with the area requiring repainting (a clipping rectangle). If you peek in the event queue, one possible result may yield:

```
java.awt.event.PaintEvent[PAINT,updateRect=java.awt.Rectangle[x=0,y=0,
width=192,height=173]] on frame0
```

4.3.2.7 InputEvent

The `InputEvent` class provides the basis for the key and mouse input and movement routines. `KeyEvent` and `MouseEvent` provide the specifics of each.

Constants The constants of `InputEvent` help identify which modifiers are present when an input event occurs, as shown in Example 4-3. To examine the event modifiers and test for the presence of these masks, call `getModifiers()` to get the current set of modifiers.

public final static int ALT_MASK ★
public final static int CTRL_MASK ★
public final static int META_MASK ★
public final static int SHIFT_MASK ★

The first set of `InputEvent` masks are for the different modifier keys on the keyboard. They are often set to indicate which button on a multibutton mouse has been pressed.

public final static int BUTTON1_MASK ★
public final static int BUTTON2_MASK ★
public final static int BUTTON3_MASK ★

The button mask constants are equivalents for the modifier masks, allowing you to write more intelligible code for dealing with button events. `BUTTON2_MASK` is the same as `ALT_MASK`, and `BUTTON3_MASK` is the same as

META_MASK; BUTTON1_MASK currently isn't usable and is never set. For example, if you want to check whether the user pressed the second (middle) mouse button, you can test against BUTTON2_MASK rather than ALT_MASK. Example 4-3 demonstrates how to use these constants.

Constructors InputEvent is an abstract class with no public constructors.

Methods Unlike the Event class, InputEvent has an isAltDown() method to check the ALT_MASK setting.

public boolean isAltDown() ★

The isAltDown() method checks to see if ALT_MASK is set. If so, isAltDown() returns true; otherwise, it returns false.

public boolean isControlDown() ★

The isControlDown() method checks to see if CONTROL_MASK is set. If so, isControlDown() returns true; otherwise, it returns false.

public boolean isMetaDown() ★

The isMetaDown() method checks to see if META_MASK is set. If so, the method isMetaDown() returns true; otherwise, it returns false.

public boolean isShiftDown() ★

The isShiftDown() method checks to see if SHIFT_MASK is set. If so, the method isShiftDown() returns true; otherwise, it returns false.

public int getModifiers() ★

The getModifiers() method returns the current state of the modifier keys. For each modifier key pressed, a different flag is raised in the return argument. To check if a modifier is set, AND the return value with a flag and check for a nonzero value.

```
if ((ie.getModifiers() & MouseEvent.META_MASK) != 0) {
    System.out.println ("Meta is set");
}
```

public long getWhen() ★

The getWhen() method returns the time at which the event occurred. The return value is in milliseconds. Convert the long value to a Date to examine the contents. For example:

```
Date d = new Date (ie.getWhen());
```

public void consume() ★

This class overrides the AWTEvent.consume() method to make it public. Anyone, not just a subclass, can mark an InputEvent as consumed.

public boolean isConsumed() ★

This class overrides the `AWTEvent.isconsumed()` method to make it public. Anyone can find out if an `InputEvent` has been consumed.

4.3.2.8 KeyEvent

The `KeyEvent` class is a subclass of `InputEvent` for dealing with keyboard events. There are two fundamental key actions: key presses and key releases. These are represented by `KEY_PRESSED` and `KEY_RELEASED` events. Of course, it's inconvenient to think in terms of all these individual actions, so Java also keeps track of the "logical" keys you type. These are represented by `KEY_TYPED` events. For every keyboard key pressed, a `KeyEvent.KEY_PRESSED` event occurs; the key that was pressed is identified by one of the virtual keycodes from Table 4-4 and is available through the `getKeyCode()` method. For example, if you type an uppercase A, you will get two `KEY_PRESSED` events, one for shift (`VK_SHIFT`) and one for the "a" (`VK_A`). You will also get two `KeyEvent.KEY_RELEASED` events. However, there will only be one `KeyEvent.KEY_TYPED` event; if you call `getKeyChar()` for the `KEY_TYPED` event, the result will be the Unicode character "A" (type `char`). `KEY_TYPED` events do not happen for action-oriented keys like function keys.

Constants Like the `Event` class, numerous constants help you identify all the keyboard keys. Table 4-4 shows the constants that refer to these keyboard keys. The values are all declared `public static final int`. A few keys represent ASCII characters that have string equivalents like `\n`.

Table 4–4: Key Constants in Java 1.1

VK_ENTER	VK_0	VK_A	VK_F1	VK_ACCEPT
VK_BACK_SPACE	VK_1	VK_B	VK_F2	VK_CONVERT
VK_TAB	VK_2	VK_C	VK_F3	VK_FINAL
VK_CANCEL	VK_3	VK_D	VK_F4	VK_KANA
VK_CLEAR	VK_4	VK_E	VK_F5	VK_KANJI
VK_SHIFT	VK_5	VK_F	VK_F6	VK_MODECHANGE
VK_CONTROL	VK_6	VK_G	VK_F7	VK_NONCONVERT
VK_ALT	VK_7	VK_H	VK_F8	
VK_PAUSE	VK_8	VK_I	VK_F9	
VK_CAPS_LOCK	VK_9	VK_J	VK_F10	
VK_ESCAPE	VK_NUMPAD0	VK_K	VK_F11	
VK_SPACE	VK_NUMPAD1	VK_L	VK_F12	
VK_PAGE_UP	VK_NUMPAD2	VK_M	VK_DELETE	

Table 4–4: Key Constants in Java 1.1 (continued)

VK_PAGE_DOWN	VK_NUMPAD3	VK_N	VK_NUM_LOCK
VK_END	VK_NUMPAD4	VK_O	VK_SCROLL_LOCK
VK_HOME	VK_NUMPAD5	VK_P	VK_PRINTSCREEN
VK_LEFT	VK_NUMPAD6	VK_Q	VK_INSERT
VK_UP	VK_NUMPAD7	VK_R	VK_HELP
VK_RIGHT	VK_NUMPAD8	VK_S	VK_META
VK_DOWN	VK_NUMPAD9	VK_T	VK_BACK_QUOTE
VK_COMMA	VK_MULTIPLY	VK_U	VK_QUOTE
VK_PERIOD	VK_ADD	VK_V	VK_OPEN_BRACKET
VK_SLASH	VK_SEPARATER[a]	VK_W	VK_CLOSE_BRACKET
VK_SEMICOLON	VK_SUBTRACT	VK_X	
VK_EQUALS	VK_DECIMAL	VK_Y	
VK_BACK_SLASH	VK_DIVIDE	VK_Z	

[a] Expect VK_SEPARATOR to be added at some future point. This constant represents the numeric separator key on your keyboard.

public final static int VK_UNDEFINED ★

When a `KEY_TYPED` event happens, there is no keycode. If you ask for it, the `getKeyCode()` method returns `VK_UNDEFINED`.

public final static char CHAR_UNDEFINED ★

For `KEY_PRESSED` and `KEY_RELEASED` events that do not have a corresponding Unicode character to display (like Shift), the `getKeyChar()` method returns `CHAR_UNDEFINED`.

Other constants identify what the user did with a key.

public final static int KEY_FIRST ★
public final static int KEY_LAST ★

The `KEY_FIRST` and `KEY_LAST` constants hold the endpoints of the range of identifiers for `KeyEvent` types.

public final static int KEY_PRESSED ★

The `KEY_PRESSED` constant identifies key events that occur because a keyboard key has been pressed. To differentiate between action and non-action keys, call the `isActionKey()` method described later. The `KeyListener.keyPressed()` interface method handles this event.

public final static int KEY_RELEASED ★

The `KEY_RELEASED` constant identifies key events that occur because a keyboard key has been released. The `KeyListener.keyReleased()` interface method handles this event.

public final static int KEY_TYPED ★

The `KEY_TYPED` constant identifies a combination of a key press followed by a key release for a non-action oriented key. The `KeyListener.keyTyped()` interface method handles this event.

Constructors

public KeyEvent(Component source, int id, long when, int modifiers, int keyCode, char keyChar) ★

This constructor* creates a `KeyEvent` with the given `source`; the source is the object generating the event. The `id` field identifies the event type. If system-generated, the `id` will be one of the constants above. However, nothing stops you from creating your own `id` for your event types. The `when` parameter represents the time the event happened. The `modifiers` parameter holds the state of the various modifier keys; masks to represent these keys are defined in the `InputEvent` class. Finally, `keyCode` is the virtual key that triggered the event, and `keyChar` is the character that triggered it.

The `KeyEvent` constructor throws the `IllegalArgumentException` run-time exception in two situations. First, if the `id` is `KEY_TYPED` and `keyChar` is `CHAR_UNDEFINED`, it throws an exception because if a key has been typed, it must be associated with a character. Second, if the `id` is `KEY_TYPED` and `keyCode` is not `VK_UNDEFINED`, it throws an exception because typed keys frequently represent combinations of key codes (for example, Shift struck with "a"). It is legal for a `KEY_PRESSED` or `KEY_RELEASED` event to contain both a `keyCode` and a `keyChar`, though it's not clear what such an event would represent.

Methods

public char getKeyChar() ★

The `getKeyChar()` method retrieves the Unicode character associated with the key in this `KeyEvent`. If there is no character, `CHAR_UNDEFINED` is returned.

public void setKeyChar(char KeyChar) ★

The `setKeyChar()` method allows you to change the character for the `KeyEvent`. You could use this method to convert characters to uppercase.

* Beta releases of Java 1.1 have an additional constructor that lacks the `keyChar` parameter. Comments in the code indicate that this constructor will be deleted prior to the 1.1.1 release.

public int getKeyCode() ★

The `getKeyCode()` method retrieves the virtual keycode (i.e., one of the constants in Table 4-4) of this `KeyEvent`.

public void setKeyCode(int keyCode) ★

The `setKeyCode()` method allows you to change the keycode for the `KeyEvent`. Changes you make to the `KeyEvent` are seen by subsequent listeners and the component's peer.

public void setModifiers(int modifiers) ★

The `setModifiers()` method allows you to change the modifier keys associated with a `KeyEvent` to `modifiers`. The parent class `InputEvent` already has a `getModifiers()` method that is inherited. Since this is your own personal copy of the `KeyEvent`, no other listener can find out about the change.

public boolean isActionKey() ★

The `isActionKey()` method allows you to check whether the key associated with the `KeyEvent` is an action key (e.g., function, arrow, keypad) or not (e.g., an alphanumeric key). For action keys, this method returns `true`; otherwise, it returns `false`. For action keys, the `keyChar` field usually has the value `CHAR_UNDEFINED`.

public static String getKeyText (int keyCode) ★

The static `getKeyText()` method returns the localized textual string for `keyCode`. For each nonalphanumeric virtual key, there is a key name (the "key text"); these names can be changed using the AWT properties. Table 4-5 shows the properties used to redefine the key names and the default name for each key.

Table 4–5: Key Text Properties

Property	**Default**	**Property**	**Default**
`AWT.accept`	Accept	`AWT.f8`	F8
`AWT.add`	NumPad +	`AWT.f9`	F9
`AWT.alt`	Alt	`AWT.help`	Help
`AWT.backQuote`	Back Quote	`AWT.home`	Home
`AWT.backSpace`	Backspace	`AWT.insert`	Insert
`AWT.cancel`	Cancel	`AWT.kana`	Kana
`AWT.capsLock`	Caps Lock	`AWT.kanji`	Kanji
`AWT.clear`	Clear	`AWT.left`	Left
`AWT.control`	Control	`AWT.meta`	Meta
`AWT.decimal`	NumPad .	`AWT.modechange`	Mode Change
`AWT.delete`	Delete	`AWT.multiply`	NumPad *
`AWT.divide`	NumPad /	`AWT.noconvert`	No Convert

Table 4–5: Key Text Properties (continued)

Property	Default	Property	Default
AWT.down	Down	AWT.numLock	Num Lock
AWT.end	End	AWT.numpad	NumPad
AWT.enter	Enter	AWT.pause	Pause
AWT.escape	Escape	AWT.pgdn	Page Down
AWT.final	Final	AWT.pgup	Page Up
AWT.f1	F1	AWT.printScreen	Print Screen
AWT.f10	F10	AWT.quote	Quote
AWT.f11	F11	AWT.right	Right
AWT.f12	F12	AWT.scrollLock	Scroll Lock
AWT.f2	F2	AWT.separator	NumPad ,
AWT.f3	F3	AWT.shift	Shift
AWT.f4	F4	AWT.space	Space
AWT.f5	F5	AWT.subtract	NumPad -
AWT.f6	F6	AWT.tab	Tab
AWT.f7	F7	AWT.unknown	Unknown keyCode
AWT.up	Up		

public static String getKeyModifiersText (int modifiers) ★

The static `getKeyModifiersText()` method returns the localized textual string for `modifiers`. The parameter `modifiers` is a combination of the key masks defined by the `InputEvent` class. As with the keys themselves, each modifier is associated with a textual name. If multiple modifiers are set, they are concatenated with a plus sign (+) separating them. Similar to `getKeyText()`, the strings are localized because for each modifier, an awt property is available to redefine the string. Table 4-6 lists the properties and the default modifier names.

Table 4–6: Key Modifiers Text Properties

Property	Default
AWT.alt	Alt
AWT.control	Ctrl
AWT.meta	Meta
AWT.shift	Shift

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `KeyEvent` level, paramString() adds a textual string for the id (if available), the text for the key (if available from getKeyText()), and modifiers (from getKeyModifiersText()). A key press event would result in something like the following:

```
java.awt.event.KeyEvent[KEY_PRESSED,keyCode=118,
F7,modifiers=Ctrl+Shift] on textfield0
```

4.3.2.9 MouseEvent

The MouseEvent class is a subclass of InputEvent for dealing with mouse events.

Constants

public final static int MOUSE_FIRST ★
public final static int MOUSE_LAST ★

The MOUSE_FIRST and MOUSE_LAST constants hold the endpoints of the range of identifiers for MouseEvent types.

public final static int MOUSE_CLICKED ★

The MOUSE_CLICKED constant identifies mouse events that occur when a mouse button is clicked. A mouse click consists of a mouse press and a mouse release. The MouseListener.mouseClicked() interface method handles this event.

public final static int MOUSE_DRAGGED ★

The MOUSE_DRAGGED constant identifies mouse events that occur because the mouse is moved over a component with a mouse button pressed. The interface method MouseMotionListener.mouseDragged() handles this event.

public final static int MOUSE_ENTERED ★

The MOUSE_ENTERED constant identifies mouse events that occur when the mouse first enters a component. The MouseListener.mouseEntered() interface method handles this event.

public final static int MOUSE_EXITED ★

The MOUSE_EXISTED constant identifies mouse events that occur because the mouse leaves a component's space. The MouseListener.mouseExited() interface method handles this event.

public final static int MOUSE_MOVED ★

The MOUSE_MOVED constant identifies mouse events that occur because the mouse is moved without a mouse button down. The interface method MouseMotionListener.mouseMoved() handles this event.

public final static int MOUSE_PRESSED ★

The MOUSE_PRESSED constant identifies mouse events that occur because a mouse button has been pressed. The MouseListener.mousePressed() interface method handles this event.

public final static int MOUSE_RELEASED ★

The `MOUSE_RELEASED` constant identifies mouse events that occur because a mouse button has been released. The `MouseListener.mouseReleased()` interface method handles this event.

Constructors

public MouseEvent(Component source, int id, long when, int modifiers, int x, int y, int clickCount, boolean popupTrigger) ★

This constructor creates a `MouseEvent` with the given `source`; the source is the object generating the event. The `id` field serves as the identifier of the event type. If system-generated, the `id` will be one of the constants described in the previous section. However, nothing stops you from creating your own `id` for your event types. The `when` parameter represents the time the event happened. The `modifiers` parameter holds the state of the various modifier keys, using the masks defined for the `InputEvent` class, and lets you determine which button was pressed. (`x`, `y`) represents the coordinates of the event relative to the origin of `source`, while `clickCount` designates the number of consecutive times the mouse button was pressed within an indeterminate time period. Finally, the `popupTrigger` parameter signifies whether this mouse event should trigger the display of a `PopupMenu`, if one is available. (The `PopupMenu` class is discussed in Chapter 10, *Would You Like to Choose from the Menu?*)

Methods

public int getX() ★

The `getX()` method returns the current x coordinate of the event relative to the source.

public int getY() ★

The `getY()` method returns the current y coordinate of the event relative to the source.

public synchronized Point getPoint() ★

The `getPoint()` method returns the current x and y coordinates of the event relative to the event source.

public synchronized void translatePoint(int x, int y) ★

The `translatePoint()` method translates the x and y coordinates of the `MouseEvent` instance by `x` and `y`. This method functions similarly to the `Event.translate()` method.

public int getClickCount() ★

The `getClickCount()` method retrieves the current `clickCount` setting for the event.

public boolean isPopupTrigger() ★

The `isPopupTrigger()` method retrieves the state of the `popupTrigger` setting for the event. If this method returns `true` and the source of the event has an associated `PopupMenu`, the event should be used to display the menu, as shown in the following code. Since the action the user performs to raise a pop-up menu is platform specific, this method lets you raise a pop-up menu without worrying about what kind of event took place. You only need to call `isPopupTrigger()` and show the menu if it returns `true`.

```
public void processMouseEvent(MouseEvent e) {
    if (e.isPopupTrigger())
        aPopup.show(e.getComponent(), e.getX(), e.getY());
    super.processMouseEvent(e);
}
```

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `MouseEvent` level, a textual string for the `id` (if available) is tacked on to the coordinates, modifiers, and click count. A mouse down event would result in something like the following:

```
java.awt.event.MouseEvent[MOUSE_PRESSED,(5,7),mods=0,clickCount=2] on textfield0
```

4.3.2.10 ActionEvent

The `ActionEvent` class is the first higher-level event class. It encapsulates events that signify that the user is doing something with a component. When the user selects a button, list item, or menu item, or presses the Return key in a text field, an `ActionEvent` passes through the event queue looking for listeners.

Constants

public final static int ACTION_FIRST ★
public final static int ACTION_LAST ★

The `ACTION_FIRST` and `ACTION_LAST` constants hold the endpoints of the range of identifiers for `ActionEvent` types.

public final static int ACTION_PERFORMED ★

The `ACTION_PERFORMED` constant represents when a user activates a component. The `ActionListener.actionPerformed()` interface method handles this event.

public static final int ALT_MASK ★
public static final int CTRL_MASK ★
public static final int META_MASK ★
public static final int SHIFT_MASK ★

Similar to the mouse events, action events have `modifiers`. However, they are not automatically set by the system, so they don't help you see what modifiers were pressed when the event occurred. You may be able to use these constants if you are generating your own action events. To see the value of an action event's modifiers, call `getModifiers()`.

Constructors

public ActionEvent(Object source, int id, String command) ★

This constructor creates an `ActionEvent` with the given `source`; the source is the object generating the event. The `id` field serves as the identifier of the event type. If system-generated, the `id` will be `ACTION_PERFORMED`. However, nothing stops you from creating your own `id` for your event types. The `command` parameter is the event's action command. Ideally, the action command should be some locale-independent string identifying the user's action. Most components that generate action events set this field to the selected item's label by default.

public ActionEvent(Object source, int id, String command, int modifiers) ★

This constructor adds `modifiers` to the settings for an `ActionEvent`. This allows you to define action-oriented events that occur only if certain modifier keys are pressed.

Methods

public String getActionCommand() ★

The `getActionCommand()` method retrieves the `command` field from the event. It represents the command associated with the object that triggered the event. The idea behind the action command is to differentiate the command associated with some event from the displayed content of the event source. For example, the action command for a button may be Help. However, what the user sees on the label of the button could be a string localized for the environment of the user. Instead of having your event handler look for 20 or 30 possible labels, you can test whether an event has the action command Help.

public int getModifiers() ★

The `getModifiers()` method returns the state of the modifier keys. For each one set, a different flag is raised in the method's return value. To check if a modifier is set, AND the return value with a flag, and check for a nonzero value.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `ActionEvent` level, `paramString()` adds a textual string for the event `id` (if available), along with the `command` from the constructor. When the user selects a `Button` with the action command Help, printing the resulting event yields:

```
java.awt.event.ActionEvent[ACTION_PERFORMED,cmd=Help] on button0
```

4.3.2.11 AdjustmentEvent

The `AdjustmentEvent` class is another higher-level event class. It encapsulates events that represent scrollbar motions. When the user moves the slider of a scrollbar or scroll pane, an `AdjustmentEvent` passes through the event queue looking for listeners. Although there is only one type of adjustment event, there are five subtypes represented by constants `UNIT_DECREMENT`, `UNIT_INCREMENT`, and so on.

Constants

public final static int ADJUSTMENT_FIRST ★
public final static int ADJUSTMENT_LAST ★

The `ADJUSTMENT_FIRST` and `ADJUSTMENT_LAST` constants hold the endpoints of the range of identifiers for `AdjustmentEvent` types.

public final static int ADJUSTMENT_VALUE_CHANGED ★

The `ADJUSTMENT_VALUE_CHANGED` constant identifies adjustment events that occur because a user moves the slider of a `Scrollbar` or `ScrollPane`. The `AdjustmentListener.adjustmentValueChanged()` interface method handles this event.

public static final int UNIT_DECREMENT ★

`UNIT_DECREMENT` identifies adjustment events that occur because the user selects the increment arrow.

public static final int UNIT_INCREMENT ★

`UNIT_INCREMENT` identifies adjustment events that occur because the user selects the decrement arrow.

public static final int BLOCK_DECREMENT ★

`BLOCK_DECREMENT` identifies adjustment events that occur because the user selects the block decrement area, between the decrement arrow and the slider.

public static final int BLOCK_INCREMENT ★

`BLOCK_INCREMENT` identifies adjustment events that occur because the user selects the block increment area, between the increment arrow and the slider.

public static final int TRACK ★

TRACK identifies adjustment events that occur because the user selects the slider and drags it. Multiple adjustment events of this subtype usually occur consecutively.

Constructors

public AdjustmentEvent(Adjustable source, int id, int type, int value) ★

This constructor creates an AdjustmentEvent with the given source; the source is the object generating the event. The id field serves as the identifier of the event type. If system-generated, the id of the AdjustmentEvent will be ADJUSTMENT_VALUE_CHANGED. However, nothing stops you from creating your own id for your event types. The type parameter is normally one of the five subtypes, with value being the current setting of the slider, but is not restricted to that.

Methods

public Adjustable getAdjustable() ★

The getAdjustable() method retrieves the Adjustable object associated with this event—that is, the event's source.

public int getAdjustmentType() ★

The getAdjustmentType() method retrieves the type parameter from the constructor. It represents the subtype of the current event and, if system-generated, is one of the following constants: UNIT_DECREMENT, UNIT_INCREMENT, BLOCK_DECREMENT, BLOCK_INCREMENT, or TRACK.

public int getValue() ★

The getValue() method retrieves the value parameter from the constructor. It represents the current setting of the adjustable object.

public String paramString() ★

When you call the toString() method of an AWTEvent, the paramString() method is called to help build the string to display. At the AdjustableEvent level, paramString() adds a textual string for the event id (if available), along with a textual string of the type (if available), and value. For example:

```
java.awt.event.AdjustableEvent[ADJUSTMENT_VALUE_CHANGED,
adjType=TRACK,value=27] on scrollbar0
```

4.3.2.12 ItemEvent

The ItemEvent class is another higher-level event class. It encapsulates events that occur when the user selects a component, like ActionEvent. When the user selects a checkbox, choice, list item, or checkbox menu item, an ItemEvent passes through the event queue looking for listeners. Although there is only one type of ItemEvent, there are two subtypes represented by the constants SELECTED and DESELECTED.

Constants

public final static int ITEM_FIRST ★
public final static int ITEM_LAST ★

The ITEM_FIRST and ITEM_LAST constants hold the endpoints of the range of identifiers for ItemEvent types.

public final static int ITEM_STATE_CHANGED ★

The ITEM_STATE_CHANGED constant identifies item events that occur because a user selects a component, thus changing its state. The interface method ItemListener.itemStateChanged() handles this event.

public static final int SELECTED ★

SELECTED indicates that the user selected the item.

public static final int DESELECTED ★

DESELECTED indicates that the user deselected the item.

Constructors

public ItemEvent(ItemSelectable source, int id, Object item, int stateChange) ★

This constructor creates a ItemEvent with the given source; the source is the object generating the event. The id field serves as the identifier of the event type. If system-generated, the id will be ITEM_STATE_CHANGE. However, nothing stops you from creating your own id for your event types. The item parameter represents the text of the item selected: for a Checkbox, this would be its label, for a Choice the current selection. For your own events, this parameter could be virtually anything, since its type is Object.

Methods

public ItemSelectable getItemSelectable() ★

The getItemSelectable() method retrieves the ItemSelectable object associated with this event—that is, the event's source.

public Object getItem() ★

The getItem() method returns the item that was selected. This usually represents some text to help identify the source but could be nearly anything for user-generated events.

public int getStateChange() ★

The `getStateChange()` method returns the `stateChange` parameter from the constructor and, if system generated, is either `SELECTED` or `DESELECTED`.

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `ItemEvent` level, `paramString()` adds a textual string for the event `id` (if available), along with a textual string indicating the value of `stateChange` (if available) and `item`. For example:

```
java.awt.event.ItemEvent[ITEM_STATE_CHANGED,item=Help,
stateChange=SELECTED] on checkbox1
```

4.3.2.13 TextEvent

The `TextEvent` class is yet another higher-level event class. It encapsulates events that occur when the contents of a `TextComponent` have changed, although is not required to have a `TextComponent` source. When the contents change, either programmatically by a call to `setText()` or because the user typed something, a `TextEvent` passes through the event queue looking for listeners.

Constants

public final static int TEXT_FIRST ★
public final static int TEXT_LAST ★

The `TEXT_FIRST` and `TEXT_LAST` constants hold the endpoints of the range of identifiers for `TextEvent` types.

public final static int TEXT_VALUE_CHANGED ★

The `TEXT_VALUE_CHANGED` constant identifies text events that occur because a user changes the contents of a text component. The interface method `TextListener.textValueChanged()` handles this event.

Constructors

public TextEvent(Object source, int id) ★

This constructor creates a `TextEvent` with the given `source`; the source is the object generating the event. The `id` field identifies the event type. If system-generated, the `id` will be `TEXT_VALUE_CHANGE`. However, nothing stops you from creating your own `id` for your event types.

Method

public String paramString() ★

When you call the `toString()` method of an `AWTEvent`, the `paramString()` method is called in turn to build the string to display. At the `TextEvent` level, `paramString()` adds a textual string for the event `id` (if available).

4.3.3 Event Listener Interfaces and Adapters

Java 1.1 has 11 event listener interfaces, which specify the methods a class must implement to receive different kinds of events. For example, the `ActionListener` interface defines the single method that is called when an `ActionEvent` occurs. These interfaces replace the various event-handling methods of Java 1.0: `action()` is now the `actionPerformed()` method of the `ActionListener` interface, `mouseUp()` is now the `mouseReleased()` method of the `MouseListener` interface, and so on. Most of the listener interfaces have a corresponding adapter class, which is an abstract class that provides a null implementation of all the methods in the interface. (Although an adapter class has no abstract methods, it is declared `abstract` to remind you that it must be subclassed.) Rather than implementing a listener interface directly, you have the option of extending an adapter class and overriding only the methods you care about. (Much more complex adapters are possible, but the adapters supplied with AWT are very simple.) The adapters are available for the listener interfaces with multiple methods. (If there is only one method in the listener interface, there is no need for an adapter.)

This section describes Java 1.1's listener interfaces and adapter classes. It's worth noting here that Java 1.1 does not allow you to modify the original event when you're writing an event handler.

4.3.3.1 ActionListener

The `ActionListener` interface contains the one method that is called when an `ActionEvent` occurs. It has no adapter class. For an object to listen for action events, it is necessary to call the `addActionListener()` method with the class that implements the `ActionListener` interface as the parameter. The method `addActionListener()` is implemented by `Button`, `List`, `MenuItem`, and `TextField` components. Other components don't generate action events.

public abstract void actionPerformed(ActionEvent e) ★

The `actionPerformed()` method is called when a component is selected or activated. Every component is activated differently; for a `List`, activation means that the user has double-clicked on an entry. See the appropriate section for a description of each component.

`actionPerformed()` is the Java 1.1 equivalent of the `action()` method in the 1.0 event model.

4.3.3.2 AdjustmentListener

The `AdjustmentListener` interface contains the one method that is called when an `AdjustmentEvent` occurs. It has no adapter class. For an object to listen for adjustment events, it is necessary to call `addAdjustmentListener()` with the class that implements the `AdjustmentListener` interface as the parameter. The `addAdjustmentListener()` method is implemented by the `Scrollbar` component and the `Adjustable` interface. Other components don't generate adjustment events.

public abstract void adjustmentValueChanged(AdjustmentEvent e) ★

The `adjustmentValueChanged()` method is called when a slider is moved. The `Scrollbar` and `ScrollPane` components have sliders, and generate adjustment events when the sliders are moved. (The `TextArea` and `List` components also have sliders, but do not generate adjustment events.) See the appropriate section for a description of each component.

There is no real equivalent to `adjustmentValueChanged()` in Java 1.0; to work with scrolling events, you had to override the `handleEvent()` method.

4.3.3.3 ComponentListener and ComponentAdapter

The `ComponentListener` interface contains four methods that are called when a `ComponentEvent` occurs; component events are used for general actions on components, like moving or resizing a component. The adapter class corresponding to `ComponentListener` is `ComponentAdapter`. If you care only about one or two of the methods in `ComponentListener`, you can subclass the adapter and override only the methods that you are interested in. For an object to listen for component events, it is necessary to call `Component.addComponentListener()` with the class that implements the interface as the parameter.

public abstract void componentResized(ComponentEvent e) ★

The `componentResized()` method is called when a component is resized (for example, by a call to `Component.setSize()`).

public abstract void componentMoved(ComponentEvent e) ★

The `componentMoved()` method is called when a component is moved (for example, by a call to `Component.setLocation()`).

public abstract void componentShown(ComponentEvent e) ★

The `componentShown()` method is called when a component is shown (for example, by a call to `Component.show()`).

public abstract void componentHidden(ComponentEvent e) ★

The `componentHidden()` method is called when a component is hidden (for example, by a call to `Component.hide()`).

4.3.3.4 ContainerListener and ContainerAdapter

The `ContainerListener` interface contains two methods that are called when a `ContainerEvent` occurs; container events are generated when components are added to or removed from a container. The adapter class for `ContainerListener` is `ContainerAdapter`. If you care only about one of the two methods in `ContainerListener`, you can subclass the adapter and override only the method that you are interested in. For a container to listen for container events, it is necessary to call `Container.addContainerListener()` with the class that implements the interface as the parameter.

public abstract void componentAdded(ContainerEvent e) ★

The `componentAdded()` method is called when a component is added to a container (for example, by a call to `Container.add()`).

public abstract void componentRemoved(ContainerEvent e) ★

The `componentRemoved()` method is called when a component is removed from a container (for example, by a call to `Container.remove()`).

4.3.3.5 FocusListener and FocusAdapter

The `FocusListener` interface has two methods, which are called when a `FocusEvent` occurs. Its adapter class is `FocusAdapter`. If you care only about one of the methods, you can subclass the adapter and override the method you are interested in. For an object to listen for a `FocusEvent`, it is necessary to call the `Component.addFocusListener()` method with the class that implements the `FocusListener` interface as the parameter.

public abstract void focusGained(FocusEvent e) ★

The `focusGained()` method is called when a component receives input focus, usually by the user clicking the mouse in the area of the component.

This method is the Java 1.1 equivalent of `Component.gotFocus()` in the Java 1.0 event model.

public abstract void focusLost(FocusEvent e) ★

The `focusLost()` method is called when a component loses the input focus.

This method is the Java 1.1 equivalent of `Component.lostFocus()` in the Java 1.0 event model.

4.3.3.6 ItemListener

The `ItemListener` interface contains the one method that is called when an `ItemEvent` occurs. It has no adapter class. For an object to listen for an `ItemEvent`, it is necessary to call `addItemListener()` with the class that implements the `ItemListener` interface as the parameter. The `addItemListener()` method is implemented by the `Checkbox`, `CheckboxMenuItem`, `Choice`, and `List` components. Other components don't generate item events.

public abstract void itemStateChanged(ItemEvent e) ★

The `itemStateChanged()` method is called when a component's state is modified. Every component is modified differently; for a `List`, modifying the component means single-clicking on an entry. See the appropriate section for a description of each component.

4.3.3.7 KeyListener and KeyAdapter

The `KeyListener` interface contains three methods that are called when a `KeyEvent` occurs; key events are generated when the user presses or releases keys. The adapter class for `KeyListener` is `KeyAdapter`. If you only care about one or two of the methods in `KeyListener`, you can subclass the adapter and only override the methods that you are interested in. For an object to listen for key events, it is necessary to call `Component.addKeyListener()` with the class that implements the interface as the parameter.

public abstract void keyPressed(KeyEvent e) ★

The `keyPressed()` method is called when a user presses a key. A key press is, literally, just what it says. A key press event is called for every key that is pressed, including keys like Shift and Control. Therefore, a `KEY_PRESSED` event has a virtual key code identifying the physical key that was pressed; but that's not the same as a typed character, which usually consists of several key presses (for example, Shift+A to type an uppercase A). The `keyTyped()` method reports actual characters.

This method is the Java 1.1 equivalent of `Component.keyDown()` in the Java 1.0 event model.

public abstract void keyReleased(KeyEvent e) ★

The `keyReleased()` method is called when a user releases a key. Like the `keyPressed()` method, when dealing with `keyReleased()`, you must think of virtual key codes, not characters.

This method is the Java 1.1 equivalent of `Component.keyUp()` in the Java 1.0 event model.

public abstract void keyTyped(KeyEvent e) ★

The `keyTyped()` method is called when a user types a key. The method `keyTyped()` method reports the actual character typed. Action-oriented keys, like function keys, do not trigger this method being called.

4.3.3.8 MouseListener and MouseAdapter

The `MouseListener` interface contains five methods that are called when a non-motion oriented `MouseEvent` occurs; mouse events are generated when the user presses or releases a mouse button. (Separate classes, `MouseMotionListener` and

`MouseMotionAdapter`, are used to handle mouse motion events; this means that you can listen for mouse clicks only, without being bothered by thousands of mouse motion events.) The adapter class for `MouseListener` is `MouseAdapter`. If you care about only one or two of the methods in `MouseListener`, you can subclass the adapter and override only the methods that you are interested in. For an object to listen for mouse events, it is necessary to call the method `Window.addWindowListener()` with the class that implements the interface as the parameter.

public abstract void mouseEntered(MouseEvent e) ★

The `mouseEntered()` method is called when the mouse first enters the bounding area of the component.

This method is the Java 1.1 equivalent of `Component.mouseEnter()` in the Java 1.0 event model.

public abstract void mouseExited(MouseEvent e) ★

The `mouseExited()` method is called when the mouse leaves the bounding area of the component.

This method is the Java 1.1 equivalent of `Component.mouseExit()` in the Java 1.0 event model.

public abstract void mousePressed(MouseEvent e) ★

The `mousePressed()` method is called each time the user presses a mouse button within the component's space.

This method is the Java 1.1 equivalent of `Component.mouseDown()` in the Java 1.0 event model.

public abstract void mouseReleased(MouseEvent e) ★

The `mouseReleased()` method is called when the user releases the mouse button after a mouse press. The user does not have to be over the original component any more; the original component (i.e., the component in which the mouse was pressed) is the source of the event.

This method is the Java 1.1 equivalent of `Component.mouseUp()` in the Java 1.0 event model.

public abstract void mouseClicked(MouseEvent e) ★

The `mouseClicked()` method is called once each time the user clicks a mouse button; that is, once for each mouse press/mouse release combination.

4.3.3.9 MouseMotionListener and MouseMotionAdapter

The `MouseMotionListener` interface contains two methods that are called when a motion-oriented `MouseEvent` occurs; mouse motion events are generated when the user moves the mouse, whether or not a button is pressed. (Separate classes, MouseListener and MouseAdapter, are used to handle mouse clicks and entering/exiting components. This makes it easy to ignore mouse motion events, which are very frequent and can hurt performance. You should listen only for mouse motion events if you specifically need them.) MouseMotionAdapter is the adapter class for MouseMotionListener. If you care about only one of the methods in MouseMotionListener, you can subclass the adapter and override only the method that you are interested in. For an object to listen for mouse motion events, it is necessary to call Component.addMouseMotionListener() with the class that implements the interface as the parameter.

public abstract void mouseMoved(MouseEvent e) ★

The mouseMoved() method is called every time the mouse moves within the bounding area of the component, and no mouse button is pressed.

This method is the Java 1.1 equivalent of Component.mouseMove() in the Java 1.0 event model.

public abstract void mouseDragged(MouseEvent e) ★

The mouseDragged() method is called every time the mouse moves while a mouse button is pressed. The source of the MouseEvent is the component that was under the mouse when it was first pressed.

This method is the Java 1.1 equivalent of Component.mouseDrag() in the Java 1.0 event model.

4.3.3.10 TextListener

The TextListener interface contains the one method that is called when a TextEvent occurs. It has no adapter class. For an object to listen for a TextEvent, it is necessary to call addTextListener() with the class that implements the TextListener interface as the parameter. The addTextListener() method is implemented by the TextComponent class, and thus the TextField and TextArea components. Other components don't generate text events.

public abstract void textValueChanged(TextEvent e) ★

The textValueChanged() method is called when a text component's contents are modified, either by the user (by a keystroke) or programmatically (by the setText() method).

4.3.3.11 WindowListener and WindowAdapter

The WindowListener interface contains seven methods that are called when a WindowEvent occurs; window events are generated when something changes the visibility or status of a window. The adapter class for WindowListener is WindowAdapter.

If you care about only one or two of the methods in `WindowListener`, you can subclass the adapter and override only the methods that you are interested in. For an object to listen for window events, it is necessary to call the method `Window.addWindowListener()` or `Dialog.addWindowListener()` with the class that implements the interface as the parameter.

public abstract void windowOpened(WindowEvent e) ★
: The `windowOpened()` method is called when a `Window` is first opened.

public abstract void windowClosing(WindowEvent e) ★
: The `windowClosing()` method is triggered whenever the user tries to close the `Window`.

public abstract void windowClosed(WindowEvent e) ★
: The `windowClosed()` method is called after the `Window` has been closed.

public abstract void windowIconified(WindowEvent e) ★
: The `windowIconified()` method is called whenever a user iconifies a `Window`.

public abstract void windowDeiconified(WindowEvent e) ★
: The `windowDeiconified()` method is called when the user deiconifies the `Window`.

public abstract void windowActivated(WindowEvent e) ★
: The `windowActivated()` method is called whenever a `Window` is brought to the front.

public abstract void windowDeactivated(WindowEvent e) ★
: The `windowDeactivated()` method is called when the `Window` is sent away from the front, either through iconification, closing, or another window becoming active.

4.3.4 AWTEventMulticaster

The `AWTEventMulticaster` class is used by AWT to manage the listener queues for the different events, and for sending events to all interested listeners when they occur (multicasting). Ordinarily, you have no need to work with this class or know about its existence. However, if you wish to create your own components that have their own set of listeners, you can use the class instead of implementing your own event-delivery system. See "Constructor methods" in this section for more on how to use the `AWTEventMulticaster`.

`AWTEventMulticaster` looks like a strange beast, and to some extent, it is. It contains methods to add and remove every possible kind of listener and implements all of the listener interfaces (11 as of Java 1.1). Because it implements all the listener interfaces, you can pass an event multicaster as an argument wherever you expect any kind of listener. However, unlike a class you might implement to listen for a specific kind of event, the multicaster includes machinery for maintaining chains of listeners. This explains the rather odd signatures for the `add()` and `remove()` methods. Let's look at one in particular:

```
public static ActionListener add(ActionListener first, ActionListener second)
```

This method takes two `ActionListeners` and returns another `ActionListener`. The returned listener is actually an event multicaster that contains the two listeners given as arguments in a linked list. However, because it implements the `ActionListener` interface, it is just as much an `ActionListener` as any class you might write; the fact that it contains two (or more) listeners inside it is irrelevant. Furthermore, both arguments can also be event multicasters, containing arbitrarily long chains of action listeners; in this case, the returned listener combines the two chains. Most often, you will use add to add a single listener to a chain that you're building, like this:

```
actionListenerChain=AWTEventMulticaster.add(actionListenerChain,
                                            newActionListener);
```

`actionListenerChain` is an `ActionListener`—but it is also a multicaster holding a chain of action listeners. To start a chain, use `null` for the first argument. You rarely need to call the `AWTEventMulticaster` constructor. `add()` is a static method, so you can use it with either argument set to `null` to start the chain.

Now that you can maintain chains of listeners, how do you use them? Simple; just deliver your event to the appropriate method in the chain. The multicaster takes care of sending the event to all the listeners it contains:

```
actionListenerChain.actionPerformed(new ActionEvent(...));
```

Variables

protected EventListener a; ★
protected EventListener b; ★

The `a` and `b` event listeners each consist of a chain of `EventListeners`.

Constructor methods

protected AWTEventMulticaster(EventListener a, EventListener b) ★

The constructor is protected. It creates an `AWTEventMulticaster` instance from the two chains of listeners. An instance is automatically created for you when you add your second listener by calling an `add()` method.

Listener methods

These methods implement all of the listener interfaces. Rather than repeating all the descriptions, the methods are just listed.

public void actionPerformed(ActionEvent e) ★
public void adjustmentValueChanged(AdjustmentEvent e) ★
public void componentAdded(ContainerEvent e) ★
public void componentHidden(ComponentEvent e) ★
public void componentMoved(ComponentEvent e) ★
public void componentRemoved(ContainerEvent e) ★
public void componentResized(ComponentEvent e) ★
public void componentShown(ComponentEvent e) ★
public void focusGained(FocusEvent e) ★
public void focusLost(FocusEvent e) ★
public void itemStateChanged(ItemEvent e) ★
public void keyPressed(KeyEvent e) ★
public void keyReleased(KeyEvent e) ★
public void keyTyped(KeyEvent e) ★
public void mouseClicked(MouseEvent e) ★
public void mouseDragged(MouseEvent e) ★
public void mouseEntered(MouseEvent e) ★
public void mouseExited(MouseEvent e) ★
public void mouseMoved(MouseEvent e) ★
public void mousePressed(MouseEvent e) ★
public void mouseReleased(MouseEvent e) ★
public void textValueChanged(TextEvent e) ★
public void windowActivated(WindowEvent e) ★
public void windowClosed(WindowEvent e) ★
public void windowClosing(WindowEvent e) ★
public void windowDeactivated(WindowEvent e) ★
public void windowDeiconified(WindowEvent e) ★
public void windowIconified(WindowEvent e) ★
public void windowOpened(WindowEvent e) ★

These methods broadcast the event given as an argument to all the listeners.

Support methods

There is an `add()` method for every listener interface. Again, I've listed them with a single description.

public static ActionListener add(ActionListener first, ActionListener second) ★
public static AdjustmentListener add(AdjustmentListener first, AdjustmentListener second) ★

public static ComponentListener add(ComponentListener first, ComponentListener second) ★
public static ContainerListener add(ContainerListener first, ContainerListener second) ★
public static FocusListener add(FocusListener first, FocusListener second) ★
public static ItemListener add(ItemListener first, ItemListener second) ★
public static KeyListener add(KeyListener first, KeyListener second)
public static MouseListener add(MouseListener first, MouseListener second) ★
public static MouseMotionListener add(MouseMotionListener first, MouseMotionListener second) ★
public static TextListener add(TextListener first, TextListener second) ★
public static WindowListener add(WindowListener first, WindowListener second) ★

These methods combine the listener sets together; they are called by the "add listener" methods of the various components. Usually, the `first` parameter is the initial listener chain, and the `second` parameter is the listener to add. However, nothing forces that. The combined set of listeners is returned.

protected static EventListener addInternal(EventListener first, EventListener second) ★

The `addInternal()` method is a support routine for the various `add()` methods. The combined set of listeners is returned.

Again, there are `remove()` methods for every listener type, and I've economized on the descriptions.

public static ComponentListener remove(ComponentListener list, ComponentListener oldListener) ★
public static ContainerListener remove(ContainerListener list, ContainerListener oldListener) ★
public static FocusListener remove(FocusListener list, FocusListener oldListener) ★
public static KeyListener remove(KeyListener list, KeyListener oldListener) ★
public static MouseMotionListener remove(MouseMotionListener list, MouseMotionListener oldListener) ★
public static MouseListener remove(MouseListener list, MouseListener oldListener) ★
public static WindowListener remove(WindowListener list, WindowListener oldListener) ★
public static ActionListener remove(ActionListener list, ActionListener oldListener) ★
public static ItemListener remove(ItemListener list, ItemListener oldListener) ★
public static AdjustmentListener remove(AdjustmentListener list, AdjustmentListener oldListener) ★
public static TextListener remove(TextListener list, TextListener oldListener) ★

These methods remove `oldListener` from the list of listeners, `list`. They are called by the "remove listener" methods of the different components. If `oldListener` is not found in the `list`, nothing happens. All these methods return the new list of listeners.

protected static EventListener removeInternal(EventListener list, EventListener oldListener) ★

The `removeInternal()` method is a support routine for the various `remove()` methods. It removes `oldListener` from the list of listeners, `list`. Nothing happens if `oldListener` is not found in the `list`. The new set of listeners is returned.

protected EventListener remove(EventListener oldListener) ★

This `remove()` method removes `oldListener` from the `AWTEventMulticaster`. It is a support routine for `removeInternal()`.

protected void saveInternal(ObjectOutputStream s, String k) throws IOException ★

The `saveInternal()` method is a support method for serialization.

4.3.4.1 *Using an event multicaster*

Example 4-4 shows how to use `AWTEventMulticaster` to create a component that generates `ItemEvents`. The `AWTEventMulticaster` is used in the `addItemListener()` and `removeItemListener()` methods. When it comes time to generate the event in `processEvent()`, the `itemStateChanged()` method is called to notify anyone who might be interested. The item event is generated when a mouse button is clicked; we just count the number of clicks to determine whether an item was selected or deselected. Since we do not have any mouse listeners, we need to enable mouse events with `enableEvents()` in the constructor, as shown in the following example.

Example 4–4: Using an AWTEventMulticaster

```
// Java 1.1 only
import java.awt.*;
import java.awt.event.*;
class ItemEventComponent extends Component implements ItemSelectable {
    boolean selected;
    int i = 0;
    ItemListener itemListener = null;
    ItemEventComponent () {
        enableEvents (AWTEvent.MOUSE_EVENT_MASK);
    }
    public Object[] getSelectedObjects() {
        Object o[] = new Object[1];
        o[0] = new Integer (i);
        return o;
    }
    public void addItemListener (ItemListener l) {
        itemListener = AWTEventMulticaster.add (itemListener, l);
    }
    public void removeItemListener (ItemListener l) {
        itemListener = AWTEventMulticaster.remove (itemListener, l);
    }
    public void processEvent (AWTEvent e) {
```

Example 4–4: Using an AWTEventMulticaster (continued)

```
            if (e.getID() == MouseEvent.MOUSE_PRESSED) {
                if (itemListener != null) {
                    selected = !selected;
                    i++;
                    itemListener.itemStateChanged (
                        new ItemEvent (this, ItemEvent.ITEM_STATE_CHANGED,
                            getSelectedObjects(),
                            (selected?ItemEvent.SELECTED:ItemEvent.DESELECTED)));
                }
            }
        }
    }

    public class ItemFrame extends Frame implements ItemListener {
        ItemFrame () {
            super ("Listening In");
            ItemEventComponent c = new ItemEventComponent ();
            add (c, "Center");
            c.addItemListener (this);
            c.setBackground (SystemColor.control);
            setSize (200, 200);
        }
        public void itemStateChanged (ItemEvent e) {
            Object[] o = e.getItemSelectable().getSelectedObjects();
            Integer i = (Integer)o[0];
            System.out.println (i);
        }
        public static void main (String args[]) {
            ItemFrame f = new ItemFrame();
            f.show();
        }
    }
```

The `ItemFrame` displays just an `ItemEventComponent` and listens for its item events.

The `EventQueue` class lets you manage Java 1.1 events directly. You don't usually need to manage events yourself; the system takes care of event delivery behind the scene. However, should you need to, you can acquire the system's event queue by calling `Toolkit.getSystemEventQueue()`, peek into the event queue by calling `peekEvent()`, or post new events by calling `postEvent()`. All of these operations may be restricted by the `SecurityManager`. You should not remove the events from the queue (i.e., don't call `getNextEvent()`) unless you really mean to.

Constructors

public EventQueue() ★

This constructor creates an `EventQueue` for those rare times when you need to manage your own queue of events. More frequently, you just work with the system event queue acquired through the `Toolkit`.

Methods

public synchronized AWTEvent peekEvent() ★

The `peekEvent()` method looks into the event queue and returns the first event, without removing that event. If you modify the event, your modifications are reflected in the event still on the queue. The returned object is an instance of `AWTEvent`. If the queue is empty, `peekEvent()` returns `null`.

public synchronized AWTEvent peekEvent(int id) ★

This `peekEvent()` method looks into the event queue for the first event of the specified type. `id` is one of the integer constants from an `AWTEvent` subclass or an integer constant of your own. If there are no events of the appropriate type on the queue, `peekEvent()` returns `null`.

Note that a few of the `AWTEvent` classes have both event types and subtypes; `peekEvent()` checks event types only and ignores the subtype. For example, to find an `ItemEvent`, you would call `peekEvent(ITEM_STATE_CHANGED)`. However, a call to `peekEvent(SELECTED)` would return `null`, since `SELECTED` identifies an `ItemEvent` subtype.

public synchronized void postEvent(AWTEvent theEvent) ★

This version of `postEvent()` puts a new style (Java1.1) event on the event queue.

public synchronized AWTEvent getNextEvent() throws InterruptedException ★

The `getNextEvent()` method removes an event from the queue. If the queue is empty, the call waits. The object returned is the item taken from the queue; it is either an `Event` or an `AWTEvent`. If the method call is interrupted, the method `getNextEvent()` throws an `InterruptedException`.

In this chapter:

- *Component*
- *Labels*
- *Buttons*
- *A Simple Calculator*
- *Canvas*
- *Creating Your Own Component*
- *Cursor*

5

Components

This chapter introduces the generic graphical widget used within the AWT package, `Component`, along with a trio of specific components: `Label`, `Button`, and `Canvas`. It also covers the `Cursor` class, new to Java 1.1. (Cursor support was previously part of the `Frame` class.) Although many objects within AWT don't subclass `Component`, and though you will never create an instance of `Component`, anything that provides screen-based user interaction and relies on the system for its layout will be a child of `Component`. As a subclass of `Component`, each child inherits a common set of methods and an API for dealing with the different events (i.e., mouse click, keyboard input) that occur within your Java programs.

After discussing the methods in `Component` classes, this chapter goes into detail about two specific components, `Label` and `Button`. A `Label` is a widget that contains descriptive text, usually next to an input field. A `Button` is a basic mechanism that lets the user signal the desire to perform an action. You will learn about the `Canvas` object and how to use a `Canvas` to create your own component. Finally, we cover the `Cursor` class, which lets you change the cursor over a `Component`.

Before going into the mechanics of the `Component` class, it's necessary to say a little about the relationship between components and containers. A `Container` is also a component with the ability to contain other components. There are several different kinds of containers; they are discussed in Chapter 6, *Containers*. To display a component, you have to put it in a container by calling the container's `add()` method. We often call the container that holds a component the component's *parent*; likewise, we call the components a container holds its *children*. Certain operations are legal only if a component has a parent—that is, the component is in a container. Of course, since containers are components, containers can contain other containers, *ad infinitum*.

NOTE If you think some component is missing a method that should obviously be there, check the methods it inherits. For example, the `Label` class appears to lack a `setFont()` method. Obviously, labels ought to be able to change their fonts. The `setFont()` method really is there; it is inherited from the `Component` class, and therefore, not documented as part of the `Label` class. Even if you're familiar with object-oriented techniques, the need to work up a class hierarchy to find all of the class's methods can lead to confusion and frustration. While all Java objects inherit methods from other classes, the potential for confusion is worst with components, which inherit over a hundred methods from `Component` and may only have a few methods of their own.

5.1 Component

Every GUI-based program consists of a screen with a set of objects. With Java, these objects are called components. Some of the more frequently used components are buttons, text fields, and containers.

A container is a special component that allows you to group different components together within it. You will learn more about containers in the next chapter, but they are in fact just another kind of component. Also, some of the parameters and return types for the methods of `Component` have not been explained yet and have their own sections in future chapters.

5.1.1 Component Methods

Constants

Prior to Java 1.1, you could not subclass `Component` or `Container`. With the introduction of the `LightweightPeer`, you can now subclass either `Component` or `Container`. However, since you no longer have a native peer, you must rely on your container to provide a display area and other services that are normally provided by a full-fledged peer. Because you cannot rely on your peer to determine your alignment, the `Component` class now has five constants to indicate six possible alignment settings (one constant is used twice). The alignment constants designate where to position a lightweight component; their values range from 0.0 to 1.0. The lower the number, the closer the component will be placed to the origin (top left corner) of the space allotted to it.*

* As of Beta 3, these constants appear to be seldom used. The `getAlignmentX()` and `getAlignmentY()` methods return these values, but there are no `setAlignment` methods.

public static final float BOTTOM_ALIGNMENT ★

The `BOTTOM_ALIGNMENT` constant indicates that the component should align itself to the bottom of its available space. It is a return value from the method `getAlignmentY()`.

public static final float CENTER_ALIGNMENT ★

The `CENTER_ALIGNMENT` constant indicates that the component should align itself to the middle of its available space. It is a return value from either the `getAlignmentX()` or `getAlignmentY()` method. This constant represents both the horizontal and vertical center.

public static final float LEFT_ALIGNMENT ★

The `LEFT_ALIGNMENT` constant indicates that the component should align itself to the left side of its available space. It is a return value from `getAlignmentX()`.

public static final float RIGHT_ALIGNMENT ★

The `RIGHT_ALIGNMENT` constant indicates that the component should align itself to the right side of its available space. It is a return value from the method `getAlignmentX()`.

public static final float TOP_ALIGNMENT ★

The `TOP_ALIGNMENT` constant indicates that the component should align itself to the top of its available space. It is a return value from `getAlignmentY()`.

Variables

protected Locale locale ★

The protected `locale` variable can be accessed by calling the `getLocale()` method.

Constructor

Prior to Java 1.1, there was no public or protected constructor for `Component`. Only package members were able to subclass `Component` directly. With the introduction of lightweight peers, components can exist without a native peer, so the constructor was made `protected`, allowing you to create your own `Component` subclasses.

protected Component() ★

The constructor for `Component` creates a new component without a native peer. Since you no longer have a native peer, you must rely on your container to provide a display area. This allows you to create components that require fewer system resources than components that subclass `Canvas`. The example in the "Using an event multicaster" section of the previous chapter is of a lightweight component. Use the `SystemColor` class to help you colorize the new component appropriately or make it transparent.

Appearance

public Toolkit getToolkit ()

The `getToolkit()` method returns the current `Toolkit` of the `Component`. This returns the parent's `Toolkit` (from a `getParent()` call) when the `Component` has not been added to the screen yet or is lightweight. If there is no parent, `getToolkit()` returns the default `Toolkit`. Through the `Toolkit`, you have access to the details of the current platform (like screen resolution, screen size, and available fonts), which you can use to adjust screen real estate requirements or check on the availability of a font.

public Color getForeground ()

The `getForeground()` method returns the foreground color of the component. If no foreground color is set for the component, you get its parent's foreground color. If none of the component's parents have a foreground color set, `null` is returned.

public void setForeground (Color c)

The `setForeground()` method changes the current foreground color of the area of the screen occupied by the component to `c`. After changing the color, it is necessary for the screen to refresh before the change has any effect. To refresh the screen, call `repaint()`.

public Color getBackground ()

The `getBackground()` method returns the background color of the component. If no background color is set for the component, its parent's background color is retrieved. If none of the component's parents have a background color set, `null` is returned.

public void setBackground (Color c)

The `setBackground()` method changes the current background color of the area of the screen occupied by the component to `c`. After changing the color, it is necessary for the screen to refresh before the change has any affect. To refresh the screen, call `repaint()`.

public Font getFont ()

The `getFont()` method returns the font of the component. If no font is set for the component, its parent's font is retrieved. If none of the component's parents have a font set, `null` is returned.

public synchronized void setFont (Font f)

The `setFont()` method changes the component's font to `f`. If the font family (such as TimesRoman) provided within `f` is not available on the current platform, the system uses a default font family, along with the supplied size and style (plain, bold, italic). Depending upon the platform, it may be necessary to refresh the component/screen before seeing any changes.

Changing the font of a component could have an affect on the layout of the component.

public synchronized ColorModel getColorModel ()

The `getColorModel()` method returns the `ColorModel` used to display the current component. If the component is not displayed, the `ColorModel` from the component's `Toolkit` is used. The normal `ColorModel` for a Java program is 8 bits each for red, green, and blue.

public Graphics getGraphics ()

The `getGraphics()` method gets the component's graphics context. Most non-container components do not manage them correctly and therefore throw an `InternalError` exception when you call this method. The `Canvas` component is one that does since you can draw on that directly. If the component is not visible, `null` is returned.

public FontMetrics getFontMetrics (Font f)

The `getFontMetrics()` method retrieves the component's view of the `FontMetrics` for the requested font `f`. Through the `FontMetrics`, you have access to the platform-specific sizing for the appearance of a character or string.

public Locale getLocale () ★

The `getLocale()` method retrieves the current `Locale` of the component, if it has one. Using a `Locale` allows you to write programs that can adapt themselves to different languages and different regional variants. If no `Locale` has been set, `getLocale()` returns the parent's `Locale`.* If the component has no locale of its own and no parent (i.e., it isn't in a container), `getLocale()` throws the run-time exception `IllegalComponentStateException`.

public void setLocale (Locale l) ★

The `setLocale()` method changes the current `Locale` of the component to `l`. In order for this change to have any effect, you must localize your components so that they have different labels or list values for different environments. Localization is part of the broad topic of internationalization and is beyond the scope of this book.

public Cursor getCursor () ★

The `getCursor()` method retrieves the component's current `Cursor`. If one hasn't been set, the default is `Cursor.DEFAULT_CURSOR`. The `Cursor` class is described fully in Section 5.7. Prior to Java 1.1, the ability to associate cursors with components was restricted to frames.

* For more on the `Locale` class, see the *Java Fundamental Classes Reference* from O'Reilly & Associates.

public synchronized void setCursor (Cursor c) ★

The `setCursor()` method changes the current `Cursor` of the component to `c`. The change takes effect as soon as the cursor is moved. Lightweight components cannot change their cursors.

Positioning/Sizing

`Component` provides a handful of methods for positioning and sizing objects. Most of these are used behind the scenes by the system. You will also need them if you create your own `LayoutManager` or need to move or size an object. All of these depend on support for the functionality from the true component's peer.

public Point getLocation () ★
public Point location () ☆

The `getLocation()` method returns the current position of the `Component` in its parent's coordinate space. The `Point` is the top left corner of the bounding box around the `Component`.

`location()` is the Java 1.0 name for this method.

public Point getLocationOnScreen () ★

The `getLocationOnScreen()` method returns the current position of the `Component` in the screen's coordinate space. The `Point` is the top left corner of the bounding box around the `Component`. If the component is not showing, the `getLocationOnScreen()` method throws the `IllegalComponentStateException` run-time exception.

public void setLocation (int x, int y) ★
public void move (int x, int y) ☆

The `setLocation()` method moves the `Component` to the new position (`x`, `y`). The coordinates provided are in the parent container's coordinate space. This method calls `setBounds()` to move the component. The `LayoutManager` of the container may make it impossible to change a component's location.

Calling this method with a new position for the component generates a `ComponentEvent` with the ID `COMPONENT_MOVED`.

`move()` is the Java 1.0 name for this method.

public void setLocation (Point p) ★

This `setLocation()` method moves the component to the position specified by the given `Point`. It is the same as calling `setLocation(p.x, p.y)`.

Calling this method with a new position for the component generates a `ComponentEvent` with the ID `COMPONENT_MOVED`.

public Dimension getSize () ★
public Dimension size () ☆

The `getSize()` method returns the width and height of the component as a `Dimension` object.

`size()` is the Java 1.0 name for this method.

public void setSize (int width, int height) ★
public void resize (int width, int height) ☆

The `setSize()` method changes the component's width and height to the `width` and `height` provided. `width` and `height` are specified in pixels. The component is resized by a call to `setBounds()`. The `LayoutManager` of the `Container` that contains the component may make it impossible to change a component's size.

Calling this method with a new size for the component generates a `ComponentEvent` with the ID `COMPONENT_RESIZED`.

`resize()` is the Java 1.0 name for this method.

public void setSize (Dimension d) ★
public void resize (Dimension d) ☆

This `setSize()` method changes the component's width and height to the `Dimension d` provided. The `Dimension` object includes the width and height attributes in one object. The component is resized by a call to the `setBounds()` method. The `LayoutManager` of the `Container` that contains the component may make it impossible to change a component's size.

Calling this method with a new size for the component generates a `ComponentEvent` with the ID `COMPONENT_RESIZED`.

`resize()` is the Java 1.0 name for this method.

public Rectangle getBounds () ★
public Rectangle bounds () ☆

The `getBounds()` method returns the bounding rectangle of the object. The fields of the `Rectangle` that you get back contain the component's position and dimensions.

`bounds()` is the Java 1.0 name for this method.

public void setBounds (int x, int y, int width, int height) ★
public void reshape (int x, int y, int width, int height) ☆

The `setBounds()` method moves and resizes the component to the bounding rectangle with coordinates of (`x`, `y`) (top left corner) and `width` `height`. If the size and shape have not changed, no reshaping is done. If the component is resized, it is invalidated, along with its parent container. The `LayoutManager` of the Container that contains the component may make it impossible to change the component's size or position. Calling setBounds() invalidates the container, which results in a call to the LayoutManager to rearrange the container's contents. In turn, the LayoutManager calls setBounds() to give the component its new size and position, which will probably be the same size and position it had originally. In short, if a layout manager is in effect, it will probably undo your attempts to change the component's size and position.

Calling this method with a new size for the component generates a ComponentEvent with the ID COMPONENT_RESIZED. Calling this method with a new position generates a ComponentEvent with the ID COMPONENT_MOVED.

reshape() is the Java 1.0 name for this method.

public void setBounds (Rectangle r) ★

This setBounds() method calls the previous method with parameters of r.x, r.y, r.width, and r.height.

Calling this method with a new size for the component generates a ComponentEvent with the ID COMPONENT_RESIZED. Calling this method with a new position generates a ComponentEvent with the ID COMPONENT_MOVED.

public Dimension getPreferredSize () ★
public Dimension preferredSize () ☆

The getPreferredSize() method returns the Dimension (width and height) for the preferred size of the component. Each component's peer knows its preferred size. Lightweight objects return getSize().

preferredSize() is the Java 1.0 name for this method.

public Dimension getMinimumSize () ★
public Dimension minimumSize () ☆

The getMinimumSize() method returns the Dimension (width and height) for the minimum size of the component. Each component's peer knows its minimum size. Lightweight objects return getSize(). It is possible that the methods getMinimumSize() and getPreferredSize() will return the same dimensions.

minimumSize() is the Java 1.0 name for this method.

public Dimension getMaximumSize () ★

The getMaximumSize() method returns the Dimension (width and height) for the maximum size of the component. This may be used by a layout manager to prevent a component from growing beyond a predetermined size. None of the java.awt layout managers call this method. By default, the value returned is Short.MAX_VALUE for both dimensions.

public float getAlignmentX () ★

The `getAlignmentX()` method returns the alignment of the component along the x axis. The alignment could be used by a layout manager to position this component relative to others. The return value is between 0.0 and 1.0. Values nearer 0 indicate that the component should be placed closer to the left edge of the area available. Values nearer 1 indicate that the component should be placed closer to the right. The value 0.5 means the component should be centered. The default setting is `Component.CENTER_ALIGNMENT`.

public float getAlignmentY () ★

The `getAlignmentY()` method returns the alignment of the component along the y axis. The alignment could be used by a layout manager to position this component relative to others. The return value is between 0.0 and 1.0. Values nearer 0 indicate that the component should be placed closer to the top of the area available. Values nearer 1 indicate that the component should be placed closer to the bottom. The value 0.5 means the component should be centered. The default setting is `Component.CENTER_ALIGNMENT`.

public void doLayout () ★
public void layout () ☆

The `doLayout()` method of `Component` does absolutely nothing. It is called when the `Component` is validated (through the `validate()` method). The `Container` class overrides this method.

`layout()` is the Java 1.0 name for this method.

public boolean contains (int x, int y) ★
public boolean inside (int x, int y) ☆

The `contains()` method checks if the `x` and `y` coordinates are within the bounding box of the component. If the `Component` is not rectangular, the method acts as if there is a rectangle around the `Component`. `contains()` returns `true` if the `x` and `y` coordinates are within the component, `false` otherwise.

`inside()` is the Java 1.0 name for this method.

public boolean contains (Point p) ★

This `contains()` method calls the previous method with parameters of `p.x` and `p.y`.

public Component getComponentAt (int x, int y) ★
public Component locate (int x, int y) ☆

The `getComponentAt()` method uses `contains()` to see if the `x` and `y` coordinates are within the component. If they are, this method returns the `Component`. If they aren't, it returns `null`. `getComponentAt()` is overridden by `Container` to provide enhanced functionality.

locate() is the Java 1.0 name for this method.

public Component getComponentAt (Point p) ★

This getComponentAt() method calls the previous method with parameters of p.x and p.y.

Painting

The only methods in this section that you call directly are the versions of repaint(). The paint() and update() methods are called by the system when the display area requires refreshing, such as when a user resizes a window. When your program changes the display you should call repaint() to trigger a call to update() and paint(). Otherwise, the system is responsible for updating the display.

public void paint (Graphics g)

The paint() method is offered so the system can display whatever you want in a Component. In the base Component class, this method does absolutely nothing. Ordinarily, it would be overridden in an applet to do something other than the default, which is display a box in the current background color. g is the graphics context of the component being drawn on.

public void update (Graphics g)

The update() method is automatically called when you ask to repaint the Component. If the component is not lightweight, the default implementation of update() clears graphics context g by drawing a filled rectangle in the background color, resetting the color to the current foreground color, and calling paint(). If you do not override update() when you do animation, you will see some flickering because Component clears the screen. Animation is discussed in Chapter 2, *Simple Graphics*.

public void paintAll (Graphics g)

The paintAll() method validates the component and paints its peer if it is visible. g represents the graphics context of the component. This method is called when the paintComponents() method of Container is called.

public void repaint ()

The repaint() method requests the scheduler to redraw the component as soon as possible. This will result in update() getting called soon thereafter. There is not a one-to-one correlation between repaint() and update() calls. It is possible that multiple repaint() calls can result in a single update().

public void repaint (long tm)

This version of `repaint()` allows for a delay of `tm` milliseconds. It says, please update this component within `tm` milliseconds, which may happen immediately.

public void repaint (int x, int y, int width, int height)

This version of `repaint()` allows you to select the region of the `Component` you desire to be updated. (`x`, `y`) are the coordinates of the upper left corner of the bounding box of the component with dimensions of `widthheight`. This is similar to creating a clipping area and results in a quicker repaint.

public void repaint (long tm, int x, int y, int width, int height)

This final version of `repaint()` is what the other three `repaint()` methods call. `tm` is the maximum delay in milliseconds before update should be called. (`x`, `y`) are the coordinates of the upper left corner of the clipping area of the component with dimensions of `width height`.

public void print (Graphics g)

The default implementation of the `print()` method calls `paint()`.

In Java 1.0, there was no way to print; in Java 1.1, if the `graphics` parameter implements `PrintGraphics`, anything drawn on `g` will be printed. Printing is covered in Chapter 17, *Printing*.

public void printAll (Graphics g)

The `printAll()` method validates the component and paints its peer if it is visible. `g` represents the graphics context of the component. This method is called when the `printComponents()` method of `Container` is called or when you call it with a `PrintGraphics` parameter.

The default implementation of `printAll()` is identical to `paintAll()`. As with `paintAll()`, `g` represents the graphics context of the component; if `g` implements `PrintGraphics`, it can be printed.

Imaging

Background information about using images is discussed in Chapter 2 and Chapter 12, *Image Processing*. The `imageUpdate()` method of `Component` is the sole method of the `ImageObserver` interface. Since images are loaded in a separate thread, this method is called whenever additional information about the image becomes available.

public boolean imageUpdate (Image image, int infoflags, int x, int y, int width, int height)

`imageUpdate()` is the `java.awt.image.ImageObserver` method implemented by `Component`. It is an asynchronous update interface for receiving notifications about `Image` information as `image` is loaded and is automatically called when additional information becomes available. This method is necessary because image loading is done in a separate thread from the `getImage()` call. Ordinarily, `x` and `y` would be the coordinates of the upper left corner of the image loaded so far, usually (0, 0). However, the method `imageUpdate()` of the component ignores these parameters. `width` and `height` are the `image`'s dimensions, so far, in the loading process.

The `infoflags` parameter is a bit-mask of information available to you about `image`. Please see the text about `ImageObserver` in Chapter 12 for a complete description of the different flags that can be set. When overriding this method, you can wait for some condition to be true by checking a flag in your program and then taking the desired action. To check for a particular flag, perform an AND (`&`) of `infoflags` and the constant. For example, to check if the `FRAMEBITS` flag is set:

```
if ((infoflags & ImageObserver.FRAMEBITS) == ImageObserver.FRAMEBITS)
    System.out.println ("The Flag is set");
```

The return value from a call to `imageUpdate()` is `true` if `image` has changed and `false` otherwise.

Two system properties let the user control the behavior of updates:

- `awt.image.incrementaldraw` allows the user to control whether or not partial images are displayed. Initially, the value of `incrementaldraw` is unset and defaults to `true`, which means that partial images are drawn. If `incrementaldraw` is set to `false`, the image will be drawn only when it is complete or when the screen is resized or refreshed.
- `awt.image.redrawrate` allows the user to change the delay between successive repaints. If not set, the default redraw rate is 100 milliseconds.

public Image createImage (int width, int height)

The `createImage()` method creates an empty `Image` of size `width height`. The returned `Image` is an in-memory image that can be drawn on for double buffering to manipulate an image in the background. If an image of size `width height` cannot be created, the call returns `null`. In order for `createImage()` to succeed, the peer of the `Component` must exist; if the component is lightweight, the peer of the component's container must exist.

public Image createImage (ImageProducer producer)

This `createImage()` method allows you to take an existing image and modify it in some way to produce a new `Image`. This can be done through `ImageFilter` and `FilteredImageSource` or a `MemoryImageSource`, which accepts an array of pixel information. You can learn more about these classes and this method in Chapter 12.

public boolean prepareImage (Image image, ImageObserver observer)

The `prepareImage()` method forces `image` to start loading, asynchronously, in another thread. `observer` is the `Component` that `image` will be rendered on and is notified (via `imageUpdate()`) as `image` is being loaded. In the case of an `Applet`, `this` would be passed as the `ImageObserver`. If `image` has already been fully loaded, `prepareImage()` returns `true`. Otherwise, `false` is returned. Since `image` is loaded asynchronously, `prepareImage()` returns immediately. Ordinarily, `prepareImage()` would be called by the system when `image` is first needed to be displayed (in `drawImage()` within `paint()`). As more information about the image gets loaded, `imageUpdate()` is called periodically.

If you do not want to go through the trouble of creating a `MediaTracker` instance to start the loading of the image objects, you can call `prepareImage()` to trigger the start of image loading prior to a call to `drawImage()`.

If `image` has already started loading when this is called or if this is an in-memory image, there is no effect.

public boolean prepareImage (Image image, int width, int height, ImageObserver observer)

This version of `prepareImage()` is identical to the previous one, with the addition of a scaling factor of `widthheight`. As with other `width` and `height` parameters, the units for these parameters are pixels. Also, if `width` and `height` are -1, no scaling factor is assumed. This method is called by one of the internal `MediaTracker` methods.

public int checkImage (Image image, ImageObserver observer)

The `checkImage()` method returns the status of the construction of a screen representation of `image`, being watched by `observer`. If `image` has not started loading yet, this will not start it. The return value is the `ImageObserver` flags ORed together for the data that is now available. The available `ImageObserver` flags are: `WIDTH`, `HEIGHT`, `PROPERTIES`, `SOMEBITS`, `FRAMEBITS`, `ALLBITS`, `ERROR`, and `ABORT`. See Chapter 12 for a complete description of `ImageObserver`.

public int checkImage (Image image, int width, int height, ImageObserver observer)

This version of `checkImage()` is identical to the previous one, with the addition of a scaling factor of `widthheight`. If you are using the `drawImage()` version with `width` and `height` parameters, you should use this version of `checkImage()` with the same `width` and `height`.

Peers

public ComponentPeer getPeer () ☆

The `getPeer()` method returns a reference to the component's peer as a `ComponentPeer` object. For example, if you issue this method from a `Button` object, `getPeer()` returns an instance of the `ComponentPeer` subclass `ButtonPeer`.

This method is flagged as deprecated in comments but not with `@deprecated`. There is no replacement method for Java 1.1.

public void addNotify ()

The `addNotify()` method is overridden by each individual component type. When `addNotify()` is called, the peer of the component gets created, and the `Component` is invalidated. The `addNotify()` method is called by the system when it needs to create the peer. The peer needs to be created when a `Component` is first shown, or when a new `Component` is added to a `Container` and the `Container` is already being shown (in which case it already has a peer, but a new one must be created to take account of the new `Component`). If you override this method for a specific `Component`, call `super.addNotify()` first, then do what you need for the `Component`. You will then have information available about the newly created peer.

Certain tasks cannot succeed unless the peer has been created. An incomplete list includes finding the size of a component, laying out a container (because it needs the component's size), and creating an `Image` object. Peers are discussed in more depth in Chapter 15, *Toolkit and Peers.*

public synchronized void removeNotify ()

The `removeNotify()` method destroys the peer of the component and removes it from the screen. The state information about the `Component` is retained by the specific subtype. The `removeNotify()` method is called by the system when it determines the peer is no longer needed. Such times would be when the `Component` is removed from a `Container`, when its container changes, or when the `Component` is disposed. If you override this method for a specific `Component`, issue the particular commands for you need for this `Component`, then call `super.removeNotify()` last.

State Procedures

These methods determine whether the component is ready to be displayed and can be seen by the user. The first requirement is that it be *valid*—that is, whether the system knows its size, and (in the case of a container) whether the layout manager is aware of all its parts and has placed them as requested. A component becomes invalid if the size has changed since it was last displayed. If the component is a container, it becomes invalid when one of the components contained within it becomes invalid.

Next, the component must be *visible*—a possibly confusing term, because components can be considered "visible" without being seen by the user. Frames (because they have their own top-level windows) are not visible until you request that they be shown, but other components are visible as soon as you create them.

Finally, to be seen, a component must be *showing*. You show a component by adding it to its container. For something to be showing, it must be visible and be in a container that is visible and showing.

A subsidiary aspect of state is the *enabled* quality, which determines whether a component can accept input.

public boolean isValid ()

The `isValid()` method tells you whether or not the component needs to be laid out.

public void validate ()

The `validate()` method sets the component's valid state to `true`. Ordinarily, this is done for you when the `Component` is laid out by its `Container`. Since objects are invalid when they are first drawn on the screen, you should call `validate()` to tell the system you are finished adding objects so that it can validate the screen and components. One reason you can override `validate()` is to find out when the container that the component exists in has been resized. The only requirement when overriding is that the original `validate()` be called. With Java 1.1, instead of overriding, you can listen for resize events.

public void invalidate ()

The `invalidate()` method sets the component's valid state to `false` and propagates the invalidation to its parent. Ordinarily, this is done for you, or should be, whenever anything that affects the layout is changed.

public boolean isVisible ()

The `isVisible()` methods tells you if the component is currently visible. Most components are initially visible, except for top-level objects like frames. Any component that is visible will be shown on the screen when the screen is painted.

public boolean isShowing ()

The `isShowing()` method tells you if the component is currently shown on the screen. It is possible for `isVisible()` to return `true` and `isShowing()` to return `false` if the screen has not been painted yet.

Table 5-1 compares possible return values from `isVisible()` and `isShowing()`. The first two entries are for objects that have their own `Window`. These will always return the same values for `isVisible()` and `isShowing()`. The next three are for `Component` objects that exist within a `Window`, `Panel`, or `Applet`. The visible setting is always initially `true`. However, the showing setting is not true until the object is actually drawn. The last case shows another possibility. If the component exists within an invisible `Container`, the component will be visible but will not be shown.

Table 5–1: isVisible vs. isShowing

Happenings	**isVisible**	**isShowing**
Frame created `Frame f = new Frame ()`	`false`	`false`
Frame showing `f.show ()`	`true`	`true`
Component created `Button b= new Button ("Help")`	`true`	`false`
Button added to screen in `init()` `add (b)`	`true`	`false`
Container laid out with Button in it	`true`	`true`
Button within Panel that is not visible	`true`	`false`

public void show ()

The `show()` method displays a component by making it visible and showing its peer. The parent `Container` becomes invalid because the set of children to display has changed. You would call `show()` directly to display a `Frame` or `Dialog`.

In Java 1.1, you should use `setVisible()` instead.

public void hide ()

The `hide()` method hides a component by making it invisible and hiding its peer. The parent `Container` becomes invalid because the set of children to display has changed. If you call `hide()` for a `Component` that does not subclass `Window`, the component's `Container` reserves space for the hidden object.

In Java 1.1, you should use `setVisible()` instead.

public void setVisible(boolean condition) ★
public void show (boolean condition) ☆

The `setVisible()` method calls either `show()` or `hide()` based on the value of `condition`. If `condition` is `true`, `show()` is called. When `condition` is `false`, `hide()` is called.

`show()` is the Java 1.0 name for this method.

public boolean isEnabled ()

The `isEnabled()` method checks to see if the component is currently enabled. An enabled `Component` can be selected and trigger events. A disabled `Component` usually has a slightly lighter font and doesn't permit the user to select or interact with it. Initially, every `Component` is enabled.

public synchronized void enable ()

The `enable()` method allows the user to interact with the component. Components are enabled by default but can be disabled by a call to `disabled()` or `setEnabled(false)`.

In Java 1.1, you should use `setEnabled()` instead.

public synchronized void disable ()

The `disable()` method disables the component so that it is unresponsive to user interactions.

In Java 1.1, you should use `setEnabled()` instead.

public void setEnabled (boolean condition) ★
public void enable (boolean condition) ☆

The `setEnabled()` method calls either `enable()` or `disable()` based on the value of `condition`. If `condition` is `true`, `enable()` is called. When `condition` is `false`, `disable()` is called. Enabling and disabling lets you create components that can be operated only under certain conditions—for example, a `Button` that can be pressed only after the user has typed into a `TextArea`.

`enable()` is the Java 1.0 name for this method.

Focus

Although there was some support for managing input focus in version 1.0, 1.1 improved on this greatly by including support for Tab and Shift+Tab to move input focus to the next or previous component, and by being more consistent across different platforms. This support is provided by the package-private class `FocusManager`.

public boolean isFocusTraversable() ★

The `isFocusTraversable()` method is the support method that tells you whether or not a component is capable of receiving the input focus. Every component asks its peer whether or not it is traversable. If there is no peer, this method returns `false`.

If you are creating a component by subclassing `Component` or `Canvas` and you want it to be traversable, you should override this method; a `Canvas` is not traversable by default.

public void requestFocus ()

The `requestFocus()` method allows you to request that a component get the input focus. If it can't (`isFocusTraversable()` returns `false`), it won't.

public void transferFocus () ★
public void nextFocus () ☆

The `transferFocus()` method moves the focus from the current component to the next one.

`nextFocus()` is the Java 1.0 name for this method.

Miscellaneous methods

public final Object getTreeLock () ★

The `getTreeLock()` method retrieves the synchronization lock for all AWT components. Instead of using `synchronized` methods in Java 1.1, previously synchronized methods lock the tree within a `synchronized (component.getTreeLock()) {}` code block. This results in a more efficient locking mechanism to improve performance.

public String getName () ★

The `getName()` method retrieves the current name of the component. The component's name is useful for object serialization. Components are given a name by default; you can change the name by calling `setName()`.

public void setName (String name) ★

The `setName()` method changes the name of the component to `name`.

public Container getParent ()

The `getParent()` method returns the component's `Container`. The container for anything added to an applet is the applet itself, since it subclasses `Panel`. The container for the applet is the browser. In the case of Netscape Navigator versions 2.0 and 3.0, the return value would be a specific instance of the `netscape.applet.EmbeddedAppletFrame` class. If the applet is running within the *appletviewer*, the return value would be an instance of `sun.applet.AppletViewerPanel`.

public synchronized void add(PopupMenu popup) ★

The `add()` method introduced in Java 1.1 provides the ability to associate a `PopupMenu` with a `Component`. The pop-up menu can be used to provide context-sensitive menus for specific components. (On some platforms for some components, pop-up menus exist already and cannot be overridden.) Interaction with the menu is discussed in Chapter 10, *Would You Like to Choose from the Menu?*

Multiple pop-up menus can be associated with a component. To display the appropriate pop-up menu, call the pop-up menu's `show()` method.

public synchronized void remove(MenuComponent popup) ★

The `remove()` method is the `MenuContainer` interface method to disassociate the `popup` from the component. (`PopupMenu` is a subclass of `MenuComponent`.) If `popup` is not associated with the `Component`, nothing happens.

protected String paramString ()

The `paramString()` method is a protected method that helps build a `String` listing the different parameters of the `Component`. When the `toString()` method is called for a specific `Component`, `paramString()` is called for the lowest level and works its way up the inheritance hierarchy to build a complete parameter string to display. At the `Component` level, potentially seven (Java1.0) or eight (1.1) items are added. The first five items added are the component's name (if non-null and using Java 1.1), x and y coordinates (as returned by `getLocation()`), along with its width and height (as returned by `getSize()`). If the component is not valid, "invalid" is added next. If the component is not visible, "hidden" is added next. Finally, if the component is not enabled, "disabled" is added.

public String toString ()

The `toString()` method returns a `String` representation of the object's values. At the `Component` level, the class's name is placed before the results of `paramString()`. This method is called automatically by the system if you try to print an object using `System.out.println()`.

public void list ()

The `list()` method prints the contents of the `Component` (as returned by `toString()`) to `System.out`. If `c` is a type of `Component`, the two statements `System.out.println(c)` and `c.list()` are equivalent. This method is more useful at the `Container` level, because it prints all the components within the container.

public void list (PrintWriter out) ★
public void list (PrintStream out)

This version of `list()` prints the contents of the `Component` (as returned by `toString()`) to a different `PrintStream`, `out`.

public void list (PrintWriter out, int indentation) ★
public void list (PrintStream out, int indentation)

These versions of `list()` are called by the other two. They print the component's contents (as returned by `toString()`) with the given indentation. This allows you to prepare nicely formatted lists of a container's contents for debugging; you could use the indentation to reflect how deeply the component is nested within the container.

5.1.2 Component Events

Chapter 4, *Events* covers event handling in detail. This section summarizes what `Component` does for the different event-related methods.

With the Java 1.0 event model, many methods return `true` to indicate that the program has handled the event and `false` to indicate that the event was not handled (or only partially handled); when `false` is returned, the system passes the event up to the parent container. Thus, it is good form to return `true` only when you have fully handled the event, and no further processing is necessary.

With the Java 1.1 event model, you register a listener for a specific event type. When that type of event happens, the listener is notified. Unlike the 1.0 model, you do not need to override any methods of `Component` to handle the event.

Controllers

The Java 1.0 event model controllers are `deliverEvent()`, `postEvent()`, and `handleEvent()`. With 1.1, the controller is a method named `dispatchEvent()`.

public void deliverEvent (Event e) ☆

The `deliverEvent()` method delivers the 1.0 `Event e` to the `Component` in which an event occurred. Internally, this method calls `postEvent()`. The `deliverEvent()` method is an important enhancement to `postEvent()` for `Container` objects since they have to determine which component in the `Container` gets the event.

public boolean postEvent (Event e) ☆

The `postEvent()` method tells the `Component` to deal with 1.0 `Event e`. It calls `handleEvent()`, which returns `true` if some other object handled `e` and `false` if no one handles it. If `handleEvent()` returns `false`, `postEvent()` posts the `Event` to the component's parent. You can use `postEvent()` to hand any events you generate yourself to some other component for processing. (Creating your own events is a useful technique that few developers take advantage of.) You can also use `postEvent()` to reflect an event from one component into another.

public boolean handleEvent (Event e) ☆

The `handleEvent()` method determines the type of event `e` and passes it along to an appropriate method to deal with it. For example, when a mouse motion event is delivered to `postEvent()`, it is passed off to `handleEvent()`, which calls `mouseMove()`. As shown in the following listing, `handleEvent()` can be implemented as one big switch statement. Since not all event types have default event handlers, you may need to override this method. If you do, remember to call the overridden method to ensure that the default behavior still takes place. To do so, call `super.handleEvent(event)` for any event your method does not deal with.

```
public boolean handleEvent(Event event) {
    switch (event.id) {
      case Event.MOUSE_ENTER:
        return mouseEnter (event, event.x, event.y);
      case Event.MOUSE_EXIT:
        return mouseExit (event, event.x, event.y);
      case Event.MOUSE_MOVE:
        return mouseMove (event, event.x, event.y);
      case Event.MOUSE_DOWN:
        return mouseDown (event, event.x, event.y);
      case Event.MOUSE_DRAG:
        return mouseDrag (event, event.x, event.y);
      case Event.MOUSE_UP:
        return mouseUp (event, event.x, event.y);
      case Event.KEY_PRESS:
      case Event.KEY_ACTION:
        return keyDown (event, event.key);
      case Event.KEY_RELEASE:
      case Event.KEY_ACTION_RELEASE:
        return keyUp (event, event.key);
      case Event.ACTION_EVENT:
        return action (event, event.arg);
      case Event.GOT_FOCUS:
        return gotFocus (event, event.arg);
      case Event.LOST_FOCUS:
        return lostFocus (event, event.arg);
    }
    return false;
}
```

public final void dispatchEvent(AWTEvent e) ★

The `dispatchEvent()` method allows you to post new AWT events to this component's listeners. `dispatchEvent()` tells the `Component` to deal with the `AWTEvent` `e` by calling its `processEvent()` method. This method is similar to Java 1.0's `postEvent()` method. Events delivered in this way bypass the system's event queue. It's not clear why you would want to bypass the event queue, except possibly to deliver some kind of high priority event.

Action

public boolean action (Event e, Object o) ☆

The `action()` method is called when the user performs some action in the `Component`. `e` is the 1.0 `Event` instance for the specific event, while the content of `o` varies depending upon the specific `Component`. The particular action that triggers a call to `action()` depends on the `Component`. For example, with a `TextField`, `action()` is called when the user presses the carriage return. This method should not be called directly; to deliver any event you generate, call `postEvent()`, and let it decide how the event should propagate.

The default implementation of the `action()` method does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.action(e, o)` to ensure that the event propagates to the component's container or component's superclass, respectively.

Keyboard

public boolean keyDown (Event e, int key) ★

The `keyDown()` method is called whenever the user presses a key. `e` is the 1.0 `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) could be either `Event.KEY_PRESS` for a regular key or `Event.KEY_ACTION` for an action-oriented key (e.g., arrow or function key). The default `keyDown()` method does nothing and returns `false`. If you are doing input validation, return `true` if the character is invalid; this keeps the event from propagating to a higher component. If you wish to alter the input (i.e., convert to uppercase), return `false`, but change `e.key` to the new character.

public boolean keyUp (Event e, int key)

The `keyUp()` method is called whenever the user releases a key. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) could be either `Event.KEY_RELEASE` for a regular key or `Event.KEY_ACTION_RELEASE` for an action-oriented key (e.g., arrow or function key). `keyUp()` may be used to determine how long `key` has been pressed. The default `keyUp()` method does nothing and returns `false`.

Mouse

NOTE Early releases of Java (1.0.2 and earlier) propagated only mouse events from `Canvas` and `Container` objects. However, Netscape Navigator seems to have jumped the gun and corrected the situation with their 3.0 release, which is based on Java release 1.0.2.1. Until other Java releases catch up, use these events with care. For more information on platform dependencies, see Appendix C, *Platform-Specific Event Handling*.

---

public boolean mouseDown (Event e, int x, int y) ☆

The `mouseDown()` method is called when the user presses a mouse button over the `Component`. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. It is necessary to examine the modifiers field of `e` to determine which mouse button the user pressed. The default `mouseDown()` method does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseDown(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

public boolean mouseDrag (Event e, int x, int y) ☆

The `mouseDrag()` method is called when the user is pressing a mouse button and moves the mouse. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. `mouseDrag()` could be called multiple times as the mouse is moved. The default `mouseDrag()` method does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseDrag(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

public boolean mouseEnter (Event e, int x, int y) ☆

The `mouseEnter()` method is called when the mouse enters the `Component`. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. The default `mouseEnter()` method does nothing and returns `false`. `mouseEnter()` can be used for implementing balloon help. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseEnter(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

public boolean mouseExit (Event e, int x, int y) ☆

The `mouseExit()` method is called when the mouse exits the `Component`. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. The default method `mouseExit()` does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseExit(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

public boolean mouseMove (Event e, int x, int y) ☆

The `mouseMove()` method is called when the user moves the mouse without pressing a mouse button. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. `mouseMove()` will be called numerous times as the mouse is moved. The default `mouseMove()` method does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseMove(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

public boolean mouseUp (Event e, int x, int y) ☆

The `mouseUp()` method is called when the user releases a mouse button over the `Component`. `e` is the `Event` instance for the specific event, while `x` and `y` are the coordinates where the cursor was located when the event was initiated. The default `mouseUp()` method does nothing and returns `false`. When you override this method, return `true` only if you fully handle the event. Your method should always have a default case that returns `false` or calls `super.mouseUp(e, x, y)` to ensure that the event propagates to the component's container or component's superclass, respectively.

Focus

Focus events indicate whether a component can get keyboard input. Not all components can get focus (e.g., `Label` cannot). Precisely which components can get the focus is platform specific.

Ordinarily, the item with the focus has a light gray rectangle around it, though the actual display depends on the platform and the component. Figure 5-1 displays the effect of focus for buttons in Windows 95.

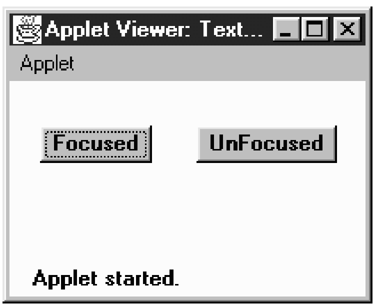


Figure 5–1: Focused and UnFocused buttons

NOTE Early releases of Java (1.0.2 and earlier) do not propagate all focus events on all platforms. Java 1.1 seems to propagate them properly. For more information on platform dependencies, see Appendix C.

---

public boolean gotFocus (Event e, Object o) ☆

The `gotFocus()` method is triggered when the `Component` gets the input focus. `e` is the 1.0 `Event` instance for the specific event, while the content of `o` varies depending upon the specific `Component`. The default `gotFocus()` method does nothing and returns `false`. For a `TextField`, when the cursor becomes active, it has the focus. When you override this method, return `true` to indicate that you have handled the event completely or `false` if you want the event to propagate to the component's container.

public boolean lostFocus (Event e, Object o) ☆

The `lostFocus()` method is triggered when the input focus leaves the `Component`. `e` is the `Event` instance for the specific event, while the content of `o` varies depending upon the specific `Component`. The default `lostFocus()` method does nothing and returns `false`. When you override this method, return `true` to indicate that you have handled the event completely or `false` if you want the event to propagate to the component's container.

Listeners and 1.1 Event Handling

With the 1.1 event model, you receive events by registering event listeners, which are told when the event happens. Components don't have to receive and handle their own events; you can cleanly separate the event-handling code from the user interface itself. This section covers the methods used to add and remove event listeners, which are part of the `Component` class. There is a pair of methods to add and remove listeners for each event type that is appropriate for a `Component`: `ComponentEvent`, `FocusEvent`, `KeyEvent`, `MouseEvent`, and `MouseMotionEvent`. Subclasses of `Component` may have additional event types and therefore will have additional methods for adding and removing listeners. For example, `Button`, `List`, `MenuItem`, and `TextField` each generate action events and therefore have methods to add and remove action listeners. These additional listeners are covered with their respective components.

public void addComponentListener(ComponentListener listener) ★

The `addComponentListener()` method registers `listener` as an object interested in being notified when a `ComponentEvent` passes through the `EventQueue` with this `Component` as its target. When such an event occurs, a method in the `ComponentListener` interface is called. Multiple listeners can be registered.

public void removeComponentListener(ComponentListener listener) ★

The `removeComponentListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

public void addFocusListener(FocusListener listener) ★

The `addFocusListener()` method registers `listener` as an object interested in being notified when a `FocusEvent` passes through the `EventQueue` with this `Component` as its target. When such an event occurs, a method in the `FocusListener` interface is called. Multiple listeners can be registered.

public void removeFocusListener(FocusListener listener) ★

The `removeFocusListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

public void addKeyListener(KeyListener listener) ★

The `addKeyListener()` method registers `listener` as an object interested in being notified when a `KeyEvent` passes through the `EventQueue` with this `Component` as its target. When such an event occurs, a method in the `KeyListener` interface is called. Multiple listeners can be registered.

public void removeKeyListener(KeyListener listener) ★

The `removeKeyListener()` method removes `listener` as a interested listener. If listener is not registered, nothing happens.

public void addMouseListener(MouseListener listener) ★

The `addMouseListener()` method registers `listener` as an object interested in being notified when a nonmotion-oriented `MouseEvent` passes through the `EventQueue` with this `Component` as its target. When such an event occurs, a method in the `MouseListener` interface is called. Multiple listeners can be registered.

public void removeMouseListener(MouseListener listener) ★

The `removeMouseListener()` method removes `listener` as a interested listener. If listener is not registered, nothing happens.

public void addMouseMotionListener(MouseMotionListener listener) ★

The `addMouseMotionListener()` method registers `listener` as an object interested in being notified when a motion-oriented `MouseEvent` passes through the `EventQueue` with this `Component` as its target. When such an event occurs, a method in the `MouseMotionListener` interface is called. Multiple listeners can be registered.

The mouse motion–oriented events are separate from the other mouse events because of their frequency of generation. If they do not have to propagate around, resources can be saved.

public void removeMouseMotionListener(MouseMotionListener listener) ★

The `removeMouseMotionListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

Handling your own events

Under the 1.1 event model, it is still possible for components to receive their own events, simulating the old event mechanism. If you want to write components that process their own events but are also compatible with the new model, you can override `processEvent()` or one of its related methods. `processEvent()` is logically similar to `handleEvent()` in the old model; it receives all the component's events and sees that they are forwarded to the appropriate listeners. Therefore, by overriding `processEvent()`, you get access to every event the component generates. If you want only a specific type of event, you can override `processComponentEvent()`, `processKeyEvent()`, or one of the other event-specific methods.

However, there is one problem. In Java 1.1, events aren't normally generated if there are no listeners. Therefore, if you want to receive your own events without registering a listener, you should first enable event processing (by a call to `enableEvent()`) to make sure that the events you are interested in are generated.

protected final void enableEvents(long eventsToEnable) ★

The `enableEvents()` method allows you to configure a component to listen for events without having any active listeners. Under normal circumstances (i.e., if you are not subclassing a component), it is not necessary to call this method.

The `eventsToEnable` parameter contains a mask specifying which event types you want to enable. The `AWTEvent` class (covered in Chapter 4) contains constants for the following types of events:

COMPONENT_EVENT_MASK
CONTAINER_EVENT_MASK
FOCUS_EVENT_MASK
KEY_EVENT_MASK
MOUSE_EVENT_MASK
MOUSE_MOTION_EVENT_MASK
WINDOW_EVENT_MASK
ACTION_EVENT_MASK
ADJUSTMENT_EVENT_MASK
ITEM_EVENT_MASK
TEXT_EVENT_MASK

OR the masks for the events you want; for example, call `enableEvents(MOUSE_EVENT_MASK | MOUSE_MOTION_EVENT_MASK)` to enable all mouse events. Any previous event mask settings are retained.

protected final void disableEvents(long eventsToDisable) ★

The `disableEvents()` method allows you to stop the delivery of events when they are no longer needed. `eventsToDisable` is similar to the `eventsToEnable` parameter but instead contains a mask specifying which event types to stop. A disabled event would still be delivered if someone were listening.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvent` with this `Component` as its target. `processEvent()` then passes them along to one of the event-specific processing methods (e.g., `processKeyEvent()`). When you subclass `Component`, overriding `processEvent()` allows you to process all events without providing listeners. Remember to call `super.processEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding `processEvent()` is like overriding the `handleEvent()` method using the 1.0 event model.

protected void processComponentEvent(ComponentEvent e) ★

The `processComponentEvent()` method receives `ComponentEvent` with this `Component` as its target. If any listeners are registered, they are then notified. When you subclass `Component`, overriding `processComponentEvent()` allows you to process component events without providing listeners. Remember to call `super.processComponentEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding `processComponentEvent()` is roughly similar to overriding `resize()`, `move()`, `show()`, and `hide()` to add additional functionality when those methods are called.

protected void processFocusEvent(FocusEvent e) ★

The `processFocusEvent()` method receives `FocusEvent` with this `Component` as its target. If any listeners are registered, they are then notified. When you subclass `Component`, overriding `processFocusEvent()` allows you to process the focus event without providing listeners. Remember to call `super.processFocusEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding `processFocusEvent()` is like overriding the methods `gotFocus()` and `lostFocus()` using the 1.0 event model.

protected void processKeyEvent(KeyEvent e) ★

The `processKeyEvent()` method receives `KeyEvent` with this `Component` as its target. If any listeners are registered, they are then notified. When you subclass `Component`, overriding `processKeyEvent()` allows you to process key events without providing listeners. Be sure to remember to call `super.processKeyEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding `processKeyEvent()` is roughly similar to overriding `keyDown()` and `keyUp()` with one method using the 1.0 event model.

protected void processMouseEvent(MouseEvent e) ★

This `processMouseEvent()` method receives all nonmotion-oriented `MouseEvents` with this `Component` as its target. If any listeners are registered, they are then notified. When you subclass `Component`, overriding the method `processMouseEvent()` allows you to process mouse events without providing listeners. Remember to call `super.processMouseEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding the method `processMouseEvent()` is roughly similar to overriding `mouseDown()`, `mouseUp()`, `mouseEnter()`, and `mouseExit()` with one method using the 1.0 event model.

protected void processMouseMotionEvent(MouseEvent e) ★

The `processMouseMotionEvent()` method receives all motion-oriented `MouseEvents` with this `Component` as its target. If there are any listeners registered, they are then notified. When you subclass `Component`, overriding `processMouseMotionEvent()` allows you to process mouse motion events without providing listeners. Remember to call `super.processMouseMotionEvent(e)` last to ensure that normal event processing still occurs; if you don't, events won't get distributed to any registered listeners. Overriding the method `processMouseMotionEvent()` is roughly similar to overriding `mouseMove()` and `mouseDrag()` with one method using the 1.0 event model.

5.2 Labels

Having covered the features of the `Component` class, we can now look at some of the simplest components. The first component introduced here is a `Label`. A label is a `Component` that displays a single line of static text.* It is useful for putting a title or message next to another component. The text can be centered or justified to the left or right. Labels react to all events they receive. However, they do not get any events from their peers.

---

* *Java in A Nutshell* (from O'Reilly & Associates) includes a multiline `Label` component.

5.2.1 Label Methods

Constants

There are three alignment specifiers for labels. The alignment tells the `Label` where to position its text within the space allotted. Setting an alignment for a `Label` might not do anything noticeable if the `LayoutManager` being used does not resize the `Label` to give it more space. With `FlowLayout`, the alignment is barely noticeable. See Chapter 7, *Layouts*, for more information.

public final static int LEFT

`LEFT` is the constant for left alignment. If no alignment is specified in the constructor, left alignment is the default.

public final static int CENTER

`CENTER` is the constant for center alignment.

public final static int RIGHT

`RIGHT` is the constant for right alignment.

Constructors

public Label ()

This constructor creates an empty `Label`. By default, the label's text is left justified.

public Label (String label)

This constructor creates a `Label` whose initial text is `label`. By default, the label's text is left justified.

public Label (String label, int alignment)

This constructor creates a `Label` whose initial text is `label`. The alignment of the label is `alignment`. If `alignment` is invalid (not `LEFT`, `RIGHT`, or `CENTER`), the constructor throws the run-time exception `IllegalArgumentException`.

Text

public String getText ()

The `getText()` method returns the current value of `Label`.

public void setText (String label)

The `setText()` method changes the text of the `Label` to `label`. If the new label is a different size from the old one, you should revalidate the display to ensure the label's entire contents will be seen.

Alignment

public int getAlignment ()

The `getAlignment()` method returns the current alignment of the `Label`.

public void setAlignment (int alignment)

The `setAlignment()` method changes the alignment of the `Label` to `alignment`. If `alignment` is invalid (not `LEFT`, `RIGHT`, or `CENTER`), `setAlignment()` throws the run-time exception `IllegalArgumentException`. Figure 5-2 shows all three alignments.

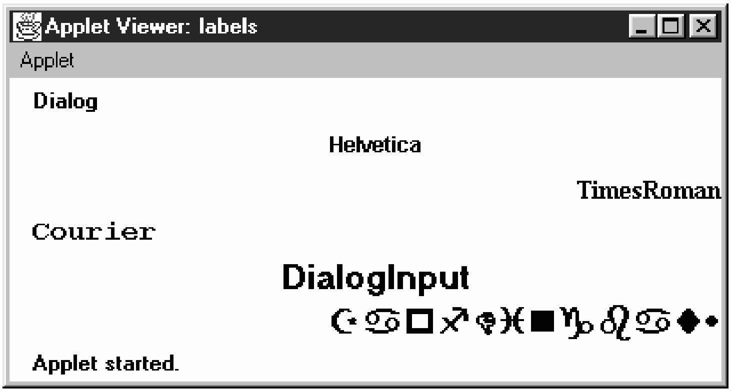


Figure 5–2: Labels with different alignments

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Label` peer. If you override this method, first call `super.addNotify()`, then put in your customizations. Then you will be able to do everything you need with the information about the newly created peer.

protected String paramString ()

The `paramString()` method overrides `Component`'s `paramString()` method. It is a protected method that calls the overridden `paramString()` to build a `String` from the different parameters of the `Component`. When the method `paramString()` is called for a `Label`, the alignment and label's text are added. Thus, for the `Label` created by the constructor `new Label ("ZapfDingbats", Label.RIGHT)`, the results displayed from a call to `toString()` would be:

```
java.awt.Label[0,0,0x0,invalid,align=right,label=ZapfDingbats]
```

5.2.2 Label Events

The `Label` component can react to any event it receives, though the `Label` peer normally does not send any. However, there is nothing to stop you from posting an event yourself.

5.3 Buttons

The `Button` component provides one of the most frequently used objects in graphical applications. When the user selects a button, it signals the program that something needs to be done by sending an action event. The program responds in its `handleEvent()` method (for Java 1.0) or its `actionPerformed()` method (defined by Java 1.1's `ActionListener` interface). Next to `Label`, which does nothing, `Button` is the simplest component to understand. Because it is so simple, we will use a lot of buttons in our examples for the next few chapters.

5.3.1 Button Methods

Constructors

public Button ()

This constructor creates an empty `Button`. You can set the label later with `setLabel()`.

public Button (String label)

This constructor creates a `Button` whose initial text is `label`.

Button Labels

public String getLabel ()

The `getLabel()` method retrieves the current text of the label on the `Button` and returns it as a `String`.

public synchronized void setLabel (String label)

The `setLabel()` method changes the text of the label on the `Button` to `label`. If the new text is a different size from the old, it is necessary to revalidate the screen to ensure that the button size is correct.

Action Commands

With Java 1.1, every button can have two names. One is what the user sees (the button's label); the other is what the programmer sees and is called the button's *action command*. Distinguishing between the label and the action command is a major help to internationalization. The label can be localized for the user's environment.

However, this means that labels can vary at run-time and are therefore useless for comparisons within the program. For example, you can't test whether the user pushed the Yes button if that button might read Oui or Ja, depending on some run-time environment setting. To give the programmer something reliable for comparisons, Java 1.1 introduces the action command. The action command for our button might be Yes, regardless of the button's actual label.

By default, the action command is equivalent to the button's label. Java 1.0 code, which only relies on the label, will continue to work. Furthermore, you can continue to write in the Java 1.0 style as long as you're sure that your program will never have to account for other languages. These days, that's a bad bet. Even if you aren't implementing multiple locales now, get in the habit of testing a button's action command rather than its label; you will have less work to do when internationalization does become an issue.

public String getActionCommand () ★

The `getActionCommand()` method returns the button's current action command. If no action command was explicitly set, this method returns the label.

public void setActionCommand (String command) ★

The `setActionCommand()` method changes the button's action command to `command`.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Button` peer. If you override this method, first call `super.addNotify()`, then add your customizations. Then you can do everything you need with the information about the newly created peer.

protected String paramString ()

The `paramString()` method overrides the component's `paramString()` method. It is a protected method that calls the overridden `paramString()` to build a `String` from the different parameters of the `Component`. When the method `paramString()` is called for a `Button`, the button's label is added. Thus, for the `Button` created by the constructor `new Button ("ZapfDingbats")`, the results displayed from a call to `toString()` could be:

```
java.awt.Button[77,5,91x21,label=ZapfDingbats]
```

5.3.2 Button Events

With the 1.0 event model, `Button` components generate an `ACTION_EVENT` when the user selects the button.

With the version 1.1 event model, you register an `ActionListener` with the method `addActionListener()`. When the user selects the `Button`, the method `ActionListener.actionPerformed()` is called through the protected `Button.processActionEvent()` method. Key, mouse, and focus listeners are registered through the `Component` methods of `addKeyListener()`, `addMouseListener()`, or `addMouseMotionListener()`, and `addFocusListener()`, respectively.

Action

public boolean action (Event e, Object o)

The `action()` method for a `Button` is called when the user presses and releases the button. `e` is the `Event` instance for the specific event, while `o` is the button's label. The default implementation of `action()` does nothing and returns `false`, passing the event to the button's container for processing. For a button to do something useful, you should override either this method or the container's `action()` method. Example 5-1 is a simple applet called `ButtonTest` that demonstrates the first approach; it creates a `Button` subclass called `TheButton`, which overrides `action()`. This simple subclass doesn't do much; it just labels the button and prints a message when the button is pressed. Figure 5-3 shows what `ButtonTest` looks like.

Example 5–1: Button Event Handling

```
import java.awt.*;
import java.applet.*;

class TheButton extends Button {
    TheButton (String s) {
        super (s);
    }
    public boolean action (Event e, Object o) {
        if ("One".equals(o)) {
            System.out.println ("Do something for One");
        } else if ("Two".equals(o)) {
            System.out.println ("Ignore Two");
        } else if ("Three".equals(o)) {
            System.out.println ("Reverse Three");
        } else if ("Four".equals(o)) {
            System.out.println ("Four is the one");
        } else {
            return false;
        }
        return true;
    }
```

Example 5–1: Button Event Handling (continued)

```
}
public class ButtonTest extends Applet {
   public void init () {
        add (new TheButton ("One"));
        add (new TheButton ("Two"));
        add (new TheButton ("Three"));
        add (new TheButton ("Four"));
   }
}
```

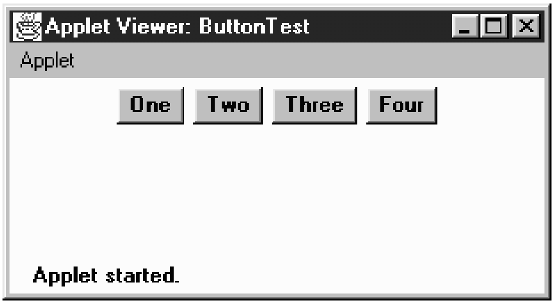


Figure 5–3: The ButtonTest applet

Keyboard

Buttons are able to capture keyboard-related events once the button has the input focus. In order to give a `Button` the input focus without triggering the action event, call `requestFocus()`. The button also gets the focus if the user selects it and drags the mouse off of it without releasing the mouse.

public boolean keyDown (Event e, int key) ☆

The `keyDown()` method is called whenever the user presses a key while the `Button` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) could be either `Event.KEY_PRESS` for a regular key or `Event.KEY_ACTION` for an action-oriented key (i.e., an arrow or a function key). There is no visible indication that the user has pressed a key over the button.

public boolean keyUp (Event e, int key) ☆

The `keyUp()` method is called whenever the user releases a key while the `Button` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) could be either `Event.KEY_RELEASE` for a regular key or `Event.KEY_ACTION_RELEASE` for an action-oriented key (i.e., an arrow or a function key). `keyUp()` may be used to determine how long `key` has been pressed.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners, which are told when the event happens.

public void addActionListener(ActionListener listener) ★

The `addActionListener()` method registers `listener` as an object interested in receiving notifications when an `ActionEvent` passes through the `EventQueue` with this `Button` as its target. The `listener.actionPerformed()` method is called when these events occur. Multiple listeners can be registered. The following code demonstrates how to use an `ActionListener` to handle the events that occur when the user selects a button. This applet has the same display as the previous one, shown in Figure 5-3.

```
// Java 1.1 only
import java.awt.*;
import java.applet.*;
import java.awt.event.*;

public class ButtonTest11 extends Applet implements ActionListener {
    Button b;
    public void init () {
        add (b = new Button ("One"));
        b.addActionListener (this);
        add (b = new Button ("Two"));
        b.addActionListener (this);
        add (b = new Button ("Three"));
        b.addActionListener (this);
        add (b = new Button ("Four"));
        b.addActionListener (this);
    }
    public void actionPerformed (ActionEvent e) {
        String s = e.getActionCommand();
        if ("One".equals(s)) {
            System.out.println ("Do something for One");
        } else if ("Two".equals(s)) {
            System.out.println ("Ignore Two");
        } else if ("Three".equals(s)) {
            System.out.println ("Reverse Three");
        } else if ("Four".equals(s)) {
            System.out.println ("Four is the one");
        }
    }
}
```

public void removeActionListener(ActionListener listener) ★

The `removeActionListener()` method removes `listener` as an interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives `AWTEvent` with this `Button` as its target. `processEvent()` then passes them along to any listeners for processing. When you subclass `Button`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processActionEvent(ActionEvent e) ★

The `processActionEvent()` method receives `ActionEvent` with this `Button` as its target. `processActionEvent()` then passes them along to any listeners for processing. When you subclass `Button`, overriding `processActionEvent()` allows you to process all action events yourself, before sending them to any listeners. In a way, overriding `processActionEvent()` is like overriding `action()` using the 1.0 event model.

If you override the `processActionEvent()` method, you must remember to call `super.processActionEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

5.4 A Simple Calculator

It is always helpful to see complete and somewhat useful examples after learning something new. Example 5-2 shows a working calculator that performs floating point addition, subtraction, multiplication, and division. Figure 5-4 shows the calculator in operation. The button in the lower left corner is a decimal point. This applet uses a number of classes that will be discussed later in the book (most notably, some layout managers and a `Panel`); try to ignore them for now. Focus on the `action()` and `compute()` methods; `action()` figures out which button was pressed, converting it to a digit (0–9 plus the decimal point) or an operator (=, +, –, *, /). As you build a number, it is displayed in the label `lab`, which conveniently serves to store the number in string form. The `compute()` method reads the label's text, converts it to a floating point number, does the computation, and displays the result in the label. The `addButtons()` method is a helper method to create a group of `Button` objects at one time.

Example 5–2: Calculator Source Code

```
import java.awt.*;
import java.applet.*;

public class JavaCalc extends Applet {
    Label lab;
    boolean firstDigit = true;
    float savedValue = 0.0f;     // Initial value
    String operator = "=";  // Initial operator
    public void addButtons (Panel p, String labels) {
        int count = labels.length();
        for (int i=0;i<count;i++)
            p.add (new Button (labels.substring(i,i+1)));
    }
    public void init () {
        setLayout (new BorderLayout());
        add ("North", lab = new Label ("0", Label.RIGHT));
        Panel p = new Panel();
        p.setLayout (new GridLayout (4, 4));
        addButtons (p, "789/");
        addButtons (p, "456*");
        addButtons (p, "123-");
        addButtons (p, ".0=+");
        add ("Center", p);
    }
    public boolean action (Event e, Object o) {
        if (e.target instanceof Button) {
            String s = (String)o;
            if ("0123456789.".indexOf (s) != -1) { // isDigit
                if (firstDigit) {
                    firstDigit = false;
                    lab.setText (s);
                } else {
                    lab.setText (lab.getText() + s);
                }
            } else { // isOperator
                if (!firstDigit) {
                    compute (lab.getText());
                    firstDigit = true;
                }
                operator = s;
            }
            return true;
        }
        return false;
    }
    public void compute (String s) {
        float sValue = new Float (s).floatValue();
        char c = operator.charAt (0);
        switch (c) {
            case '=':   savedValue  = sValue;
                        break;
            case '+':   savedValue += sValue;
```

Example 5–2: Calculator Source Code (continued)

```
                        break;
                case '-':   savedValue -= sValue;
                            break;
                case '*':   savedValue *= sValue;
                            break;
                case '/':   savedValue /= sValue;
                            break;
            }
            lab.setText (String.valueOf(savedValue));
        }
    }
```

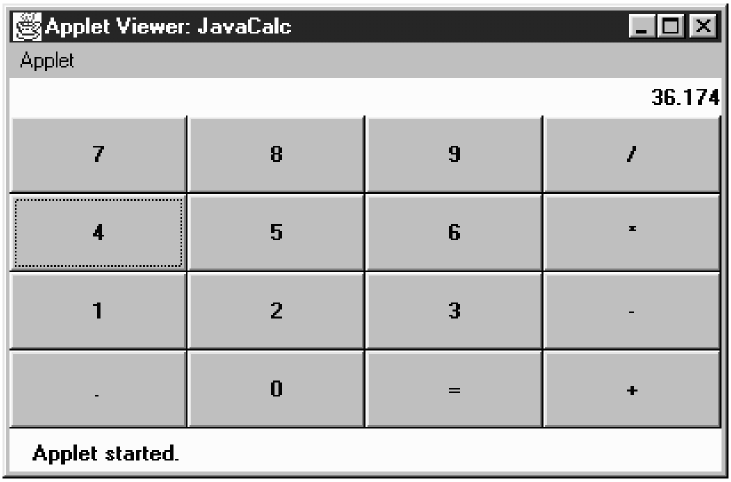


Figure 5–4: Calculator applet

5.5 Canvas

A `Canvas` is a class just waiting to be subclassed. Through `Canvas`, you can create additional AWT objects that are not provided by the base classes. `Canvas` is also useful as a drawing area, particularly when additional components are on the screen. It is tempting to draw directly onto a `Container`, but this often isn't a good idea. Anything you draw might disappear underneath the components you add to the container. When you are drawing on a container, you are essentially drawing on the background. The container's layout manager doesn't know anything about what you have drawn and won't arrange components with your artwork in mind. To be safe, do your drawing onto a `Canvas` and place that `Canvas` in a `Container`.

5.5.1 Canvas Methods

Constructors

public Canvas () ★

The constructor creates a new `Canvas` with no default size. If you place the canvas in a container, the container's layout manager sizes the canvas for you. If you aren't placing the canvas in a container, call `setBounds()` to specify the canvas's size.

Java 1.0 used the default constructor for `Canvas`; there was no explicit constructor.

Miscellaneous methods

public void paint (Graphics g) ★

The default implementation of the `paint()` method colors the entire `Canvas` with the current background color. When you subclass this method, your `paint()` method needs to draw whatever should be shown on the canvas.

public synchronized void addNotify ()

The `addNotify()` method creates the `Canvas` peer. If you override this method, first call `super.addNotify()`, then add your customizations. Then you can do everything you need with the information about the newly created peer.

5.5.2 Canvas Events

The `Canvas` peer passes all events to you, which is why it's well suited to creating your own components.

5.6 Creating Your Own Component

If you find that no AWT component satisfies your needs, you can create your own. This is usually done either by extending an existing component or by starting from scratch. When extending an existing component, you start with the base functionality of an existing object and add to it. The users will not see anything new or different about the object until they start to interact with it, since it is not a new component. For example, a `TextField` could be subclassed to convert all letters input to uppercase. On the other hand, if you create a new component from scratch, it will appear the same on all platforms (regardless of what the platform's native components look like), and you have to make sure the user can fairly easily figure out how to work with it. Example 5-3 shows how to create your own `Component` by creating a `Label` that displays vertically, as opposed to the standard `Label Component` that displays horizontally. The whole process is fairly easy.

The third possibility for creating your own components involves adding functionality to containers. This is fairly easy to do and can be useful if you are constantly grouping components together. For example, if you are always adding a `TextField` or `Label` to go with a `Scrollbar` to display the value, do it once, and call it something meaningful like `LabeledScrollbarPanel`. Then whenever you need it again, reuse your `LabeledScrollbarPanel`. Think about reusability whenever you can.

With Java 1.1, the colors for these new components should be set to color values consistent to the user's platform. This is done through color constants provided in the `SystemColor` class introduced in Chapter 2.

5.6.1 VerticalLabel

When you create new components, they must meet three requirements:

- In Java 1.0, you must extend a subclass of `Component`, usually `Canvas`. In Java 1.1, you can extend `Component` itself, creating a lightweight component. In many cases, this alternative is more efficient.
- You must provide a constructor for the new component so that you can create new instances of it; if you really don't need a constructor, you can use the default constructor that you inherit from `Canvas` or `Component`.
- You must provide a way to draw the object on the screen by overriding the `paint()` method.

If initializing the component requires information about display characteristics (for example, you need to know the default `Font`), you must wait until the object is displayed on the screen before you initialize it. This is done by overriding the `addNotify()` method. First, call `super.addNotify()` to create the peer; you can now ask for platform-dependent information and initialize your component accordingly. Remember to override `getPreferredSize()` and `getMinimumSize()` (the Java 1.0 names are `preferredSize()` and `minimumSize()`) to return the proper dimensions for the new component, so that layout management works properly. There can be other support methods, depending upon the requirements of the object. For example, it is helpful, but not required, to provide a `toString()` or `paramString()` method.

Creating a new component sounds a lot harder than it is. Example 5-3 contains the source for a new component called `VerticalLabel`. It displays a label that reads from top to bottom, instead of from left to right, and can be configured to display its text right or left justified or centered. Figure 5-5 displays the new component `VerticalLabel` in action.

Example 5–3: Source for VerticalLabel Component

```
import java.awt.*;

public class VerticalLabel extends Canvas {
   public static final int LEFT = 0;
   public static final int CENTER = 1;
   public static final int RIGHT = 2;
   private String text;
   private int    vgap;
   private int    alignment;
   Dimension      mySize;
   int            textLength;
   char           chars[];
   // constructors
   public VerticalLabel () {
        this (null, 0, CENTER);
   }
   public VerticalLabel (String text) {
        this (text, 0, CENTER);
   }
   public VerticalLabel (String text, int vgap, int alignment) {
      this.text = text;
      this.vgap = vgap;
      this.alignment = alignment;
   }
   void init () {
      textLength = text.length();
      chars = new char[textLength];
      text.getChars (0, textLength, chars, 0);
      Font f = getFont();
      FontMetrics fm = getFontMetrics (f);
      mySize = new Dimension(0,0);
      mySize.height = (fm.getHeight() * textLength) + (vgap * 2);
      for (int i=0; i < textLength; i++) {
          mySize.width = Math.max (mySize.width, fm.charsWidth(chars, i, 1));
      }
   }
   public int getAlignment () {
      return alignment;
   }
   public void addNotify () {
       super.addNotify();
       init();  // Component must be visible for init to work
   }
   public void setText (String text)    {this.text = text; init();}
   public String getText ()             {return text; }
   public void setVgap (int vgap)       {this.vgap = vgap; init();}
   public int getVgap ()                {return vgap; }
   public Dimension preferredSize ()    {return mySize; }
   public Dimension minimumSize ()      {return mySize; }
   public void paint (Graphics g) {
      int x,y;
      int xPositions[];
```

Example 5–3: Source for VerticalLabel Component (continued)

```
        int yPositions[];
    // Must redo this each time since font/screen area might change
    // Use actual width for alignment
        Font f = getFont();
        FontMetrics fm = getFontMetrics (f);
        xPositions = new int[textLength];
        for (int i=0; i < textLength; i++) {
            if (alignment == RIGHT) {
                xPositions[i] = size().width - fm.charWidth (chars[i]);
            } else if (alignment == LEFT) {
                xPositions[i] = 0;
            } else {// CENTER
                xPositions[i] = (size().width - fm.charWidth (chars[i])) / 2;
            }
        }
        yPositions = new int[textLength];
        for (int i=0; i < textLength; i++) {
            yPositions[i] = (fm.getHeight() * (i+1)) + vgap;
        }
        for (int i = 0; i < textLength; i++) {
            x = xPositions[i];
            y = yPositions[i];
            g.drawChars (chars, i, 1, x, y);
        }
    }
    protected String paramString () {
        String str=",align=";
        switch (alignment) {
            case LEFT:    str += "left"; break;
            case CENTER:  str += "center"; break;
            case RIGHT:   str += "right"; break;
        }
        if (vgap!=0) str+= ",vgap=" + vgap;
        return super.paramString() + str + ",label=" + text;
    }
}
```

The following code is a simple applet using the `VerticalLabel`. It creates five instances of `VerticalLabel` within a `BorderLayout` panel, with gaps (see Chapter 7 for more on `BorderLayout`). The top and bottom labels are justified to the left and right, respectively, to demonstrate justification.

```
import java.awt.*;
import java.applet.*;
public class vlabels extends Applet {
    public void init () {
        setLayout (new BorderLayout (10, 10));
        setFont (new Font ("TimesRoman", Font.BOLD, 12));
        add ("North",  new VerticalLabel ("One", 10, VerticalLabel.LEFT));
        add ("South",  new VerticalLabel ("Two", 10, VerticalLabel.RIGHT));
        add ("West",   new VerticalLabel ("Three"));
        add ("East",   new VerticalLabel ("Four"));
```

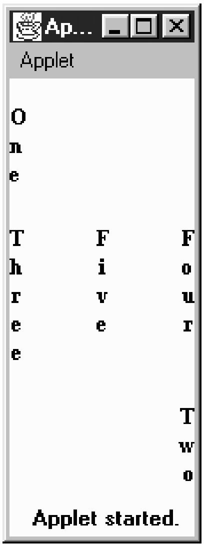


Figure 5–5: Using VerticalLabel

```
        add ("Center", new VerticalLabel ("Five"));
        resize (preferredSize());
    }
}
```

5.6.2 Lightweight VerticalLabel

The `VerticalLabel` in Example 5-3 works in both Java 1.0 and 1.1 but is relatively inefficient. When you create one, the system must create a `Canvas` and the peer of the `Canvas`. This work doesn't gain you anything; since this is a new component, it doesn't have to match the native appearance of any other component.

In Java 1.1, there's a way to avoid the overhead if you are creating a component that doesn't have to match a native object. This is called a *lightweight component.* To create one, you just subclass `Component` itself. To make a lightweight version of our `VerticalLabel`, we have to change only one line of code.

```
// Java 1.1 only
public class VerticalLabel extends Component
```

Everything else remains unchanged.

5.7 Cursor

Introduced in Java 1.1, the `Cursor` class provides the different cursors that can be associated with a `Component`. Previously, cursors could only be associated with a whole `Frame`. Now any component can use fancy cursors when the user is interacting with the system.

To change the cursor, a component calls its `setCursor()` method; its argument is a `Cursor` object, which is defined by this class.

NOTE There is still no way to assign a user-defined cursor to a `Component`. You are restricted to the 14 predefined cursors.

5.7.1 Cursor Constants

The following is a list of `Cursor` constants. The cursors corresponding to the constants are shown in Figure 5-6.

public final static int DEFAULT_CURSOR
public final static int CROSSHAIR_CURSOR
public final static int TEXT_CURSOR
public final static int WAIT_CURSOR
public final static int HAND_CURSOR
public final static int MOVE_CURSOR
public final static int N_RESIZE_CURSOR
public final static int S_RESIZE_CURSOR
public final static int E_RESIZE_CURSOR
public final static int W_RESIZE_CURSOR
public final static int NE_RESIZE_CURSOR
public final static int NW_RESIZE_CURSOR
public final static int SE_RESIZE_CURSOR
public final static int SW_RESIZE_CURSOR

5.7.2 Cursor Methods

public Cursor (int type) ★

The sole constructor creates a `Cursor` of the specified `type`. `type` must be one of the `Cursor` class constants. If `type` is not one of the class constants, the constructor throws the run-time exception `IllegalArgumentException`.

This constructor exists primarily to support object serialization; you don't need to call it in your code. It is more efficient to call `getPredefinedCursor()`, discussed later in this section.

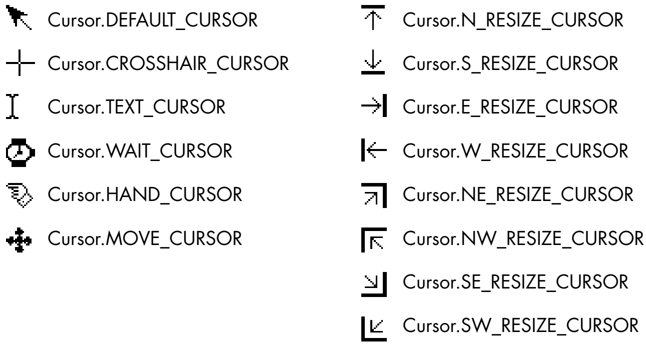


Figure 5–6: Standard Java cursors

Miscellaneous methods

public int getType() ★

The `getType()` method returns the cursor type. The value returned is one of the class constants.

static public Cursor getPredefinedCursor(int type) ★

The `getPredefinedCursor()` method returns the predefined `Cursor` of the given `type`. If `type` is not one of the class constants, this method throws the run-time exception `IllegalArgumentException`. This method checks what `Cursor` objects already exist and gives you a reference to a preexisting `Cursor` if it can find one with the appropriate type. Otherwise, it creates a new `Cursor` for you. This is more efficient than calling the `Cursor` constructor whenever you need one.

static public Cursor getDefaultCursor() ★

The `getDefaultCursor()` method returns the predefined `Cursor` for the `DEFAULT_CURSOR` type.

In this chapter:

- *Container*
- *Panel*
- *Insets*
- *Window*
- *Frames*
- *Dialogs*
- *FileDialog*

6

Containers

This chapter covers a special type of `Component` called `Container`. A `Container` is a subclass of `Component` that can contain other components, including other containers. `Container` allows you to create groupings of objects on the screen. This chapter covers the methods in the `Container` class and its subclasses: `Panel`, `Window`, `Frame`, `Dialog`, and `FileDialog`. It also covers the `Insets` class, which provides an internal border area for the `Container` classes.

Every container has a layout associated with it that controls how the container organizes the components in it. The layouts are described in Chapter 7, *Layouts*.

Java 1.1 introduces a special `Container` called `ScrollPane`. Because of the similarities between scrolling and `ScrollPane`, the new `ScrollPane` container is covered with the `Scrollbar` class in Chapter 11, *Scrolling*.

6.1 Container

`Container` is an abstract class that serves as a general purpose holder of other `Component` objects. The `Container` class holds the methods for grouping the components together, laying out the components inside it, and dealing with events occurring within it. Because `Container` is an abstract class, you never see a pure `Container` object; you only see subclasses that add specific behaviors to a generic container.

6.1.1 *Container Methods*

Constructors

The abstract Container class contains a single constructor to be called by its children. Prior to Java 1.1, the constructor was package private.

protected Container() ★

The constructor for Container creates a new component without a native peer. Since you no longer have a native peer, you must rely on your container to provide a display area. This allows you to create containers that require fewer system resources. For example, if you are creating panels purely for layout management, you might consider creating a LightweightPanel class to let you assign a layout manager to a component group. Using LightweightPanel will speed things up since events do not have to propagate through the panel and you do not have to get a peer from the native environment. The following code creates the LightweightPanel class:

```
import java.awt.*;
public class LightweightPanel extends Container {
    LightweightPanel () {}
    LightweightPanel (LayoutManager lm) {
        setLayout(lm);
    }
}
```

Grouping

A Container holds a set of objects within itself. This set of methods describes how to examine and add components to the set.

public int getComponentCount () ★
public int countComponents () ☆

The getComponentCount() method returns the number of components within the container at this level. getComponentCount() does not count components in any child Container (i.e., containers within the current container).

countComponents() is the Java 1.0 name for this method.

public Component getComponent (int position)

The getComponent() method returns the component at the specific position within it. If position is invalid, this method throws the run-time exception ArrayIndexOutOfBoundsException.

public Component[] getComponents ()

getComponents() returns an array of all the components held within the container. Since these are references to the actual objects on the screen, any changes made to the components returned will be reflected on the display.

public Component add (Component component, int position)

The add() method adds component to the container at position. If position is -1, add() inserts component as the last object within the container. What the container does with position depends upon the LayoutManager of the container. If position is invalid, the add() method throws the run-time exception IllegalArgumentException. If you try to add component's container to itself (anywhere in the containment tree), this method throws an IllegalArgumentException. In Java 1.1, if you try to add a Window to a container, add() throws the run-time exception IllegalArgumentException. If you try to add component to a container that already contains it, the container is removed and re-added, probably at a different position.

Assuming that nothing goes wrong, the parent of component is set to the container, and the container is invalidated. add() returns the component just added.

Calling this method generates a ContainerEvent with the id COMPONENT_ADDED.

public Component add (Component component)

The add() method adds component to the container as the last object within the container. This is done by calling the earlier version of add() with a position of -1. If you try to add component's container to itself (anywhere in the containment tree), this method throws the run-time exception IllegalArgumentException. In Java 1.1, if you try to add a Window to a container, add() throws the run-time exception IllegalArgumentException.

Calling this method generates a ContainerEvent with the id COMPONENT_ADDED.

public void add (Component component, Object constraints) ★
public Component add (String name, Component component)

This next version of add() is necessary for layouts that require additional information in order to place components. The additional information is provided by the constraints parameter. This version of the add() method calls the addLayoutComponent() method of the LayoutManager. What the container does with constraints depends upon the actual LayoutManager. It can be used for naming containers within a CardLayout, specifying a screen area for BorderLayout, or providing a set of GridBagConstraints for a GridBagLayout. In the event that this add() is called and the current LayoutManager does not take advantage of constraints, component is added at the end with a position of -1. If you try to add `component`'s container to itself (anywhere in the containment tree), this method throws the run-time exception `IllegalArgumentException`. In Java 1.1, if you try to add a `Window` to a container, `add()` throws the run-time exception `IllegalArgumentException`.

The `add(String, Component)` method was changed to `add(component, object)` in Java 1.1 to accommodate the `LayoutManager2` interface (discussed in Chapter 7) and to provide greater flexibility. In all cases, you can just flip the parameters to bring the code up to 1.1 specs. The string used as an identifier in Java 1.0 is just treated as a particular kind of constraint.

Calling this method generates a `ContainerEvent` with the id `COMPONENT_ADDED`.

public void add (Component component, Object constraints, int index) ★

This final version of `add()` is necessary for layouts that require an `index` and need additional information to place components. The additional information is provided by the `constraints` parameter. This version of `add()` also calls the `addLayoutComponent()` method of the `LayoutManager`. `component` is added with a position of `index`. If you try to add `component`'s container to itself (anywhere in the containment tree), this method throws the run-time exception `IllegalArgumentException`. In Java 1.1, if you try to add a `Window` to a `Container`, `add()` throws the run-time exception `IllegalArgumentException`.

Some layout managers ignore any index. For example, if you call `add(aButton, BorderLayout.NORTH, 3)` to add a `Button` to a `BorderLayout` panel, the `Button` appears in the north region of the layout, no matter what the index.

Calling this method generates a `ContainerEvent` with the id `COMPONENT_ADDED`.

protected void addImpl(Component comp, Object constraints, int index) ★

The protected `addImpl()` method is the helper method that all the others call. It deals with synchronization and enforces all the restrictions on adding components to containers.

The `addImpl()` method tracks the container's components in an internal list. The index with which each component is added determines its position in the list. The lower the component's index, the higher it appears in the stacking order. In turn, the stacking order determines how components are displayed when sufficient space isn't available to display all of them. Components that are added without indices are placed at the end of the list (i.e., at the end of the stacking order) and therefore displayed behind other components. If all components are added without indices, the first component added to the container is first in the stacking order and therefore displayed in front.

You could override `addImpl()` to track when components are added to a container. However, the proper way to find out when components are added is to register a `ContainerListener` and watch for the `COMPONENT_ADDED` and the `COMPONENT_REMOVED` events.

public void remove (int index) ★

The `remove()` method deletes the `component` at position `index` from the container. If `index` is invalid, the `remove()` method throws the run-time exception `IllegalArgumentException`. This method calls the `removeLayoutComponent()` method of the container's `LayoutManager`.

`removeAll()` generates a `ContainerEvent` with the id `COMPONENT_REMOVED`.

public void remove (Component component)

The `remove()` method deletes `component` from the container, if the container directly contains `component`. `remove()` does not look through nested containers trying to find `component`. This method calls the `removeLayoutComponent()` method of the container's `LayoutManager`.

When you call this method, it generates a `ContainerEvent` with the id `COMPONENT_REMOVED`.

public void removeAll ()

The `removeAll()` method removes all components from the container. This is done by looping through all the components, setting each component's parent to `null`, setting the container's reference to the component to `null`, and invalidating the container.

When you call this method, it generates a `ContainerEvent` with the id `COMPONENT_REMOVED` for each component removed.

public boolean isAncestorOf(Component component) ★

The `isAncestorOf()` method checks to see if `component` is a parent (or grandparent or great grandparent) of this container. It could be used as a helper method for `addImpl()` but is not. If `component` is an ancestor of the container, `isAncestorOf()` returns `true`; otherwise, it returns `false`.

Layout and sizing

Every container has a `LayoutManager`. The `LayoutManager` is responsible for positioning the components inside the container. The `Container` methods listed here are used in sizing the objects within the container and specifying a layout.

public LayoutManager getLayout ()

The `getLayout()` method returns the container's current `LayoutManager`.

public void setLayout (LayoutManager manager)

The `setLayout()` method changes the container's `LayoutManager` to `manager` and invalidates the container. This causes the components contained inside to be repositioned based upon `manager`'s rules. If `manager` is `null`, there is no layout manager, and you are responsible for controlling the size and position of all the components within the container yourself.

public Dimension getPreferredSize () ★
public Dimension preferredSize () ☆

The `getPreferredSize()` method returns the `Dimension` (`width` and `height`) for the preferred size of the components within the container. The container determines its preferred size by calling the `preferredLayoutSize()` method of the current `LayoutManager`, which says how much space the layout manager needs to arrange the components. If you override this method, you are overriding the default preferred size.

`preferredSize()` is the Java 1.0 name for this method.

public Dimension getMinimumSize () ★
public Dimension minimumSize () ☆

The `getMinimumSize()` method returns the minimum `Dimension` (`width` and `height`) for the size of the components within the container. This container determines its minimum size by calling the `minimumLayoutSize()` method of the current `LayoutManager`, which computes the minimum amount of space the layout manager needs to arrange the components. It is possible for `getMinimumSize()` and `getPreferredSize()` to return the same dimensions. There is no guarantee that you will get this amount of space for the layout.

`minimumSize()` is the Java 1.0 name for this method.

public Dimension getMaximumSize () ★

The `getMaximumSize()` method returns the maximum `Dimension` (`width` and `height`) for the size of the components within the container. This container determines its maximum size by calling the `maximumLayoutSize()` method of the current `LayoutManager2`, which computes the maximum amount of space the layout manager needs to arrange the components. If the layout manager is not an instance of `LayoutManager2`, this method calls the `getMaximumSize()` method of the `Component`, which returns `Integer.MAX_VALUE` for both dimensions. None of the `java.awt` layout managers use the concept of maximum size yet.

public float getAlignmentX () ★

The `getAlignmentX()` method returns the alignment of the components within the container along the x axis. This container determines its alignment by calling the current `LayoutManager2`'s `getLayoutAlignmentX()` method, which computes it based upon its children. The return value is between 0.0 and 1.0. Values nearer 0 indicate that the component should be placed closer to the left edge of the area available. Values nearer 1 indicate that the component should be placed closer to the right. The value 0.5 means the component should be centered. If the layout manager is not an instance of `LayoutManager2`, this method calls `Component`'s `getAlignmentX()` method, which returns the constant `Component.CENTER_ALIGNMENT`. None of the `java.awt` layout managers use the concept of alignment yet.

public float getAlignmentY () ★

The `getAlignmentY()` method returns the alignment of the components within the container along the y axis. This container determines its alignment by calling the current `LayoutManager2`'s `getLayoutAlignmentY()` method, which computes it based upon its children. The return value is between 0.0 and 1.0. Values nearer 0 indicate that the component should be placed closer to the top of the area available. Values nearer 1 indicate that the component should be placed closer to the bottom. The value 0.5 means the component should be centered. If the layout manager is not an instance of `LayoutManager2`, this method calls `Component`'s `getAlignmentY()` method, which returns the constant `Component.CENTER_ALIGNMENT`. None of the `java.awt` layout managers use the concept of alignment yet.

public void doLayout () ★
public void layout () ☆

The `doLayout()` method of `Container` instructs the `LayoutManager` to lay out the container. This is done by calling the `layoutContainer()` method of the current `LayoutManager`.

`layout()` is the Java 1.0 name for this method.

public void validate ()

The `validate()` method sets the container's valid state to `true` and recursively validates all of its children. If a child is a `Container`, its children are in turn validated. Some components are not completely initialized until they are validated. For example, you cannot ask a `Button` for its display dimensions or position until it is validated.

protected void validateTree () ★

The `validateTree()` method is a helper for `validate()` that does all the work.

public void invalidate () ★

The `invalidate()` method invalidates the container and recursively invalidates the children. If the layout manager is an instance of `LayoutManager2`, its `invalidateLayout()` method is called to invalidate any cached values.

Event delivery

The event model for Java is described in Chapter 4, *Events*. These methods help in the handling of the various system events at the container level.

public void deliverEvent (Event e) ☆

The `deliverEvent()` method is called by the system when the Java 1.0 `Event e` happens. `deliverEvent()` tries to locate a component contained in the container that should receive it. If one is found, the x and y coordinates of `e` are translated for the new target, and `Event e` is delivered to this by calling its `deliverEvent()`. If `getComponentAt()` fails to find an appropriate target, the event is just posted to the container with `postEvent()`.

public Component getComponentAt (int x, int y) ★
public Component locate (int x, int y) ☆

The container's `getComponentAt()` method calls each component's `contains()` method to see if the `x` and `y` coordinates are within it. If they are, that component is returned. If the coordinates are not in any child component of this container, the container is returned. It is possible for `getComponentAt()` to return `null` if the `x` and `y` coordinates are not within the container. The method `getComponentAt()` can return another `Container` or a lightweight component.

`locate()` is the Java 1.0 name for this method.

public Component getComponentAt (Point p) ★

This `getComponentAt()` method is identical to the previous method, with the exception that the location is passed as a single point, rather than as separate `x` and `y` coordinates.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners, which are told when events occur. Container events occur when a component is added or removed.

public synchronized void addContainerListener(ContainerListener listener) ★

The `addContainerListener()` method registers `listener` as an object interested in receiving notifications when an ContainerEvent passes through the EventQueue with this Container as its target. The listener.componentAdded() or listener.componentRemoved() method is called when these events occur. Multiple listeners can be registered. The following code demonstrates how to use a ContainerListener to register action listeners for all buttons added to an applet. It is similar to the ButtonTest11 example in Section 5.3.2. The trick that makes this code work is the call to enableEvents() in init(). This method makes sure that container events are delivered in the absence of listeners. In this applet, we know there won't be any container listeners, so we must enable container events explicitly before adding any components.

```
// Java 1.1 only
import java.awt.*;
import java.applet.*;
import java.awt.event.*;
public class NewButtonTest11 extends Applet implements ActionListener {
        Button b;
        public void init () {
                enableEvents (AWTEvent.CONTAINER_EVENT_MASK);
                add (b = new Button ("One"));
                add (b = new Button ("Two"));
                add (b = new Button ("Three"));
                add (b = new Button ("Four"));
        }
        protected void processContainerEvent (ContainerEvent e) {
                if (e.getID() == ContainerEvent.COMPONENT_ADDED) {
                        if (e.getChild() instanceof Button) {
                                Button b = (Button)e.getChild();
                                b.addActionListener (this);
                        }
                }
        }
        public void actionPerformed (ActionEvent e) {
                System.out.println ("Selected: " + e.getActionCommand());
        }
}
```

public void removeContainerListener(ContainerListener listener) ★

The removeContainerListener() method removes listener as an interested listener. If listener is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The processEvent() method receives all AWTEvents with this Container as its target. processEvent() then passes them along to any listeners for processing. When you subclass Container, overriding processEvent() allows you to process all events yourself, before sending them to any listeners. There is no equivalent under the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processContainerEvent(ContainerEvent e) ★

The `processContainerEvent()` method receives all `ContainerEvents` with this `Container` as its target. `processContainerEvent()` then passes them along to any listeners for processing. When you subclass `Container`, overriding the `processContainerEvent()` method allows you to process all container events yourself, before sending them to any listeners. There is no equivalent under the 1.0 event model.

If you override the `processContainerEvent()` method, remember to call `super.processContainerEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

Painting

The following methods are early vestiges of an approach to painting and printing. They are not responsible for anything that couldn't be done with a call to `paintAll()` or `printAll()`. However, they are available if you wish to call them.

public void paintComponents (Graphics g)

The `paintComponents()` method of `Container` paints the different components it contains. It calls each component's `paintAll()` method with a clipped graphics context `g`, which is eventually passed to `paint()`.

public void printComponents (Graphics g)

The `printComponents()` method of `Container` prints the different components it contains. It calls each component's `printAll()` method with a clipped graphics context `g`, which is passed to `print()`, and eventually works its way to `paint()`.

Since it is the container's responsibility to deal with painting lightweight peers, the `paint()` and `print()` methods are overridden in Java 1.1.

public void paint(Graphics g) ★

The `paint()` method of `Container` paints the different lightweight components it contains.

public void print(Graphics g) ★

The `print()` method of `Container` prints the different lightweight components it contains.

NOTE If you override `paint()` or `print()` in your containers (especially applets), call `super.paint(g)` or `super.print(g)`, respectively, to make sure that lightweight components are rendered. This is a good practice even if you don't currently use any lightweight components; you don't want your code to break mysteriously if you add a lightweight component later.

Peers

The container is responsible for creating and destroying all the peers of the components within it.

public void addNotify ()

The `addNotify()` method of `Container` creates the peer of all the components within it. After `addNotify()` is called, the `Container` is invalid. It is useful for top-level containers to call this method explicitly before calling the method `setVisible(true)` to guarantee that the container is laid out before it is displayed.

public void removeNotify ()

The `removeNotify()` method destroys the peer of all the top-level objects contained within it. This in effect destroys the peers of all the components within the container.

Miscellaneous methods

protected String paramString ()

When you call the `toString()` method of a container, the default `toString()` method of `Component` is called. This in turn calls `paramString()` which builds up the string to display. At the `Container` level, `paramString()` appends the layout manager name, like `layout=java.awt.BorderLayout`, to the output.

public Insets getInsets () ★
public Insets insets () ☆

The `getInsets()` method gets the container's current insets. An inset is the amount of space reserved for the container to use between its edge and the area actually available to hold components. For example, in a `Frame`, the inset for the top would be the space required for the title bar and menu bar. Insets exist for top, bottom, right, and left. When you override this method, you are providing an area within the container that is reserved for free space. If the container has insets, they would be the default. If not, the default values are all zeroes.

The following code shows how to override insets() to provide values other than the default. The top and bottom have 20 pixels of inset. The left and right have 50. Section 6.3 describes the Insets class in more detail.

```
public Insets insets () {            // getInsets() for Java 1.1
        return new Insets (20, 50, 20, 50);
}
```

To find out the current value, just call the method and look at the results. For instance, for a Frame the results could be the following in the format used by toString():

```
java.awt.Insets[top=42,left=4,right=4,bottom=4]
```

The 42 is the space required for the title and menu bar, while the 4 around the edges are for the window decorations. These results are platform specific and allow you to position items based upon the user's run-time environment.

When drawing directly onto the graphics context of a container with a large inset such as Frame, remember to work around the insets. If you do something like g.drawString("Hello World", 5, 5) onto a Frame, the user won't see the text. It will be under the title bar and menu bar.

insets() is the Java 1.0 name for this method.

public void list (PrintWriter output, int indentation) ★
public void list (PrintStream output, int indentation)

The list() method is very helpful if you need to find out what is inside a container. It recursively calls itself for each container level of objects inside it, increasing the indentation at each level. The results are written to the PrintStream or PrintWriter output.

6.2 Panel

The Panel class provides a generic container within an existing display area. It is the simplest of all the containers. When you load an applet into Netscape Navigator or an *appletviewer*, you have a Panel to work with at the highest level.

A Panel has no physical appearance. It is just a rectangular display area. The default LayoutManager of Panel is FlowLayout; FlowLayout is described in Section 7.2.

6.2.1 Panel Methods

Constructors

public Panel ()

The first constructor creates a `Panel` with a `LayoutManager` of `FlowLayout`.

public Panel (LayoutManager layout) ★

This constructor allows you to set the initial `LayoutManager` of the new `Panel` to `layout`. If `layout` is `null`, there is no `LayoutManager`, and you must shape and position the components within the `Panel` yourself.

Miscellaneous methods

public void addNotify ()

The `addNotify()` method creates the `Panel` peer. If you override this method, first call `super.addNotify()`, then add your customizations for the new class. Then you can do everything you need with the information about the newly created peer.

6.2.2 Panel Events

In Java 1.0, a `Panel` peer generates all the events that are generated by the `Component` class; it does not generate events that are specific to a particular type of component. That is, it generates key events, mouse events, and focus events; it doesn't generate action events or list events. If an event happens within a child component of a `Panel`, the target of the event is the child component, not the `Panel`. There's one exception to this rule: if a component uses the `LightweightPeer` (new to Java 1.1), it cannot be the target of an event.

With Java 1.1, events are delivered to whatever listener is associated with a contained component. The fact that the component is within a `Panel` has no relevance.

6.3 Insets

The `Insets` class provides a way to encapsulate the layout margins of the four different sides of a container. The class helps in laying out containers. The `Container` can retrieve their values through the `getInsets()` method, then analyze the settings to position components. The different inset values are measured in pixels. The space reserved by insets can still be used for drawing directly within `paint()`. Also, if the `LayoutManager` associated with the container does not look at the insets, the request will be completely ignored.

6.3.1 Insets Methods

Variables

There are four variables for insets, one for each border.

public int top

This variable contains the border width in pixels for the top of a container.

public int bottom

This variable contains the border width in pixels for the bottom of a container.

public int left

This variable contains the border width in pixels for the left edge of a container.

public int right

This variable contains the border width in pixels for the right edge of a container.

Constructors

public Insets (int top, int left, int bottom, int right)

The constructor creates an `Insets` object with `top`, `left`, `bottom`, and `right` being the size of the insets in pixels. If this object was the return object from the `getInsets()` method of a container, these values represent the size of a border inside that container.

Miscellaneous methods

public Object clone ()

The `clone()` method creates a clone of the `Insets` so the same `Insets` object can be associated with multiple containers.

public boolean equals(Object object) ★

The `equals()` method defines equality for insets. Two `Insets` objects are equal if the four settings for the different values are equal.

public String toString ()

The `toString()` method of `Insets` returns the current settings. Using the `new Insets (10, 20, 30, 40)` constructor, the results would be:

```
java.awt.Insets[top=10,left=20,bottom=30,right=40]
```

6.3.2 Insets Example

The following source code demonstrates the use of insets within an applet's `Panel`. The applet displays a button that takes up the entire area of the `Panel`, less the insets, then draws a rectangle around that area. This is shown visually in Figure 6-1. The example demonstrates that if you add components to a container, the `LayoutManager` deals with the insets for you in positioning them. But if you are drawing directly to the `Panel`, you must look at the insets if you want to avoid the requested area within the container.

```
import java.awt.*;
import java.applet.*;
public class myInsets extends Applet {
    public Insets insets () {
        return new Insets (50, 50, 50, 50);
    }
    public void init () {
        setLayout (new BorderLayout ());
        add ("Center", new Button ("Insets"));
    }
    public void paint (Graphics g) {
        Insets i = insets();
        int width  = size().width - i.left - i.right;
        int height = size().height - i.top - i.bottom;
        g.drawRect (i.left-2, i.top-2, width+4, height+4);
        g.drawString ("Insets Example", 25, size().height - 25);
    }
}
```

To change the applet's insets from the default, we override the `insets()` method to return a new `Insets` object, with the new values.

6.4 Window

A `Window` is a top-level display area that exists outside the browser or applet area you are working in. It has no adornments, such as the borders, window title, or menu bar that a typical window manager might provide. A `Frame` is a subclass of `Window` that adds these parts (borders, window title). Normally you will work with the children of `Window` and not `Window` directly. However, you might use a `Window` to create your own pop-up menu or some other GUI component that requires its own window and isn't provided by AWT. This technique isn't as necessary in Java 1.1, which has a `PopupMenu` component.

The default `LayoutManager` for `Window` is `BorderLayout`, which is described in Section 7.3.

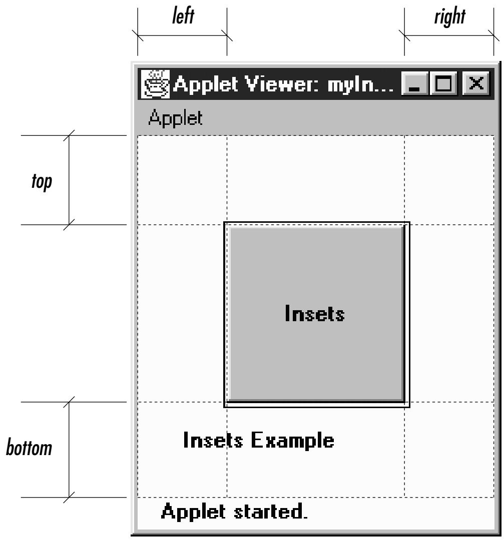


Figure 6–1: Insets

6.4.1 Window Methods

Constructors

public Window (Frame parent)

There is one public constructor for `Window`. It has one parameter, which specifies the `parent` of the `Window`. When the `parent` is minimized, so is the `Window`. In an application, you must therefore create a `Frame` before you can create a `Window`; this isn't much of an inconvenience since you usually need a `Frame` in which to build your user interface. In an applet, you often do not have access to a `Frame` to use as the parent, so you can pass `null` as the argument.

Figure 6-2 shows a simple `Window` on the left. Notice that there are no borders or window management adornments present. The `Window` on the right was created by an applet loaded over the network. Notice the warning message you get in the status bar at the bottom of the screen. This is to warn users that the `Window` was created by an applet that comes from an untrusted source, and you can't necessarily trust it to do what it says. The warning is particularly appropriate for windows, since a user can't necessarily tell whether a window was created by an applet or any other application. It is therefore possible to write applets that mimic windows from well-known applications, to trick the user into giving away passwords, credit card numbers, or other sensitive information.

In some environments, you can get the browser's `Frame` to use with the `Window`'s constructor. This is one way to create a `Dialog`, as we shall see. By

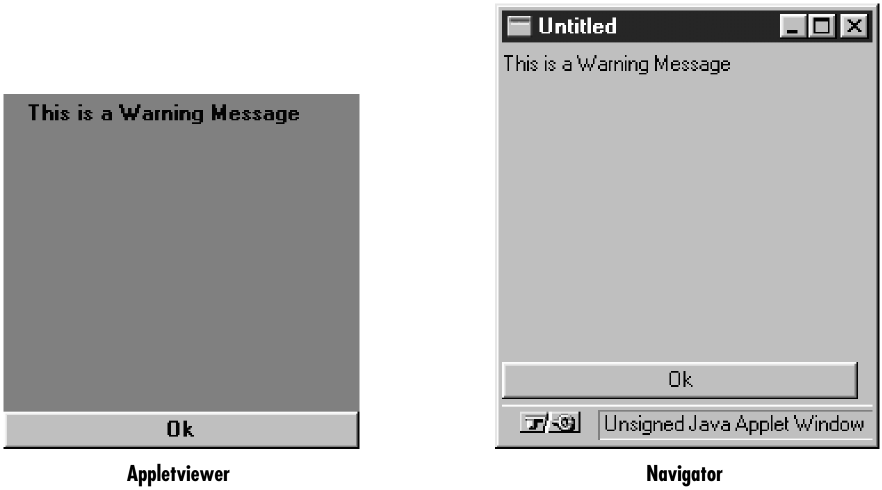


Figure 6–2: Two windows

repeatedly calling `getParent()` until there are no more parents, you can discover an applet's top-level parent, which should be the browser's `Frame`. Example 6-1 contains the code you would write to do this. You should then check the return value to see if you got a `Frame` or `null`. This code is completely nonportable, but you may happen to be in an environment where it works.

Example 6–1: Finding a Parent Frame

```
import java.awt.*;
public class ComponentUtilities {
    public static Frame getTopLevelParent (Component component) {
        Component c = component;
        while (c.getParent() != null)
            c = c.getParent();
        if (c instanceof Frame)
            return (Frame)c;
        else
            return null;
    }
}
```

Appearance methods

A handful of methods assist with the appearance of the `Window`.

public void pack ()

The `pack()` method resizes the `Window` to the preferred size of the components it contains and validates the `Window`.

public void show ()

The `show()` method displays the `Window`. When a `Window` is initially created it is hidden. If the window is already showing when this method is called, it calls `toFront()` to bring the window to the foreground. To hide the window, just call the `hide()` method of `Component`. After you `show()` a window, it is validated for you.

The first call to `show()` for any `Window` generates a `WindowEvent` with the ID `WINDOW_OPENED`.

public void dispose ()

The `dispose()` method releases the resources of the `Window` by hiding it and removing its peer. Calling this method generates a `WindowEvent` with the ID `WINDOW_CLOSED`.

public void toFront ()

The `toFront()` method brings the `Window` to the foreground of the display. This is automatically called if you call `show()` and the `Window` is already shown.

public void toBack ()

The `toBack()` method puts the `Window` in the background of the display.

public boolean isShowing() ★

The `isShowing()` method returns `true` if the `Window` is visible on the screen.

Miscellaneous methods

public Toolkit getToolkit ()

The `getToolkit()` method returns the current `Toolkit` of the window. The `Toolkit` provides you with information about the native platform. This will allow you to size the `Window` based upon the current screen resolution and get images for an application. See Section 6.5.5 for a usage example.

public Locale getLocale () ★

The `getLocale()` method retrieves the current `Locale` of the window, if it has one. Using a `Locale` allows you to write programs that can adapt themselves to different languages and different regional variants. If no `Locale` has been set, `getLocale()` returns the default `Locale`. The default `Locale` has a user language of English and no region. To change the default `Locale`, set the system properties `user.language` and `user.region` or call `Locale.setDefault()` (`setDefault()` verifies access rights with the security manager).*

* For more on the `Locale` class, see the *Java Fundamental Classes Reference* from O'Reilly & Associates.

public final String getWarningString ()

The `getWarningString()` method returns `null` or a string that is displayed on the bottom of insecure `Window` instances. If the `SecurityManager` says that top-level windows do not get a warning message, this method returns `null`. If a message is required, the default text is “Warning: Applet Window”. However, Java allows the user to change the warning by setting the system property `awt.appletWarning`. (Netscape Navigator and Internet Explorer do not allow the warning message to be changed. Netscape Navigator’s current (V3.0) warning string is “Unsigned Java Applet Window.”) The purpose of this string is to warn users that the `Window` was created by an untrusted source, as opposed to a standard application, and should be used with caution.

public Component getFocusOwner () ★

The `getFocusOwner()` method allows you to ask the `Window` which of its components currently has the input focus. This is useful if you are cutting and pasting from the system clipboard; asking who has the input focus tells you where to put the data you get from the clipboard. The system clipboard is covered in Chapter 16, *Data Transfer*. If no component in the `Window` has the focus, `getFocusOwner()` returns `null`.

public synchronized void addNotify ()

The `addNotify()` method creates the `Window` peer. This is automatically done when you call the `show()` method of the `Window`. If you override this method, first call `super.addNotify()`, then add your customizations for the new class. Then you can do everything you need to with the information about the newly created peer.

6.4.2 Window Events

In Java 1.0, a `Window` peer generates all the events that are generated by the `Component` class; it does not generate events that are specific to a particular type of component. That is, it generates key events, mouse events, and focus events; it doesn’t generate action events or list events. If an event occurs within a child component of a `Window`, the target of the event is the child component, not the `Window`.

In addition to the `Component` events, five events are specific to windows, none of which are passed on by the window’s peer. These events happen at the `Frame` and `Dialog` level. The events are `WINDOW_DESTROY`, `WINDOW_EXPOSE`, `WINDOW_ICONIFY`, `WINDOW_DEICONIFY`, and `WINDOW_MOVED`. The default event handler, `handleEvent()`, doesn’t call a convenience method to handle any of these events. If you want to work with them, you must override `handleEvent()`. See Section 6.5.4 for an example that catches the `WINDOW_DESTROY` event.

public boolean postEvent (Event e) ☆

The `postEvent()` method tells the `Window` to deal with `Event e`. It calls the `handleEvent()` method, which returns `true` if somebody handled `e` and `false` if no one handles it. This method, which overrides `Component.postEvent()`, is necessary because a `Window` is, by definition, an outermost container, and therefore does not need to post the event to its parent.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners for different event types; the listeners are told when the event happens. These methods register listeners and let the `Window` component inspect its own events.

public void addWindowListener(WindowListener listener) ★

The `addWindowListener()` method registers `listener` as an object interested in being notified when an `WindowEvent` passes through the `EventQueue` with this `Window` as its target. When such an event occurs, one of the methods in the `WindowListener` interface is called. Multiple listeners can be registered.

public void removeWindowListener(WindowListener listener) ★

The `removeWindowListener()` method removes `listener` as an interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives every `AWTEvent` with this `Window` as its target. `processEvent()` then passes them along to any listeners for processing. When you subclass `Window`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processWindowEvent(WindowEvent e) ★

The `processWindowEvent()` method receives every `WindowEvent` with this `Window` as its target. `processWindowEvent()` then passes them along to any listeners for processing. When you subclass `Window`, overriding `processWindowEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processWindowEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override processWindowEvent(), you must remember to call super.processWindowEvent(e) last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call enableEvents() (inherited from Component) to ensure that events are delivered even in the absence of registered listeners.

6.5 Frames

The Frame is a special type of Window that looks like other high level programs in your windowing environment. It adds a MenuBar, window title, and window gadgets (like resize, maximize, minimize, window menu) to the basic Window object. All the menu-related pieces are discussed in Chapter 10, *Would You Like to Choose from the Menu?*

The default layout manager for a Frame is BorderLayout.

6.5.1 Frame Constants

The Frame class includes a number of constants used to specify cursors. These constants are left over from Java 1.0 and maintained for compatibility. In Java 1.1, you should use the new Cursor class, introduced in the previous chapter, and the Component.setCursor() method to change the cursor over a frame. Avoid using the Frame constants for new code. To see these cursors, refer to Figure 5-6.

public final static int DEFAULT_CURSOR
public final static int CROSSHAIR_CURSOR
public final static int TEXT_CURSOR
public final static int WAIT_CURSOR
public final static int SW_RESIZE_CURSOR
public final static int SE_RESIZE_CURSOR
public final static int NW_RESIZE_CURSOR
public final static int NE_RESIZE_CURSOR
public final static int N_RESIZE_CURSOR
public final static int S_RESIZE_CURSOR
public final static int W_RESIZE_CURSOR
public final static int E_RESIZE_CURSOR
public final static int HAND_CURSOR
public final static int MOVE_CURSOR

NOTE HAND_CURSOR and MOVE_CURSOR are not available on Windows platforms with Java 1.0. If you ask to use these and they are not available, you get DEFAULT_CURSOR.

6.5.2 Frame Constructors

public Frame ()

The constructor for `Frame` creates a hidden window with a window title of "Untitled" (Java1.0) or an empty string (Java1.1). Like `Window`, the default `LayoutManager` of a `Frame` is `BorderLayout`. `DEFAULT_CURSOR` is the initial cursor. To position the `Frame` on the screen, call `Component.move()`. Since the `Frame` is initially hidden, you need to call the `show()` method before the user sees the `Frame`.

public Frame (String title)

This version of `Frame`'s constructor is identical to the first but sets the window title to `title`. Figure 6-3 shows the results of a call to `new Frame("My Frame")` followed by `resize()` and `show()`.

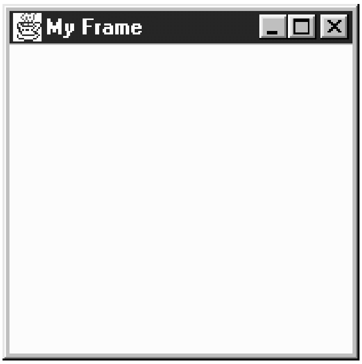


Figure 6–3: A typical Frame

6.5.3 Frame Methods

public String getTitle ()

The `getTitle()` method returns the current title for the `Frame`. If there is no title, this method returns `null`.

public void setTitle (String title)

The `setTitle()` method changes the `Frame`'s title to `title`.

public Image getIconImage ()

The `getIconImage()` method returns the image used as the icon. Initially, this returns `null`. For some platforms, the method should not be used because the platform does not support the concept.

public void setIconImage (Image image)

The `setIconImage()` method changes the image to display when the `Frame` is iconified to `image`. Not all platforms utilize this resource.

public MenuBar getMenuBar ()

The `getMenuBar()` method retrieves the `Frame`'s current menu bar.

public synchronized void setMenuBar (MenuBar bar)

The `setMenuBar()` method changes the menu bar of the `Frame` to `bar`. If `bar` is `null`, it removes the menu bar so that none is available. It is possible to have multiple menu bars based upon the context of the application. However, the same menu bar cannot appear on multiple frames and only one can appear at a time. The `MenuBar` class, and everything to do with menus, is covered in Chapter 10.

public synchronized void remove (MenuComponent component)

The `remove()` method removes `component` from `Frame` if `component` is the frame's menu bar. This is equivalent to calling `setMenuBar()` with a parameter of `null` and in actuality is what `remove()` calls.

public synchronized void dispose ()

The `dispose()` method frees up the system resources used by the `Frame`. If any `Dialogs` or `Windows` are associated with this `Frame`, their resources are freed, too. Some people like to call `Component.hide()` before calling the `dispose()` method so users do not see the frame decomposing.

public boolean isResizable ()

The `isResizable()` method will tell you if the current `Frame` is resizable.

public void setResizable (boolean resizable)

The `setResizable()` method changes the resize state of the `Frame`. A `resizable` value of `true` means the user can resize the `Frame`, `false` means the user cannot. This must be set before the `Frame` is shown or the peer created.

public void setCursor (int cursorType)

The `setCursor()` method changes the cursor of the `Frame` to `cursorType`. `cursorType` must be one of the cursor constants provided with the `Frame` class. You cannot create your own cursor image yet. When changing from the `DEFAULT_CURSOR` to another cursor, the mouse must be moved for the cursor icon to change to the new cursor. If `cursorType` is not one of the predefined cursor types, `setCursor()` throws the `IllegalArgumentException` run-time exception.

This method has been replaced by the `Component.setCursor()` method. Both function equivalently, but this method is being phased out.

public int getCursorType ()

The `getCursorType()` method retrieves the current cursor.

This method has been replaced by the `Component.getCursor()` method. Both function equivalently, but this method is being phased out.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Frame` peer. This is automatically done when you call the `show()` method of the `Frame`. If you override this method, first call `super.addNotify()`, then add your customizations for the new class. Then you can do everything you need to do with the information about the newly created peer.

protected String paramString ()

When you call the `toString()` method of `Frame`, the default `toString()` method of `Component` is called. This in turn calls `paramString()`, which builds up the string to display. At the `Frame` level, `paramString()` appends `resizable` (if `true`) and the `title` (if present). Using the default `Frame` constructor, the results would be:

```
java.awt.Frame[0,0,0x0,invalid,hidden,layout=java.awt.BorderLayout,
resizable,title=]
```

Until the `Frame` is shown, via `show()`, the position and size are not known and therefore appear as zeros. After showing the `Frame`, you might see:

```
java.awt.Frame[44,44,300x300,layout=java.awt.BorderLayout,
resizable,title=]
```

6.5.4 Frame Events

In Java 1.0, a `Frame` peer generates all the events that are generated by the `Component` class; it does not generate events that are specific to a particular type of component. That is, it generates key events, mouse events, and focus events; it doesn't generate action events or list events. If an event happens within a child component of a `Frame`, the target of the event is the child component, not the `Frame`.

Window

In addition to the `Component` events, `Frame` generates the `WINDOW` events. These events are `WINDOW_DESTROY`, `WINDOW_EXPOSE`, `WINDOW_ICONIFY`, `WINDOW_DEICONIFY`, and `WINDOW_MOVED`.

One common event, WINDOW_DESTROY, is generated when the user tries to close the Frame by selecting Quit, Close, or Exit (depending on your windowing environment) from the window manager's menu. By default, this event does nothing. You must provide an event handler that explicitly closes the Frame. If you do not, your Frame will close only when the Java Virtual Machine exits—for example, when you quit Netscape Navigator. The handleEvent() method in the following example, or one like it, should therefore be included in all classes that extend Frame. If a WINDOW_DESTROY event occurs, it gets rid of the Frame and exits the program. Make sure your method calls super.handleEvent() to process the other events.

```
public boolean handleEvent (Event e) {
    if (e.id == Event.WINDOW_DESTROY) {
        hide();
        dispose();
        System.exit(0);
        return true;         // boolean method, must return something
    } else {
                             // handle other events we find interesting
    }
                             // make sure normal event processing happens
    return super.handleEvent (e);
}
```

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners for different event types; the listeners are told when the event happens. The Frame class inherits all its listener handling from Window.

Here's the Java 1.1 code necessary to handle WINDOW_CLOSING events; it is equivalent to the handleEvent() method in the previous example. First, you must add the following line to the Frame's constructor:

```
enableEvents (AWTEvent.WINDOW_EVENT_MASK);
```

This line guarantees that we will receive window events, even if there is no listener. The processWindowEvent() method in the following code does the actual work of closing things down:

```
// Java 1.1 only
protected void processWindowEvent(WindowEvent e) {
    if (e.getID() == WindowEvent.WINDOW_CLOSING) {
        // Notify others we are closing
        if (windowListener != null)
            windowListener.windowClosing(e);
        System.exit(0);
    } else {
        super.processEvent(e);
    }
}
```

If you forget to enable events, `processWindowEvent()` may never be called, and your windows will not shut down until the Java Virtual Machine exits. All subclasses of `Frame` should include code like this to make sure they terminate gracefully.

6.5.5 Building a New Component from a Window

Now that we have discussed the `Frame` and `Window` objects, we can briefly investigate some ways to use them together. Previously I said that you can use a `Window` to build your own pop-up menu. That's no longer necessary in Java 1.1, but the same techniques apply to plenty of other objects. In the following example, we build a set of pop-up buttons; it also uses the `Toolkit` of a `Frame` to load images within an application. The pop-up button set appears when the user presses the right mouse button over the image. It is positioned at the coordinates of the `mouseDown()` event; to do so, we add the current `location()` of the `Frame` to the mouse's `x` and `y` coordinates. Figure 6-4 shows what this application looks like when the pop-up button set is on the screen.

```
import java.awt.*;
public class PopupButtonFrame extends Frame {
    Image im;
    Window w = new PopupWindow (this);
    PopupButtonFrame () {
        super ("PopupButton Example");
        resize (250, 100);
        show();
        im = getToolkit().getImage ("rosey.jpg");
        MediaTracker mt = new MediaTracker (this);
        mt.addImage (im, 0);
        try {
            mt.waitForAll();
        } catch (Exception e) {e.printStackTrace(); }
    }
    public static void main (String args[]) {
        Frame f = new PopupMenuFrame ();
    }
    public void paint (Graphics g) {
        if (im != null)
            g.drawImage (im, 20, 20, this);
    }
    public boolean mouseDown (Event e, int x, int y) {
        if (e.modifiers == Event.META_MASK) {
            w.move (location().x+x, location().y+y);
            w.show();
            return true;
        }
        return false;
    }
}
class PopupWindow extends Window {
    PopupWindow (Frame f) {
```

```
        super (f);
        Panel p = new Panel ();
        p.add (new Button ("About"));
        p.add (new Button ("Save"));
        p.add (new Button ("Quit"));
        add ("North", p);
        setBackground (Color.gray);
        pack();
    }
    public boolean action (Event e, Object o) {
        if ("About".equals (o))
            System.out.println ("About");
        else if ("Save".equals (o))
            System.out.println ("Save Me");
        else if ("Quit".equals (o))
            System.exit (0);
        hide();
        return true;
    }
}
```

Figure 6–4: Pop-up buttons

The most interesting method in this application is `mouseDown()`. When the user clicks on the mouse, `mouseDown()` checks whether the `META_MASK` is set in the event modifiers; this indicates that the user pressed the right mouse button, or pressed the left button while pressing the Meta key. If this is `true`, `mouseDown()` moves the window to the location of the mouse click, calls `show()` to display the window, and returns `true` to indicate that the event was handled completely. If `mouseDown` were called with any other kind of mouse event, we return `false` to let the event propagate to any other object that might be interested. Remember that the coordinates passed with the mouse event are the coordinates of the mouse click relative to the `Frame`; to find out where to position the pop-up window, we need an absolute location and therefore ask the `Frame` for its location.

`PopupWindow` itself is a simple class. Its constructor simply creates a display with three buttons. The call to `pack()` sizes the window so that it provides a nice border around the buttons but isn't excessively large; you can change the border by playing with the window's insets if you want, but that usually isn't necessary. The class `PopupWindow` has an `action()` method that is called when the user clicks one of the buttons. When the user clicks on a button, `action()` prints a message and hides the window.

6.6 Dialogs

The `Dialog` class provides a special type of display window that is normally used for pop-up messages or input from the user. It should be associated with a `Frame` (a required parameter for the constructor), and whenever anything happens to this `Frame`, the same thing will happen to the `Dialog`. For instance, if the parent `Frame` is iconified, the `Dialog` disappears until the `Frame` is de-iconified. If the `Frame` is destroyed, so are all the associated dialogs. Figure 6-5 and Figure 6-6 show typical dialog boxes.

In addition to being associated with a `Frame`, `Dialog` is either modeless or modal. A modeless `Dialog` means a user can interact with both the `Frame` and the `Dialog` at the same time. A modal `Dialog` is one that blocks input to the remainder of the application, including the `Frame`, until the `Dialog` box is acted upon. Note that the parent `Frame` is still executing; unlike some windowing systems, Java does not suspend the entire application for a modal `Dialog`. Normally, blocking access would be done to get input from the user or to show a warning message. Example 6-2 shows how to create and use a modal `Dialog` box, as we will see later in the chapter.

Since `Dialog` subclasses `Window`, its default `LayoutManager` is `BorderLayout`.

In applets, when you create a `Dialog`, you need to provide a reference to the browser's `Frame`, not the applet. In order to get this, you can try to go up the container hierarchy of the `Applet` with `getParent()` until it returns `null`. (You cannot specify a null parent as you can with a `Window`.) See Example 6-1 for a utility method to do this. Simple include a line like the following in your applet:

```
Frame top = ComponentUtilities.getTopLevelParent (this);
```

Then pass `top` to the `Dialog` constructor. Another alternative is to create a new `Frame` to associate with your dialog.

6.6.1 Dialog Constructors and Methods

Constructors

If any constructor is passed a `null` parent, the constructor throws the run-time exception `IllegalArgumentException`.

public Dialog (Frame parent) ★

This constructor creates an instance of `Dialog` with no title and with `parent` as the `Frame` owning it. It is not modal and is initially resizable.

public Dialog (Frame parent, boolean modal) ☆

This constructor creates an instance of `Dialog` with no title and with `parent` as the `Frame` owning it. If `modal` is `true`, the `Dialog` grabs all the user input of the program until it is closed. If `modal` is `false`, there is no special behavior associated with the `Dialog`. Initially, the `Dialog` will be resizable. This constructor is comment-flagged as deprecated.

public Dialog (Frame parent, String title) ★

This version of the constructor creates an instance of `Dialog` with `parent` as the `Frame` owning it and a window title of `title`. It is not modal and is initially resizable.

public Dialog (Frame parent, String title, boolean modal)

This version of the constructor creates an instance of `Dialog` with `parent` as the `Frame` owning it and a window title of `title`. If `mode` is `true`, the `Dialog` grabs all the user input of the program until it is closed. If `modal` is `false`, there is no special behavior associated with the `Dialog`. Initially, the `Dialog` will be resizable.

NOTE In some 1.0 versions of Java, modal dialogs were not supported properly. You needed to create some multithreaded contraption that simulated modality. Modal dialogs work properly in 1.1.

Appearance methods

public String getTitle ()

The `getTitle()` method returns the current title for the `Dialog`. If there is no title for the `Dialog`, `getTitle()` returns `null`.

public void setTitle (String title)

The `setTitle()` method changes the current title of the `Dialog` to `title`. To turn off any title for the `Dialog`, use `null` for `title`.

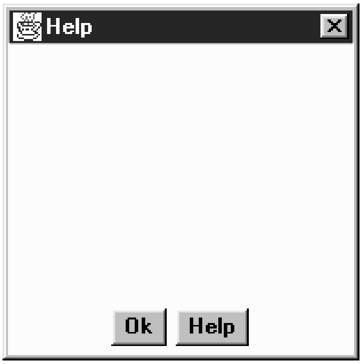


Figure 6–5: A Dialog in an application or local applet

Figure 6–6: The same Dialog in an applet that came across the network

public boolean isResizable ()

The `isResizable()` method tells you if the current `Dialog` is resizable.

public void setResizable (boolean resizable)

The `setResizable()` method changes the resize state of the `Dialog`. A `resizable` value of `true` means the user can resize the `Dialog`, while `false` means the user cannot. This must be set before the `Dialog` is shown or the peer created.

Modal methods

public boolean isModal ()

The `isModal()` method returns the current mode of the `Dialog`. `true` indicates the dialog traps all user input.

public void setModal (boolean mode) ★

The `setModal()` method changes the current mode of the `Dialog` to `mode`. The next time the dialog is displayed via `show()`, it will be modal. If the dialog is currently displayed, `setModal()` has no immediate effect. The change will take place the next time `show()` is called.

public void show () ★

The `show()` method brings the `Dialog` to the front and displays it. If the dialog is modal, `show()` takes care of blocking events so that they don't reach the parent `Frame`.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Dialog` peer. The peer is created automatically when you call the dialog's `show()` method. If you override the method `addNotify()`, first call `super.addNotify()`, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

protected String paramString ()

When you call the `toString()` method of `Dialog`, the default `toString()` method of `Component` is called. This in turn calls `paramString()` which builds up the string to display. At the `Dialog` level, `paramString()` appends the current mode (modal/modeless) and title (if present). Using the constructor `Dialog (top, "Help", true)`, the results would be as follows:

```
java.awt.Dialog[0,0,0x0,invalid,hidden,layout=java.awt.BorderLayout,
    modal,title=Help]
```

6.6.2 Dialog Events

In Java 1.0, a `Dialog` peer generates all the events that are generated by the `Component` class; it does not generate events that are specific to a particular type of component. That is, it generates key events, mouse events, and focus events; it doesn't generate action events or list events. If an event happens within a child component of a `Dialog`, the target of the event is the child component, not the `Dialog`.

Window

In addition to the `Component` events, `Dialog` generates the `WINDOW` events. These events are `WINDOW_DESTROY`, `WINDOW_EXPOSE`, `WINDOW_ICONIFY`, `WINDOW_DEICONIFY`, and `WINDOW_MOVED`.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners for different event types; the listeners are told when the event happens. The `Dialog` class inherits all its listener handling from `Window`.

6.6.3 Dialog Example

Example 6-2 demonstrates how a modal `Dialog` tries to work in Java 1.0. In some windowing systems, "modal" means that the calling application, and sometimes the entire system stops, and input to anything other than the `Dialog` is blocked. With Java 1.0, a modal `Dialog` acts only on the parent frame and simply prevents it from getting screen-oriented input by disabling all components within the frame. The Java program as a whole continues to execute.

Example 6-2 displays a `Dialog` window with username and password fields, and an Okay button. When the user selects the Okay button, a realistic application would validate the username and password; in this case, they are just displayed on a `Frame`. Since the `Frame` must wait for the `Dialog` to finish before looking at the values of the two fields, the `Dialog` must tell the `Frame` when it can look. This is done through a custom interface implemented by the parent `Frame` and invoked by the `Dialog` in its action method.

Figure 6-7 is the initial `Dialog`; Figure 6-8 shows the result after you click Okay. Example 6-2 contains the source code.

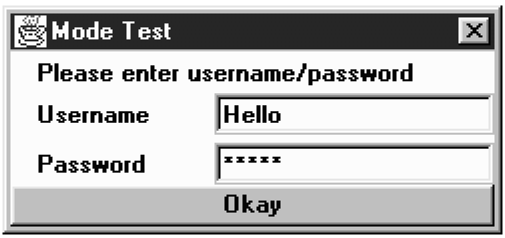


Figure 6–7: Username and password Dialog

Notice the use of the newly created `DialogHandler` interface when the user selects the Okay button. Also, see how the pre– and post–event-handling methods are separated. All the pre-event processing takes place before the `Dialog` is shown. The post-event processing is called by the `Dialog` through the new `DialogHandler` interface method, `dialogDoer()`. The interface provides a common method name for all your `Dialog` boxes to call.

Figure 6–8: Resulting Frame

Example 6–2: Modal Dialog Usage

```
import java.awt.*;
interface DialogHandler {
    void dialogDoer (Object o);
}
class modeTest extends Dialog {
    TextField user;
    TextField pass;
    modeTest (DialogHandler parent) {
        super ((Frame)parent, "Mode Test", true);
        add ("North", new Label ("Please enter username/password"));
        Panel left = new Panel ();
        left.setLayout (new BorderLayout ());
        left.add ("North", new Label ("Username"));
        left.add ("South", new Label ("Password"));
        add ("West", left);
        Panel right = new Panel ();
        right.setLayout (new BorderLayout ());
        user = new TextField (15);
        pass = new TextField (15);
        pass.setEchoCharacter ('*');
        right.add ("North", user);
        right.add ("South", pass);
        add ("East", right);
        add ("South", new Button ("Okay"));
        resize (250, 125);
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            dispose();
            return true;
        } else if ((e.target instanceof Button) &&
             (e.id == Event.ACTION_EVENT)) {
            ((DialogHandler)getParent ()).dialogDoer(e.arg);
        }
        return super.handleEvent (e);
    }
}

public class modeFrame extends Frame implements DialogHandler {
    modeTest d;
    modeFrame (String s) {
        super (s);
```

Example 6–2: Modal Dialog Usage (continued)

```
        resize (100, 100);
        d = new modeTest (this);
        d.show ();
    }
    public static void main (String []args) {
        Frame f = new modeFrame ("Frame");
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            hide();
            dispose();
            System.exit (0);
        }
        return super.handleEvent (e);
    }
    public void dialogDoer(Object o) {
        d.dispose();
        add ("North", new Label (d.user.getText()));
        add ("South", new Label (d.pass.getText()));
        show ();
    }
}
```

Since the Java 1.1 modal `Dialog` blocks the calling `Frame` appropriately, the overhead of the `DialogHandler` interface is not necessary and all the work can be combined into the `main()` method, as shown in the following:

```
// only reliable in Java 1.1
import java.awt.*;
class modeTest11 extends Dialog {
    TextField user;
    TextField pass;
    modeTest11 (Frame parent) {
        super (parent, "Mode Test", true);
        add ("North", new Label ("Please enter username/password"));
        Panel left = new Panel ();
        left.setLayout (new BorderLayout ());
        left.add ("North", new Label ("Username"));
        left.add ("South", new Label ("Password"));
        add ("West", left);
        Panel right = new Panel ();
        right.setLayout (new BorderLayout ());
        user = new TextField (15);
        pass = new TextField (15);
        pass.setEchoCharacter ('*');
        right.add ("North", user);
        right.add ("South", pass);
        add ("East", right);
        add ("South", new Button ("Okay"));
        resize (250, 125);
    }
    public boolean handleEvent (Event e) {
```

```
        if (e.id == Event.WINDOW_DESTROY) {
            dispose();
            return true;
        } else if ((e.target instanceof Button) &&
             (e.id == Event.ACTION_EVENT)) {
            hide();
        }
        return super.handleEvent (e);
    }
}

public class modeFrame11 extends Frame {
    modeFrame11 (String s) {
        super (s);
        resize (100, 100);
    }
    public static void main (String []args) {
        Frame f = new modeFrame11 ("Frame");
        modeTest11 d;
        d = new modeTest11 (f);
        d.show ();
        d.dispose();
        f.add ("North", new Label (d.user.getText()));
        f.add ("South", new Label (d.pass.getText()));
        f.show ();
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            hide();
            dispose();
            System.exit (0);
        }
        return super.handleEvent (e);
    }
}
```

The remainder of the code is virtually identical. The most significant difference is that the dialog's `handleEvent()` method just hides the dialog, rather than calling `DialogHandler.dialogDoer()`.

6.7 FileDialog

`FileDialog` is a subclass of `Dialog` that lets the user select files for opening or saving. You must load or save any files yourself. If used in an application or *appletviewer*, the `FileDialog` always looks like the local system's file dialog. The `FileDialog` is always a modal `Dialog`, meaning that the calling program is blocked from continuing (and cannot accept input) until the user responds to the `FileDialog`. Figure 6-9 shows the `FileDialog` component in Motif, Windows NT/95, and the Macintosh.

Unlike the other `Window` subclasses, there is no `LayoutManager` for `FileDialog`, since you are creating the environment's actual file dialog. This means you cannot subclass `FileDialog` to alter its behavior or appearance. However, the class is not "final."

NOTE Netscape Navigator throws an `AWTError` when you try to create a `FileDialog` because Navigator does not permit local file system access.

6.7.1 FileDialog Methods

Constants

A `FileDialog` has two modes: one for loading a file (input) and one for saving (output). The following variables provide the mode to the constructor. The `FileDialog` functions the same way in both modes. The only visible difference is whether a button on the screen is labeled Load or Save. You must load or save the requested file yourself. On certain platforms there may be functional differences: in `SAVE` mode, the `FileDialog` may ask if you want to replace a file if it already exists; in `LOAD` mode, the `FileDialog` may not accept a filename that does not exist.

public final static int LOAD

`LOAD` is the constant for load mode. It is the default mode.

public final static int SAVE

`SAVE` is the constant for save mode.

Constructors

public FileDialog (Frame parent) ★

The first constructor creates a `FileDialog` for loading with a parent `Frame` of `parent`. The window title is initially empty.

public FileDialog (Frame parent, String title)

This constructor creates a `FileDialog` for loading with a parent `Frame` of `parent`. The window title is `title`.

public FileDialog (Frame parent, String title, int mode)

The final constructor creates a `FileDialog` with an initial mode of `mode`. If `mode` is neither `LOAD` nor `SAVE`, the `FileDialog` is in `SAVE` mode.

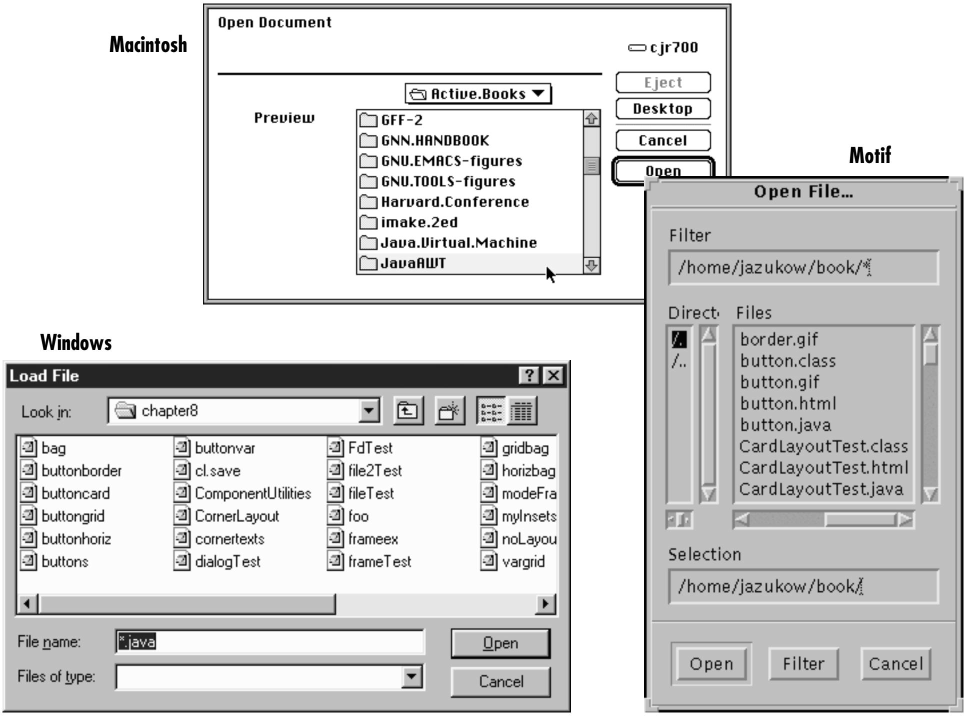


Figure 6–9: FileDialogs for Motif, Windows NT/95, and the Macintosh

Appearance methods

public String getDirectory ()

`getDirectory()` returns the current directory for the `FileDialog`. Normally, you check this when `FileDialog` returns after a `show()` and a call to `getFile()` returns something other than `null`.

public void setDirectory (String directory)

The `setDirectory()` method changes the initial directory displayed in the `FileDialog` to `directory`. You must call `setDirectory()` prior to displaying the `FileDialog`.

public String getFile ()

The `getFile()` method returns the current file selection from the `FileDialog`. If the user pressed the Cancel button on the `FileDialog`, `getFile()` returns `null`. This is the only way to determine if the user pressed Cancel.

NOTE On some platforms in Java 1.0 `getFile()` returns a string that ends in `.*.*` (two periods and two asterisks) if the file does not exist. You need to remove the extra characters before you can create the file.

---

public void setFile (String file)

The `setFile()` method changes the default file for the `FileDialog` to `file`. Because the `FileDialog` is modal, this must be done before you call `show()`. The string may contain a filename filter like **.java* to show a preliminary list of files to select. This has nothing to do with the use of the `FilenameFilter` class.

public FilenameFilter getFilenameFilter ()

The `getFilenameFilter()` method returns the current `FilenameFilter`. The `FilenameFilter` class is part of the `java.io` package. `FilenameFilter` is an interface that allows you to restrict choices to certain directory and filename combinations. For example, it can be used to limit the user to selecting *.jpg*, *.gif*, and *.xbm* files. The class implementing `FilenameFilter` would not return other possibilities as choices.

public void setFilenameFilter (FilenameFilter filter)

The `setFilenameFilter()` method changes the current filename filter to `filter`. This needs to be done before you `show()` the `FileDialog`.

NOTE The JDK does not support the `FilenameFilter` with `FileDialog` boxes. `FilenameFilter` works but can't be used with `FileDialog`.

Miscellaneous methods

public int getMode ()

The `getMode()` method returns the current mode of the `FileDialog`. If an invalid mode was used in the constructor, this method returns an invalid mode here. No error checking is performed.

public void setMode (int mode) ★

The `setMode()` method changes the current mode of the `FileDialog` to `mode`. If `mode` is not one of the class constants `LOAD` or `SAVE`, `setMode()` throws the run-time exception `IllegalArgumentException`.

public synchronized void addNotify ()

The `addNotify()` method creates the `FileDialog` peer. This is automatically done when you call the `show()` method of the `FileDialog`. If you override this method, first call `super.addNotify()`, then add your customizations for the new class. Then you can do everything you need with the information about the newly created peer.

protected String paramString ()

When you call the `toString()` method of `FileDialog`, the default `toString()` method of `Component` is called. This in turn calls `paramString()`, which builds up the string to display. At the `FileDialog` level, `paramString()` appends the directory (if not `null`) and current mode to the return value. Using the constructor `FileDialog(top, "Load Me")`, the results would be as follows:

```
java.awt.FileDialog[0,0,0x0,invalid,hidden,modal,title=Load Me,load]
```

6.7.2 A FileDialog Example

To get a better grasp of how the `FileDialog` works, the following application uses a `FileDialog` to select a file for display in a `TextArea`. You can also use `FileDialog` to save the file back to disk. Figure 6-10 shows the application, with a file displayed in the text area; the `FileDialog` itself looks like any other file dialog on the runtime system. Example 6-3 shows the code.

CAUTION This example can overwrite an existing file.

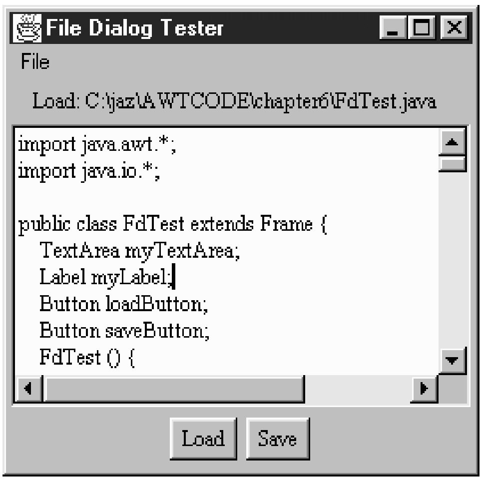


Figure 6–10: FileDialog test program

Example 6–3: Complete FileDialog

```
import java.awt.*;
import java.io.*;

public class FdTest extends Frame {
    TextArea myTextArea;
    Label myLabel;
```

Example 6–3: Complete FileDialog (continued)

```
    Button loadButton;
    Button saveButton;
    FdTest () {
        super ("File Dialog Tester");
        Panel p = new Panel ();
        p.add (loadButton = new Button ("Load"));
        p.add (saveButton = new Button ("Save"));
        add ("North", myLabel = new Label ());
        add ("South", p);
        add ("Center", myTextArea = new TextArea (10, 40));
        Menu m = new Menu ("File");
        m.add (new MenuItem ("Quit"));
        MenuBar mb = new MenuBar();
        mb.add (m);
        setMenuBar (mb);
        pack();
    }
    public static void main (String args[]) {
        FdTest f = new FdTest();
            f.show();
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            hide();
            dispose ();
            System.exit(0);
            return true;  // never gets here
        }
        return super.handleEvent (e);
    }
    public boolean action (Event e, Object o) {
        if (e.target instanceof MenuItem) {
            hide();
            dispose ();
            System.exit(0);
            return true;  // never gets here
        } else if (e.target instanceof Button) {
            int state;
            String msg;
            if (e.target == loadButton) {
                state = FileDialog.LOAD;
                msg = "Load File";
            } else {// if (e.target == saveButton)
                state = FileDialog.SAVE;
                msg = "Save File";
            }
            FileDialog file = new FileDialog (this, msg, state);
            file.setFile ("*.java");  // set initial filename filter
            file.show(); // Blocks
            String curFile;
            if ((curFile = file.getFile()) != null) {
                String filename = file.getDirectory() + curFile;
```

Example 6–3: Complete FileDialog (continued)

```
                // curFile ends in .*.* if file does not exist
                byte[] data;
                setCursor (Frame.WAIT_CURSOR);
                if (state == FileDialog.LOAD) {
                    File f = new File (filename);
                    try {
                        FileInputStream fin = new FileInputStream (f);
                        int filesize = (int)f.length();
                        data = new byte[filesize];
                        fin.read (data, 0, filesize);
                    } catch (FileNotFoundException exc) {
                        String errorString = "File Not Found: " + filename;
                        data = new byte[errorString.length()];
                        errorString.getBytes (0, errorString.length(), data, 0);
                    } catch (IOException exc) {
                        String errorString = "IOException: " + filename;
                        data = new byte[errorString.length()];
                        errorString.getBytes (0, errorString.length(), data, 0);
                    }
                    myLabel.setText ("Load: " + filename);
                } else {
// Remove trailing ".*.*" if present - signifies file does not exist
                    if (filename.indexOf (".*.*") != -1) {
                        filename = filename.substring (0, filename.length()-4);
                    }
                    File f = new File (filename);
                    try {
                        FileOutputStream fon = new FileOutputStream (f);
                        String text = myTextArea.getText();
                        int textsize = text.length();
                        data = new byte[textsize];
                        text.getBytes (0, textsize, data, 0);
                        fon.write (data);
                        fon.close ();
                    } catch (IOException exc) {
                        String errorString = "IOException: " + filename;
                        data = new byte[errorString.length()];
                        errorString.getBytes (0, errorString.length(), data, 0);
                    }
                    myLabel.setText ("Save: " + filename);
                }
                // Note - on successful save, text is redisplayed
                myTextArea.setText (new String (data, 0));
                setCursor (Frame.DEFAULT_CURSOR);
            }
            return true;
        }
        return false;
    }
}
```

Most of this application is one long `action()` method that handles all the action events that take place within the `Frame`. The constructor doesn't do much besides arrange the display; it includes code to create a File menu with one item, Quit. This menu is visible in the upper left corner of the `Frame`; we'll see more about working with menus in Chapter 10 We provide a `main()` method to display the `Frame` and a `handleEvent()` method to shut the application down if the event `WINDOW_DESTROY` occurs.

But the heart of this program is clearly its `action()` method. `action()` starts by checking whether the user selected a menu item; if so, it shuts down the application because the only item on our menu is Quit. It then checks whether the user clicked on one of the buttons and sets the `FileDialog` mode to `LOAD` or `SAVE` accordingly. It then sets a default filename, **.java*, which limits the display to filenames ending in *.java*. Next, `action()` shows the dialog. Because file dialogs are modal, `show()` blocks until the user selects a file or clicks Cancel.

The next line detects whether or not `getFile()` returns `null`. A `null` return indicates that the user selected Cancel; in this case, the dialog disappears, but nothing else happens. We then build a complete filename from the directory name and the name the user selected. If the dialog's state is `LOAD`, we read the file and display it in the text area. Otherwise, the dialog's state must be `SAVE`, so we save the contents of the text area under the given filename. Note that we first check for the string `*.*` and remove it if it is present. In Java 1.1, these two lines are unnecessary, but they don't hurt, either.

In this chapter:

7

Layouts

This chapter expands upon the idea of a layout manager, which was mentioned briefly in the previous chapter. Every container has a `LayoutManager` that is responsible for positioning the component objects within it, regardless of the platform or the screen size. Layout managers eliminate the need to compute component placement on your own, which would be a losing proposition since the size required for any component depends on the platform on which it is displayed. Even for a simple layout, the code required to discover component sizes and compute absolute positions could be hundreds of lines, particularly if you concern yourself with what happens when the user resizes a window. A layout manager takes care of this for you. It asks each component in the layout how much space it requires, then arranges the components on the screen as best it can, based on the component sizes on the platform in use and the space available, resizing the components as needed.

To find out how much space a component needs, a layout manager calls the component's `getMinimumSize()` and `getPreferredSize()` methods. (Java 1.1 also has a `getMaximumSize()` method; the existing layout managers don't take advantage of it.) These methods report the minimum space that a component requires to be displayed correctly and the optimal size at which it looks best. Thus, each component must know its space requirements; the layout manager uses these to arrange the screen; and your Java program never has to worry about platform-dependent positioning.

The `java.awt` package provides five layout managers: `FlowLayout`, `BorderLayout`, `GridLayout`, `CardLayout`, and `GridBagLayout`. Four additional layouts are provided in the `sun.awt` package: `HorizBagLayout`, `VerticalBagLayout`, `OrientableFlowLayout`, and `VariableGridLayout`. `OrientableFlowLayout` is new to Java 1.1. Of the 1.0 layouts, all are available in the JDK and Internet Explorer. The `VariableGridLayout` is also available with Netscape Navigator. This chapter discusses all of them, along with the `LayoutManager` and `LayoutManager2` interfaces; we'll pay particular attention to how each layout manager computes positions for its components. We will also discuss how to combine layouts to generate more complex screens and how to create your own `LayoutManager` for special situations.

7.1 The LayoutManager Interface

The `LayoutManager` interface defines the responsibilities of something that wants to lay out `Components` within a `Container`. It is the `LayoutManager`'s duty to determine the position and size of each component within the `Container`. You will never directly call the methods of the `LayoutManager` interface; for the most part, layout managers do their work behind the scenes. Once you have created a `LayoutManager` object and told the container to use it (by calling `setLayout()`), you're finished with it. The system calls the appropriate methods in the layout manager when necessary.

Therefore, the `LayoutManager` interface is most important when you are writing a new layout manager; we'll discuss it here because it's the scaffolding on which all layout managers are based. Like any interface, `LayoutManager` specifies the methods a layout manager must implement but says nothing about how the `LayoutManager` does its job. Therefore, we'll make a few observations before proceeding. First, a layout manager is free to ignore some of its components; there is no requirement that a layout manager display everything. For example, a `Container` using a `BorderLayout` might include thirty or forty components. However, the `BorderLayout` will display at most five of them (the last component placed in each of its five named areas). Likewise, a `CardLayout` may manage many components but displays only one at a time.

Second, a layout manager can do anything it wants with the components' minimum and preferred sizes. It is free to ignore either. It makes sense that a layout manager can ignore a preferred size; after all, "preferred" means "give me this if it's available." However, a layout manager can also ignore a minimum size. At times, there is no reasonable alternative: the container may not have enough room to display a component at its minimum size. How to handle this situation is left to the layout manager's discretion. All layout managers currently ignore a component's maximum size, though this may change in the future.

7.1.1 Methods of the LayoutManager Interface

Five methods make up the `LayoutManager` interface. If you create your own class that implements `LayoutManager`, you must define all five. As you will see, many of the methods do not have to do anything, but there must still be a stub with the appropriate method signature.

public abstract void addLayoutComponent (String name, Component component)

The `addLayoutComponent()` method is called only when the program assigns a `name` to the `component` when adding it to the layout (i.e., the program calls `add(String, Component)` rather than simply calling `add(Component)` or the Java 1.1 `add(Component, Object)`). It is up to the layout manager to decide what, if anything, to do with the name. For example, `BorderLayout` uses `name` to specify an area on the screen in which to display the component. Most layout managers don't require a name and will only implement a stub.

public abstract void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method's responsibility is to remove `component` from any internal storage used by the layout manager. This method will probably be stubbed out for your own layouts and do nothing. However, it may need to do something if your layout manager associates components with names.

public abstract Dimension preferredLayoutSize (Container parent)

The `preferredLayoutSize()` method is called to determine the preferred size of the components within the `Container`. It returns a `Dimension` object that contains the required height and width. `parent` is the object whose components need to be laid out. Usually, the `LayoutManager` determines how to size `parent` by calculating the sizes of the components within it and calculating the dimensions required to display them. On other occasions, it may just return `parent.setSize()`.

public abstract Dimension minimumLayoutSize (Container parent)

The `minimumLayoutSize()` method is called to determine the minimum size of the components within the `Container`. It returns a `Dimension` object that contains the required height and width. `parent` is the object whose components need to be laid out.

public abstract void layoutContainer (Container parent)

The `layoutContainer()` method is where a `LayoutManager` does most of its work. The `layoutContainer()` method is responsible for the positioning of all the `Components` of `parent`. Each specific layout positions the enclosed components based upon its own rules.

7.1.2 The LayoutManager2 Interface

Numerous changes were introduced in Java 1.1 to make it conform to various design patterns. These patterns provide consistency in usage and make Java programming easier. The `LayoutManager2` interface was introduced for this reason. This new interface solves a problem that occurs when working with the `GridBagLayout`. While the `addLayoutComponent(String, Component)` method of `LayoutManager` works great for `BorderLayout` and `CardLayout`, you can't use it for a `GridBagLayout`. The position of a component in a `GridBagLayout` is controlled by a number of constraints, which are encapsulated in a `GridBagConstraints` object. To associate constraints with a component, you needed to call a `setConstraints()` method. Although this works, it is not consistent with the way you add components to other layouts. Furthermore, as more and more people create their own layout managers, the number of ways to associate positioning information with a component could grow endlessly. `LayoutManager2` defines a version of `addLayoutComponent()` that can be used by all constraint-based layout managers, including older managers like `BorderLayout` and `CardLayout`. This method lets you pass an arbitrary object to the layout manager to provide positioning information. Layout managers that need additional information (like the `GridBagConstraints` object) now implement `LayoutManager2` instead of `LayoutManager`.

In addition to swapping the parameters to the `addLayoutComponent(Component, Object)`, the new `LayoutManager2` interface also defines several methods that aren't really needed now but will facilitate the introduction of "peerless components" in a later release.

Methods of the LayoutManager2 interface

public abstract void addLayoutComponent(Component comp, Object constraints) ★

The `addLayoutComponent()` method is called when a program assigns `constraints` to the component `comp` when adding it to the layout. In practice, this means that the program added the component by calling the new method `add(Component component, Object constraints)` rather than the older methods `add(Component component)` or `add(String name, Component component))`. It is up to the layout manager to decide what, if anything, to do with the `constraints`. For example, `GridBagLayout` uses `constraints` to associate a `GridBagConstraints` object to the component `comp`. `BorderLayout` uses `constraints` to associate a location string (like "Center") with the component.

public abstract Dimension maximumLayoutSize(Container target) ★

The `maximumLayoutSize()` method must return the maximum size of the `target` container under this layout manager. Previously, only minimum and preferred sizes were available. Now a container can have a maximum size. Once layout managers support the concept of maximum sizes, containers will not grow without bounds when additional space is available. If there is no actual maximum, the `Dimension` should have a width and height of the constant `Integer.MAX_VALUE`.

public abstract float getLayoutAlignmentX(Container target) ★

The `getLayoutAlignmentX()` method must return the alignment of `target` along the x axis. The return value should be between 0.0 and 1.0. Values nearer 0 mean that the container will be positioned closer to the left edge of the area available. Values nearer 1 mean that the container will be positioned closer to the right. The value 0.5 means the container should be centered.

public abstract float getLayoutAlignmentY(Container target) ★

The `getLayoutAlignmentY()` method must return the alignment of `target` along the y axis. The return value should be between 0.0 and 1.0. Values nearer 0 mean that the container will be positioned closer to the top of the area available. Values nearer 1 mean that the container will be positioned closer to the bottom. The value 0.5 means the container should be centered.

public abstract void invalidateLayout(Container target) ★

The `invalidateLayout()` method tells the layout manager that any layout information it has for `target` is invalid. This method will usually be implemented as a stub (i.e., `{}`). However, if the layout manager caches any information about `target` when this method is called, the manager should consider that information invalid and discard it.

7.2 FlowLayout

`FlowLayout` is the default `LayoutManager` for a `Panel`. A `FlowLayout` adds components to the container in rows, working from left to right. When it can't fit any more components in a row, it starts a new row—not unlike a word processor with word wrap enabled. When the container gets resized, the components within it get repositioned based on the container's new size. If sufficient space is available, components within `FlowLayout` containers are given their preferred size. If there is insufficient space, you do not see the components in their entirety.

7.2.1 FlowLayout Methods

Constants

`FlowLayout` defines three constants, all of which are used to specify alignment. The alignment tells `FlowLayout` where to start positioning the components on each row. Each component is still added from left to right, no matter what the alignment setting is.

public final static int LEFT

`LEFT` is the constant for left alignment.

public final static int CENTER

`CENTER` is the constant for center alignment and is the default.

public final static int RIGHT

`RIGHT` is the constant for right alignment.

Constructors

public FlowLayout ()

This constructor creates a `FlowLayout` using default settings: center alignment with a horizontal and vertical gap of five pixels. The gap is the space between the different components in the different directions. By default, there will be five pixels between components. The constructor is usually called within a call to `setLayout()`: `setLayout (new FlowLayout())`. Figure 7-1 shows how the default `FlowLayout` behaves with different screen sizes. As the screen C shows, if the screen is too small, the components will *not* be shrunk so that they can fit better.

public FlowLayout (int alignment)

This version of the constructor creates a `FlowLayout` using the specified `alignment` and a horizontal and vertical gap of five pixels. Valid alignments are the `FlowLayout` constants, although there is no verification. Figure 7-2 shows the effect of different alignments: `FlowLayout.LEFT` (screen A), `FlowLayout.CENTER` (B), and `FlowLayout.RIGHT` (C).

public FlowLayout (int alignment, int hgap, int vgap)

The final version of the constructor is called by the other two. It requires you to explicitly specify the alignment, horizontal gap (`hgap`), and vertical gap (`vgap`). This creates a `FlowLayout` with an alignment of `alignment`, horizontal gap of `hgap`, and vertical gap of `vgap`. The units for gaps are pixels. It is possible to have negative gaps if you want components to be placed on top of one another. Figure 7-3 shows the effect of changing the gap sizes.

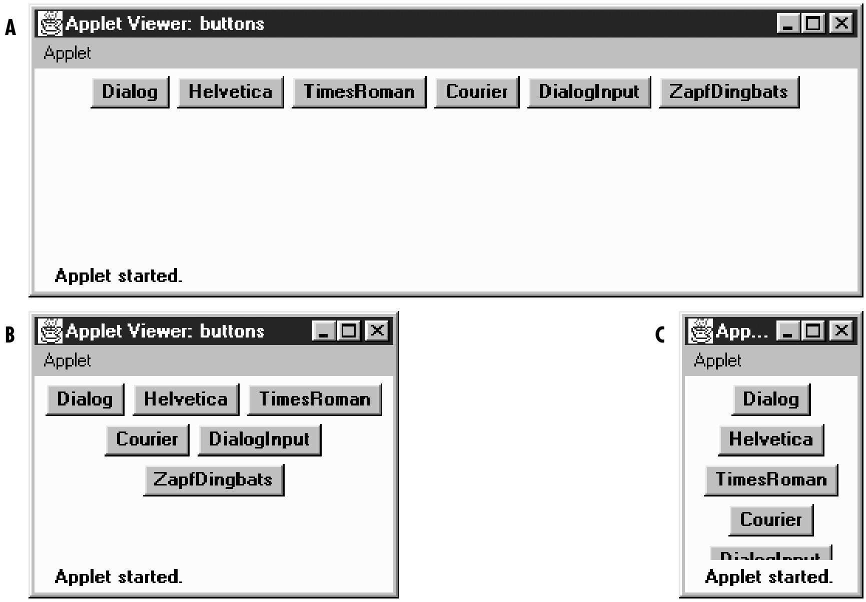


Figure 7–1: FlowLayout with six buttons and three different screen sizes

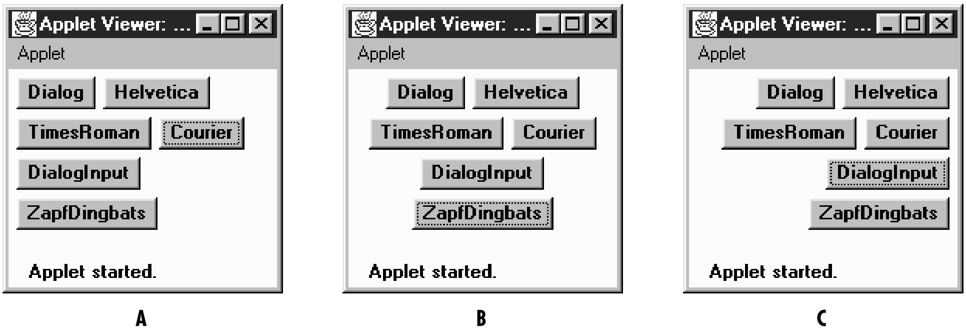


Figure 7–2: FlowLayout with three different alignments

Informational methods

public int getAlignment () ★

The `getAlignment()` method retrieves the current alignment of the `FlowLayout`. The return value should equal one of the class constants `LEFT`, `CENTER`, or `RIGHT`.

public void setAlignment (int alignment) ★

The `setAlignment()` method changes the `FlowLayout` alignment to `alignment`. The alignment value should equal one of the class constants `LEFT`,

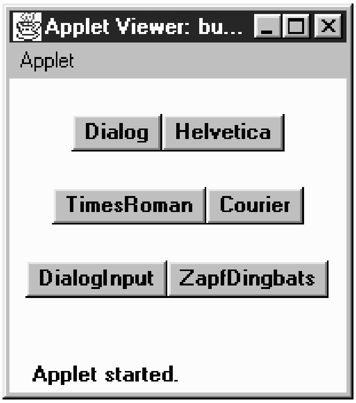


Figure 7–3: FlowLayout with hgap of 0 and vgap of 20

CENTER, or RIGHT, but this method does not check. After changing the alignment, you must validate() the Container.

public int getHgap () ★

The getHgap() method retrieves the current horizontal gap setting.

public void setHgap (int hgap) ★

The setHgap() method changes the current horizontal gap setting to hgap. After changing the gaps, you must validate() the Container.

public int getVgap () ★

The getVgap() method retrieves the current vertical gap setting.

public void setVgap (int hgap) ★

The setVgap() method changes the current vertical gap setting to vgap. After changing the gaps, you must validate() the Container.

LayoutManager methods

public void addLayoutComponent (String name, Component component)

The addLayoutComponent() method of FlowLayout does nothing.

public void removeLayoutComponent (Component component)

The removeLayoutComponent() method of FlowLayout does nothing.

public Dimension preferredLayoutSize (Container target)

The preferredLayoutSize() method of FlowLayout calculates the preferred dimensions for the target container. The FlowLayout computes the preferred size by placing all the components in one row and adding their individual preferred sizes along with gaps and insets.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method of `FlowLayout` calculates the minimum dimensions for the container by adding up the sizes of the components. The `FlowLayout` computes the minimum size by placing all the components in one row and adding their individual minimum sizes along with gaps and insets.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen, starting with the first row of the display, going left to right across the screen, based on the current alignment setting. When it reaches the right margin of the container, it skips down to the next row, and continues drawing additional components.

Miscellaneous methods

public String toString ()

The `toString()` method of `FlowLayout` returns the current horizontal and vertical gap settings along with the alignment (left, center, right). For a `FlowLayout` that uses all the defaults, `toString()` produces:

```
java.awt.FlowLayout[hgap=5,vgap=5,align=center]
```

7.3 BorderLayout

`BorderLayout` is the default `LayoutManager` for a `Window`. It provides a very flexible way of positioning components along the edges of the window. The following call to `setLayout()` changes the `LayoutManager` of the current container to the default `BorderLayout`: `setLayout(new BorderLayout())`. Figure 7-4 shows a typical `BorderLayout`.

`BorderLayout` is the only layout provided that requires you to name components when you add them to the layout; if you're using a `BorderLayout`, you must use `add(String name, Component component)` in Java 1.0 or `add(Component component, String name)` in Java 1.1 (parameter order switched). (The `CardLayout` can use these versions of `add()`, but does not require it.) The `name` parameter of `add()` specifies the region to which the component should be added. The five different regions are "North", "South", "East", and "West" for the edges of the window, and "Center" for any remaining interior space. These names are case sensitive. It is not necessary that a container use all five regions. If a region is not used, it relinquishes its space to the regions around it. If you `add()` multiple objects to a single region, the layout manager only displays the last one. If you want to display multiple objects within a region, group them within a `Panel` first, then `add()` the `Panel`.

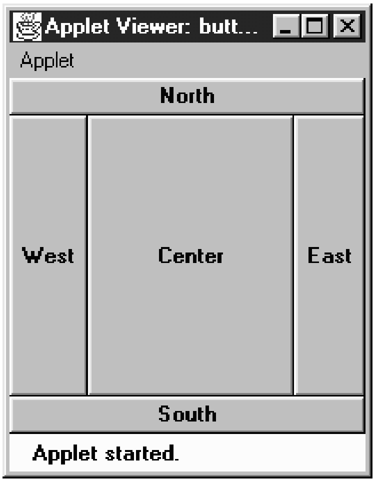


Figure 7–4: BorderLayout

NOTE In Java 1.1, if you do not provide a name, the component is placed in the "Center" region.

7.3.1 BorderLayout Methods

Constants

Prior to Java 1.1, you had to use string constants to specify the constraints when adding a component to a container whose layout is `BorderLayout`. With Java 1.1, you can use class constants, instead of a literal string, in the following list.

public static final String CENTER ★

The `CENTER` constant represents the "Center" string and indicates that a component should be added to the center region.

public static final String EAST ★

The `EAST` constant represents the "East" string and indicates that a component should be added to the east region.

public static final String NORTH ★

The `NORTH` constant represents the "North" string and indicates that a component should be added to the north region.

public static final String SOUTH ★

The `SOUTH` constant represents the "South" string and indicates that a component should be added to the south region.

public static final String WEST ★

The `WEST` constant represents the "West" string and indicates that a component should be added to the west region.

Constructors

public BorderLayout ()

This constructor creates a `BorderLayout` using a default setting of zero pixels for the horizontal and vertical gaps. The gap specifies the space between adjacent components. With horizontal and vertical gaps of zero, components in adjacent regions will touch each other. As Figure 7-4 shows, each component within a `BorderLayout` will be resized to fill an entire region.

public BorderLayout (int hgap, int vgap)

This version of the constructor allows you to create a `BorderLayout` with a horizontal gap of `hgap` and vertical gap of `vgap`, putting some space between the different components. The units for gaps are pixels. It is possible to have negative gaps if you want components to overlap.

Informational methods

public int getHgap () ★

The `getHgap()` method retrieves the current horizontal gap setting.

public void setHgap (int hgap) ★

The `setHgap()` method changes the current horizontal gap setting to `hgap`. After changing the gaps, you must `validate()` the `Container`.

public int getVgap () ★

The `getVgap()` method retrieves the current vertical gap setting.

public void setVgap (int hgap) ★

The `setVgap()` method changes the current vertical gap setting to `vgap`. After changing the gaps, you must `validate()` the `Container`.

LayoutManager methods

public void addLayoutComponent (String name, Component component) ☆

This version of `addLayoutComponent()` has been deprecated and replaced by the `addLayoutComponent(Component, Object)` method of the `LayoutManager2` interface.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `BorderLayout` removes `component` from the container, if it is in one of the five regions. If `component` is not in the container already, nothing happens.

public Dimension preferredLayoutSize (Container target)

The `preferredLayoutSize()` method of `BorderLayout` calculates the preferred dimensions for the components in `target`. To compute the preferred height, a `BorderLayout` adds the height of the `getPreferredSize()` of the north and south components to the maximum `getPreferredSize()` height of the east, west, and center components. The vertical gaps are added in for the north and south components, if present. The top and bottom insets are also added into the height. To compute the preferred width, a `BorderLayout` adds the width of the `getPreferredSize()` of east, west, and center components, along with the horizontal gap for the east and west regions. It compares this value to the preferred widths of the north and south components. The `BorderLayout` takes the maximum of these three and then adds the left and right insets, plus twice the horizontal gap. The result is the preferred width for the container.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method of `BorderLayout` calculates the minimum dimensions for the components in `target`. To compute the minimum height, a `BorderLayout` adds the height of the `getMinimumSize()` of the north and south components to the maximum of the minimum heights of the east, west, and center components. The vertical gaps are added in for the north and south components, if present, along with the container's top and bottom insets. To compute the minimum width, a `BorderLayout` adds the width of the `getMinimumSize()` of east, west, and center components, along with the horizontal gap for the east and west regions. The `BorderLayout` takes the maximum of these three and then adds the left and right insets, plus twice the horizontal gap. The result is the minimum width for the container.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen in the appropriate regions. The north region takes up the entire width of the container along the top. South does the same along the bottom. The heights of north and south will be the heights of the components they contain. The east and west regions are given the widths of the components they contain. For height, east and west are given whatever is left in the container after satisfying north's and south's height requirements. If there is any extra vertical space, the east and west components are resized accordingly. Any space left in the middle of the screen is assigned to the center region. If there is insufficient space for all the components, space is allocated according to the following priority: north, south, west, east, and center. Unlike `FlowLayout`, `BorderLayout` reshapes the internal components of the container to fit within their region. Figure 7-5 shows what happens if the east and south regions are not present and the gaps are nonzero.

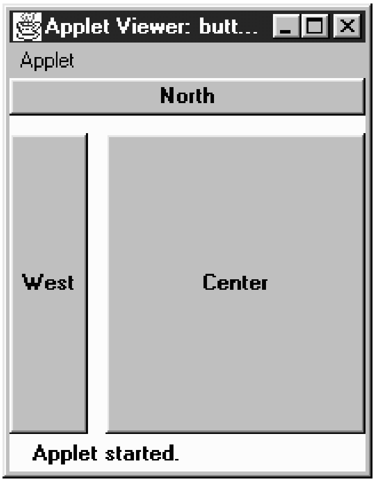


Figure 7–5: BorderLayout with missing regions

LayoutManager2 methods

public void addLayoutComponent (Component component, Object name) ★

This `addLayoutComponent()` method puts `component` in the `name` region of the container. In Java 1.1, if `name` is null, `component` is added to the center. If the name is not "North", "South", "East", "West", or "Center", the component is added to the container but won't be displayed. Otherwise, it is displayed in the appropriate region.

There can only be one component in any region, so any component already in the named region is removed. To get multiple components in one region of a `BorderLayout`, group the components in another container, and add the container as a whole to the layout.

If `name` is not a `String`, `addLayoutComponent()` throws the run-time exception `IllegalArgumentException`.

public abstract Dimension maximumLayoutSize(Container target) ★

The `maximumLayoutSize()` method returns a `Dimension` object with a width and height of `Integer.MAX_VALUE`. In effect, this means that `BorderLayout` does not support the concept of maximum size.

public abstract float getLayoutAlignmentX(Container target) ★

The `getLayoutAlignmentX()` method says that `BorderLayout` containers should be centered horizontally within the area available.

public abstract float getLayoutAlignmentY(Container target) ★

The `getLayoutAlignmentY()` method says that `BorderLayout` containers should centered vertically within the area available.

public abstract void invalidateLayout(Container target) ★

The `invalidateLayout()` method of `BorderLayout` does nothing.

Miscellaneous methods

public String toString ()

The `toString()` method of `BorderLayout` returns a string showing the current horizontal and vertical gap settings. If both gaps are zero, the result will be:

```
java.awt.BorderLayout[hgap=0,vgap=0]
```

7.4 GridLayout

The `GridLayout` layout manager is ideal for laying out objects in rows and columns, where each cell in the layout has the same size. Components are added to the layout from left to right, top to bottom. `setLayout(new GridLayout(2,3))` changes the `LayoutManager` of the current container to a 2 row by 3 column `GridLayout`. Figure 7-6 shows an applet using this layout.

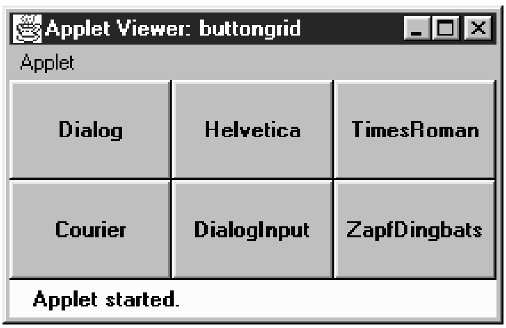


Figure 7–6: Applet using GridLayout

7.4.1 GridLayout Methods

Constructors

public GridLayout () ★

This constructor creates a `GridLayout` initially configured to have one row, an infinite number of columns, and no gaps. A gap is the space between adjacent components in the horizontal or vertical direction. With a gap of zero, components in adjacent cells will have no space between them.

public GridLayout (int rows, int columns)

This constructor creates a `GridLayout` initially configured to be `rows columns` in size. The default setting for horizontal and vertical gaps is zero pixels. The gap is the space between adjacent components in the horizontal and vertical directions. With a gap of zero, components in adjacent cells will have no space between them.

You can set the number of rows or columns to zero; this means that the layout will grow without bounds in that direction. If both `rows` and `columns` are zero, the run-time exception `IllegalArgumentException` will be thrown.

NOTE The rows and columns passed to the `GridLayout` constructor are only recommended values. It is possible that the system will pick other values if the number of objects you add to the layout is sufficiently different from the size you requested; for example, you placed nine objects in a six-element grid.

---

public GridLayout (int rows, int columns, int hgap, int vgap)

This version of the constructor is called by the previous one. It creates a `GridLayout` with an initial configuration of `rows columns`, with a horizontal gap of `hgap` and vertical gap of `vgap`. The gap is the space between the different components in the different directions, measured in pixels. It is possible to have negative gaps if you want components to overlap.

You can set the number of rows or columns to zero; this means that the layout will grow without bounds in that direction. If both `rows` and `columns` are zero, the run-time exception `IllegalArgumentException` will be thrown.

Informational methods

public int getColumns () ★

The `getColumns()` method retrieves the current column setting, which may differ from the number of columns displayed.

public void setColumns (int columns) ★

The `setColumns()` method changes the current column setting to `columns`. After changing the setting, you must `validate()` the `Container`. If you try to set the number of rows and the number of columns to zero, this method throws the run-time exception `IllegalArgumentException`.

public int getRows () ★

The `getRows()` method retrieves the current row setting; this may differ from the number of rows displayed.

public void setRows (int rows) ★

The `setRows()` method changes the current row setting to `rows`. After changing the setting, you must `validate()` the `Container`. If you try to set the number of rows and the number of columns to zero, this method throws the run-time exception `IllegalArgumentException`.

public int getHgap () ★

The `getHgap()` method retrieves the current horizontal gap setting.

public void setHgap (int hgap) ★

The `setHgap()` method changes the current horizontal gap setting to `hgap`. After changing the gaps, you must `validate()` the `Container`.

public int getVgap () ★

The `getVgap()` method retrieves the current vertical gap setting.

public void setVgap (int hgap) ★

The `setVgap()` method changes the current vertical gap setting to `vgap`. After changing the gaps, you must `validate()` the `Container`.

LayoutManager methods

public void addLayoutComponent (String name, Component component)

The `addLayoutComponent()` method of `GridLayout` does nothing.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `GridLayout` does nothing.

public Dimension preferredLayoutSize (Container target)

The `preferredLayoutSize()` method of `GridLayout` calculates the preferred dimensions for the components in `target`. The preferred size depends on the size of the grid, which may not be the size requested by the constructor; the `GridLayout` treats the constructor's arguments as recommendations and may ignore them if appropriate.

The actual number of rows and columns is based upon the number of components within the `Container`. The `GridLayout` tries to observe the number of rows requested first, calculating the number of columns. If the requested number of rows is nonzero, the number of columns is determined by (# components + rows – 1) / rows. If request is for zero rows, the number of rows to use is determined by a similar formula: (# components + columns – 1) / columns. Table 7-1 demonstrates this calculation. The last entry in this table is of special interest: if you request a 33 grid but only place four components in the layout, you get a 22 layout as a result. If you do not want to be surprised, size the `GridLayout` based on the number of objects you plan to put into the display.

Table 7–1: GridLayout Row/Column Calculation

Rows	Columns	# Components	Display Rows	Display Columns
0	1	10	10	1
0	2	10	5	2
1	0	10	1	10
2	0	10	2	5
2	3	10	2	5
2	3	20	2	10
3	2	10	3	4
3	3	3	3	1
3	3	4	2	2

Once we know the dimensions of the grid, it's easy to compute the preferred size for the layout. The `GridLayout` takes the maximum height and maximum width of the preferred sizes for all the components in the layout. (Note that the maximum width and maximum height aren't necessarily from the same component.) This becomes the preferred size of each cell within the layout. The preferred size of the layout as a whole is computed using the preferred size of a cell and adding gaps and insets as appropriate.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method of `GridLayout` calculates the minimum dimensions for the components in `target`. First it determines the actual number of rows and columns in the final layout, using the method described previously. The `minimumLayoutSize()` method then determines the widest and tallest `getMinimumSize()` of a component, and this becomes the minimum size of a cell within the layout. The minimum size of the layout as a whole is computed using the minimum size of a cell and adding gaps and insets as appropriate.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen in a series of rows and columns. Each component within a `GridLayout` will be the same size, if it is possible. If there is insufficient space for all the components, the size of each is reduced proportionally.

Miscellaneous methods

public String toString ()

The `toString()` method of `GridLayout` returns a string including the current horizontal and vertical gap settings, along with the rows and columns settings. For a `GridLayout` created with 2 rows and 3 columns, the result would be:

```
java.awt.GridLayout[hgap=0,vgap=0,rows=2,cols=3]
```

7.5 CardLayout

The `CardLayout` layout manager is significantly different from the other layouts. Whereas the other layout managers attempt to display all the components within the container at once, a `CardLayout` displays only one component at a time. (That component could be a `Component` or another `Container`.) The result is similar to Netscape Navigator's Property sheets or a tabbed Dialog, without the tabs. You can flip through the cards (components) in the layout in order or jump to a specific card if you know its name. The following call to `setLayout()` changes the `LayoutManager` of the current container to `CardLayout`:

```
lm = new CardLayout();
setLayout (lm);
```

Unlike most other layout managers, `CardLayout` has a number of instance methods that programs have to call. Therefore, you usually have to retain a reference to the layout manager. In addition, you usually have some other component to control the `CardLayout` (i.e., select which card to view). Most simply, you could put some buttons in a panel and stick this panel in the north region of a `BorderLayout`; then make another panel with a `CardLayout`, and place that in the center. A more complex task would be to build a set of tabs to control the `CardLayout`.

A `CardLayout` allows you to assign names to the components it manages. You can use the name to jump to an arbitrary component by calling the manager's `show()` method. In Java 1.0, naming was optional; you could call `add(Component)` to put a component in the layout with a null name. A null name meant only that you couldn't flip to the component at will; you could only display the component by calling `next()` or `previous()` (or `first()` or `last()`), which cycle through all the components in order. In Java 1.1, all components added to a `CardLayout` must be named.

7.5.1 CardLayout Methods

Constructors

public CardLayout ()

This constructor creates a `CardLayout` using a horizontal and vertical gap of zero pixels. With `CardLayout`, there is no space between components because only one component is visible at a time; think of the gaps as insets.

public CardLayout (int hgap, int vgap)

This version of the constructor allows you to create a `CardLayout` with a horizontal gap of `hgap` and vertical gap of `vgap` to add some space around the outside of the component that is displayed. The units for gaps are pixels. Using negative gaps chops off components at the edges of the container.

Informational methods

public int getHgap () ★

The `getHgap()` method retrieves the current horizontal gap setting.

public void setHgap (int hgap) ★

The `setHgap()` method changes the current horizontal gap setting to `hgap`. After changing the gaps, you must `validate()` the `Container`.

public int getVgap () ★

The `getVgap()` method retrieves the current vertical gap setting.

public void setVgap (int hgap) ★

The `setVgap()` method changes the current vertical gap setting to `vgap`. After changing the gaps, you must `validate()` the `Container`.

LayoutManager methods

public void addLayoutComponent (String name, Component component) ☆

This version of `addLayoutComponent()` has been deprecated and replaced by the `addLayoutComponent(Component, Object)` method of the `LayoutManager2` interface.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `CardLayout` removes `component` from the container. If `component` is not in the container already, nothing happens.

public Dimension preferredLayoutSize (Container target)

The `preferredLayoutSize()` method of `CardLayout` retrieves the preferred size for all the components within it. The `preferredLayoutSize()` method then determines the widest and tallest size of all components (not necessarily from the same one), adds the appropriate insets and gaps, and uses that as the preferred size for the layout.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method of `CardLayout` calculates the minimum size for all the components within it. The `minimumLayoutSize()` method then determines the widest and tallest minimum size of all components (not necessarily from the same one), adds the appropriate insets and gaps, and uses that as the minimum size for the layout.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s visible components one on top of another. Initially, all components are visible. Components do not become invisible until you select one for display, by calling the `first()`, `last()`, `next()`, `previous()`, or `show()` methods. Where possible, `CardLayout` reshapes all components to fit the target container.

LayoutManager2 methods

public void addLayoutComponent (Component component, Object name) ★

This `addLayoutComponent()` method of `CardLayout` puts `component` into an internal table with a key of `name`. The `name` comes from the version of `add()` that has a constraints object as a parameter. The name allows you to refer to the component when you call other card layout methods, like `show()`. If you call the version of `add()` that only takes a `Component` parameter, you cannot call the `show()` method to flip to the specific component.

If `name` is not a `String`, the run-time exception `IllegalArgumentException` is thrown.

public abstract Dimension maximumLayoutSize(Container target) ★

The `maximumLayoutSize()` method returns a `Dimension` object with a width and height of `Integer.MAX_VALUE`. In practice, this means that `CardLayout` doesn't support the concept of maximum size.

public abstract float getLayoutAlignmentX(Container target) ★

The `getLayoutAlignmentX()` method says that `CardLayout` containers should be centered horizontally within the area available.

public abstract float getLayoutAlignmentY(Container target) ★

The `getLayoutAlignmentY()` method says that `CardLayout` containers should be centered vertically within the area available.

public abstract void invalidateLayout(Container target) ★

The `invalidateLayout()` method of `CardLayout` does nothing.

CardLayout methods

This group of methods controls which component the `CardLayout` displays. The `show()` is only usable if you assigned components names when adding them to the container. The others can be used even if the components are unnamed; they cycle through the components in the order in which they were added. All of these methods require the parent `Container` (i.e., the container being managed by this layout manager) as an argument. If the layout manager of the `parent` parameter is anything other than the container using this instance of the `CardLayout`, the method throws the run-time exception `IllegalArgumentException`.

public void first (Container parent)

The `first()` method flips to the initial component in `parent`.

public void next (Container parent)

The `next()` method flips to the following component in `parent`, wrapping back to the beginning if the current component is the last.

public void previous (Container parent)

The `previous()` method flips to the prior component in `parent`, wrapping to the end if the current component is the first.

public void last (Container parent)

The `last()` method flips to the final component in `parent`.

public void show (Container parent, String name)

The `show()` method displays the component in parent that was assigned the given `name` when it was added to the container. If there is no component with `name` contained within `parent`, nothing happens.

Miscellaneous methods

public String toString ()

The `toString()` method of `CardLayout` returns the a string showing the current horizontal and vertical gap settings. The result for a typical `CardLayout` would be:

```
java.awt.CardLayout[hgap=0,vgap=0]
```

7.5.2 CardLayout Example

Figure 7-7 shows a simple `CardLayout`. This layout has three cards that cycle when you make a selection. The first card (A) contains some `Checkbox` items within a `Panel`, the second card (B) contains a single `Button`, and the third (C) contains a `List` and a `Choice` within another `Panel`.

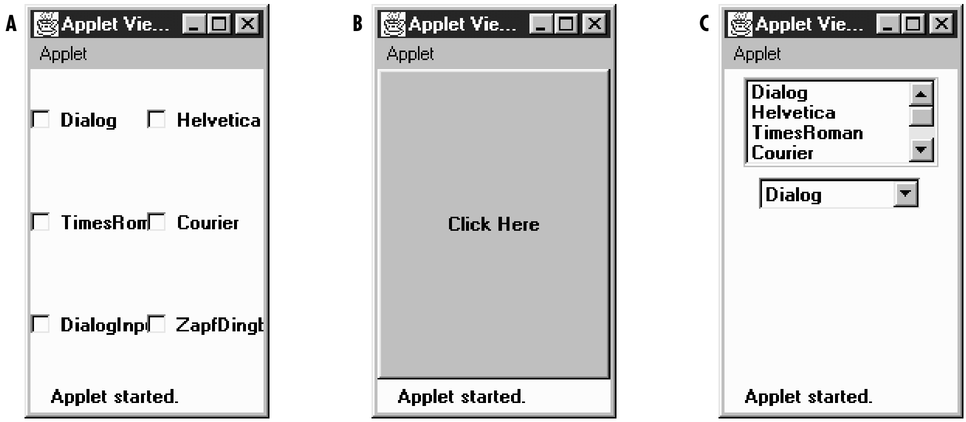


Figure 7–7: Different views of CardLayout

Example 7-1 is the code that generated Figure 7-7.

Example 7–1: The CardExample Class

```
import java.awt.*;
import java.applet.*;
public class CardExample extends Applet {
    CardLayout cl = new CardLayout();
    public void init () {
        String fonts[] = Toolkit.getDefaultToolkit().getFontList();
        setLayout (cl);
        Panel pA = new Panel();
        Panel pC = new Panel ();
        p1.setLayout (new GridLayout (3, 2));
        List l = new List(4, false);
        Choice c = new Choice ();
        for (int i=0;i<fonts.length;i++) {
            pA.add (new Checkbox (fonts[i]));
            l.addItem (fonts[i]);
            c.addItem (fonts[i]);
        }
        pC.add (l);
        pC.add (c);
        add ("One", pA);
        add ("Two", new Button ("Click Here"));
        add ("Three", pC);
    }
```

Example 7–1: The CardExample Class (continued)

```
        public boolean action (Event e, Object o) {
            cl.next(this);
            return true;
        }
    }
```

Each panel within the `CardLayout` has its own layout manager. `Panel` A uses a `GridLayout`; panel C uses its default layout manager, which is a `FlowLayout`. When the user takes any action (i.e., clicking on a checkbox or button, or selecting an item from the `List` or `Choice` components), the system generates a call to `action()`, which calls the `CardLayout`'s `next()` method, thus displaying the next card in the sequence.

7.6 GridBagLayout

The `GridBagLayout` is the most complex and flexible of the standard layout managers. Although it sounds like it should be a subclass of `GridLayout`, it's a different animal entirely. With `GridLayout`, elements are arranged in a rectangular grid, and each element in the container is sized identically (where possible). With `GridBagLayout`, elements can have different sizes and can occupy multiple rows or columns. The position and behavior of each element is specified by an instance of the `GridBagConstraints` class. By properly constraining the elements, you can specify the number of rows and columns an element occupies, which element grows when additional screen real estate is available, and various other restrictions. The actual grid size is based upon the number of components within the `GridBagLayout` and the `GridBagConstraints` of those objects. For example, Figure 7-8 shows a `GridBagLayout` with seven components, arranged on a 33 grid. The maximum capacity of a screen using `GridBagLayout` in Java 1.0 is 128 128 cells; in Java 1.1, the maximum size is 512 512 cells.

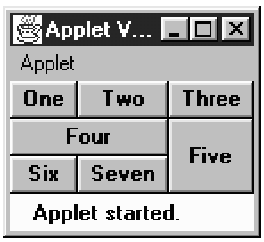


Figure 7–8: GridBagLayout with seven components on a 33 grid

With the other layout managers, adding a component to the container requires only a call to `add()`. In Java 1.0, the `GridBagLayout` also requires you to call `setConstraints()` to tell the layout manager how to position the component. With Java 1.1, you use the new `add()` method that permits you to pass the component and its constraints in a single method call (`add(Component, Object)`). If no components are added with constraints (thus all using the defaults), the `GridBagLayout` places the components in a single row at the center of the screen and sizes them to their `getPreferredSize()`. This is a nice way to place a single object in the center of the screen without stretching it to take up the available space, as `BorderLayout` does. Figure 7-9 compares the default `GridBagLayout` with a `BorderLayout` displaying the same object in the center region.

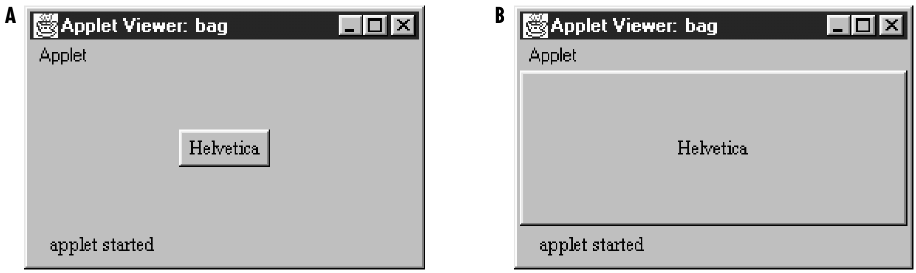


Figure 7–9: Centering a component: GridBagLayout vs. BorderLayout

When designing a container that will use `GridBagLayout`, it is easiest to plan what you want on graph paper, and then determine how the constraints should be set. The alternative, adding the components to the layout and then tweaking the constraints until you have something you like, could lead to premature baldness. Seriously, a trial-and-error approach to getting the constraints right will certainly be frustrating and will probably fail. Figure 7-10, using the same `GridBagLayout` used in Figure 7-8, indicates how the layout manager counts cells. The partial code used to create the screen follows in Example 7-2.

Example 7–2: Creating a GridBagLayout

```
public void init() {
    Button b;
    GridBagLayout gb = new GridBagLayout();
    GridBagConstraints gbc = new GridBagConstraints();
    setLayout(gb);
    try {
/* Row One - Three button */
        b = new Button ("One");
        addComponent (this, b, 0, 0, 1, 1,
                GridBagConstraints.NONE, GridBagConstraints.CENTER);
        b = new Button ("Two");
        addComponent (this, b, 1, 0, 1, 1,
                GridBagConstraints.NONE, GridBagConstraints.CENTER);
```

Example 7–2: Creating a GridBagLayout (continued)

```
            b = new Button ("Three");
            addComponent (this, b, 2, 0, 1, 1,
                    GridBagConstraints.NONE, GridBagConstraints.CENTER);
    /* Row Two - Two buttons */
            b = new Button ("Four");
            addComponent (this, b, 0, 1, 2, 1,
                    GridBagConstraints.NONE, GridBagConstraints.CENTER);
            b = new Button ("Five");
            addComponent (this, b, 2, 1, 1, 2,
                    GridBagConstraints.NONE, GridBagConstraints.CENTER);
    /* Row Three - Two buttons */
            b = new Button ("Six");
            addComponent (this, b, 0, 2, 1, 1,
                    GridBagConstraints.NONE, GridBagConstraints.CENTER);
            b = new Button ("Seven");
            addComponent (this, b, 1, 2, 1, 1,
                    GridBagConstraints.NONE, GridBagConstraints.CENTER);
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
```

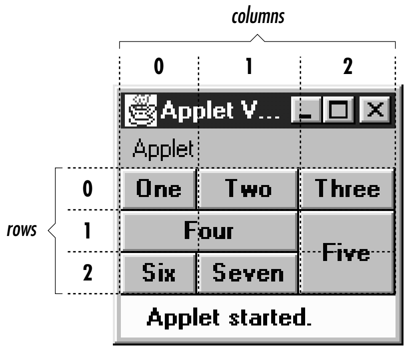


Figure 7–10: How GridBagLayout counts rows and columns

Most of the work in Example 7-2 is done by the helper method `addComponent()`, which creates a set of constraints, applies them to a component, and adds the component to a container. The code for `addComponent()` appears in Section 7.7; its signature is:

```
public static void addComponent (Container container, Component component,
        int gridx, int gridy, int gridwidth, int gridheight, int fill,
        int anchor) throws AWTException ;
```

The top left cell in the layout has location `(0,0)`. There's nothing very surprising about buttons one, two, three, six, and seven. They occupy a 11 area on the layout's 33 grid. Button four occupies a 21 area; it is placed at location (0,1), and thus occupies this cell plus the cell at (1,1). Likewise, button five occupies a 12 area, and takes up the cells at (2,1) and (2,2). The total size of the layout is determined entirely by the components that are placed in it and their constraints.

7.6.1 GridBagLayout Methods

Variables

There are a handful of instance variables for `GridBagLayout`. They are not initialized until the container whose layout is `GridBagLayout` has been validated.

public int columnWidths[]

The `columnWidths[]` array contains the widths of the components in the row with the most elements. The values of this array are returned by the `getLayoutDimensions()` method. You can access the array directly, but it is not recommended.

public int rowHeights[]

The `rowHeights[]` array contains the heights of the components in the column with the most elements. The values of this array are returned by the `getLayoutDimensions()` method. You can access the array directly, but it is not recommended.

public double columnWeights[]

The `columnWeights[]` array contains the `weightx` values of the components in the row with the most elements. The values of this array are returned by the `getLayoutWeights()` method. You can access the array directly, but it is not recommended.

public double rowWeights[]

The `rowWeights[]` array contains the `weighty` values of the components in the column with the most elements. The values of this array are returned by the `getLayoutWeights()` method. You can access the array directly, but it is not recommended.

Constructors

public GridBagLayout ()

The constructor for `GridBagLayout` creates an instance of `GridBagLayout` with default `GridBagConstraints` behavior. An internal table is used to keep track of the components added to the layout.

LayoutManager methods

public void addLayoutComponent (String name, Component component)

The `addLayoutComponent()` method of `GridBagLayout` does nothing. This method is not deprecated, unlike the similarly named methods in the other layout managers that implement `LayoutManager2`.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `GridBagLayout` does nothing.

public Dimension preferredLayoutSize (Container target)

The `preferredLayoutSize()` method calculates the preferred dimensions of the components of `target`. Sizing is based on the constraints of the various components. This task is definitely better off left to the computer.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method calculates the minimum dimensions required to position the components of `target`. Sizing is based on the constraints of the various components.

public void layoutContainer (Container target)

The `layoutContainer()` method positions the components within `target` based upon the constraints of each component. If a component's anchor constraints are invalid, `layoutContainer()` throws the run-time exception `IllegalArgumentException`. The process of arranging the components is very complicated and beyond the scope of this book.

LayoutManager2 methods

public void addLayoutComponent (Component component, Object constraints) ★

This `addLayoutComponent()` method of `GridBagLayout` associates the `component` with the given `constraints` object. It calls the `setConstaints()` method.

If `name` is not a `GridBagConstraints`, `addLayoutComponent()` throws the run-time exception `IllegalArgumentException`.

public abstract Dimension maximumLayoutSize(Container target) ★

The `maximumLayoutSize()` method returns a `Dimension` object with a width and height of `Integer.MAX_VALUE`. In practice, this means that `GridBagLayout` doesn't support the concept of maximum size.

public abstract float getLayoutAlignmentX(Container target) ★

The `getLayoutAlignmentX()` method says that `GridBagLayout` containers should be centered horizontally within the area available.

public abstract float getLayoutAlignmentY(Container target) ★

The `getLayoutAlignmentY()` method says that `GridBagLayout` containers should be centered vertically within the area available.

public abstract void invalidateLayout(Container target) ★

The `invalidateLayout()` method of `GridBagLayout` does nothing.

Constraints

public GridBagConstraints getConstraints (Component component)

The `getConstraints()` method returns a clone of the current constraints for `component`. This makes it easier to generate constraints for a component based on another component.

public void setConstraints (Component component, GridBagConstraints constraints)

The `setConstraints()` method changes the `constraints` on `component` to a clone of `constraints`. The system creates a `clone()` of `constraints` so you can change the original constraints without affecting `component`.

Layout

public Point getLayoutOrigin ()

The `getLayoutOrigin()` method returns the origin for the `GridBagLayout`. The origin is the top left point within the container at which the components are drawn. Before the container is validated, `getLayoutOrigin()` returns the `Point (0,0)`. After validation, `getLayoutOrigin()` returns the actual origin of the layout. The space used by the components within a `GridBagLayout` may not fill the entire container. You can use the results of `getLayoutOrigin()` and `getLayoutDimensions()` to find the layout's actual size and draw a `Rectangle` around the objects.

public int[][] getLayoutDimensions ()

The `getLayoutDimensions()` method returns two one-dimensional arrays as a single two-dimensional array. Index 0 is an array of widths (`columnWidths` instance variable), while index 1 is an array of heights (`rowHeights` instance variable). Until the layout is validated, these will be empty. After validation, the first array contains the widths of the components in the row with the most elements. The second contains the heights of the components in the column with the most elements. For Figure 7-10, the results would be (38, 51, 48) for widths since the first row has three elements and (21, 21, 21) for the heights since the first (and second) column has three elements in it.

public double[][] getLayoutWeights ()

The `getLayoutWeights()` method returns two one-dimensional arrays as a single two-dimensional array. Index 0 is an array of column weights (`columnWeights` instance variable), while index 1 is an array of row weights (`rowWeights` instance variable). Until the layout is validated, these will be empty. After validation, the first dimension contains all the `weightx` values of the components in the row with the most elements. The second dimension contains all the `weighty` values of the components in the column with the most elements. For Figure 7-10, the results would be (0, 0, 0) for `weightx` since the first row has three elements and (0, 0, 0) for `weighty` since the first column has three elements in it.

Miscellaneous methods

public Point location (int x, int y)

The `location()` method returns the `Point (0,0)` until the container is validated. After validation, this method returns the grid element under the location (`x`, `y`), where `x` and `y` are in pixels. The results could be used as the `gridx` and `gridy` constraints when adding another component.

public String toString ()

The `toString()` method of `GridBagLayout` returns the name of the class:

```
java.awt.GridBagLayout
```

7.7 GridBagConstraints

`GridBagConstraints` are the meat behind the `GridBagLayout`; they specify how to display components. Unlike other layout managers, which have a built-in idea about what to do with their display, the `GridBagLayout` is a blank slate. The constraints attached to each component tell the layout manager how to build its display.

Every `Component` added to a `GridBagLayout` has a `GridBagConstraints` object associated with it. When an object is first added to the layout, it is given a default set of constraints (described later in this section). Calling `setConstraints()` (or `add(Component, GridBagConstraints)`) applies a new set of constraints to the object. Most people create a helper method to make the `setConstraints()` calls, passing constraint information as parameters. The helper method used in Example 7-2 follows:

```
public static void addComponent (Container container, Component component,
    int gridx, int gridy, int gridwidth, int gridheight, int fill,
    int anchor) throws AWTException {
    LayoutManager lm = container.getLayout();
    if (!(lm instanceof GridBagLayout)) {
```

```
            throw new AWTException ("Invalid layout" + lm);
        } else {
            GridBagConstraints gbc = new GridBagConstraints ();
            gbc.gridx = gridx;
            gbc.gridy = gridy;
            gbc.gridwidth = gridwidth;
            gbc.gridheight = gridheight;
            gbc.fill = fill;
            gbc.anchor = anchor;
            ((GridBagLayout)lm).setConstraints(component, gbc);
            container.add (component);
        }
    }
```

In Java 1.1, you can make this method slightly cleaner by adding the component and applying the constraints in the same call to `add()`. To do so, replace the lines calling `setConstraints()` and `add()` with this line:

```
            // Java 1.1 only
            container.add(component, gbc);
```

7.7.1 GridBagConstraints Methods

Constants and variables

public int anchor

The `anchor` specifies the direction in which the component will drift in the event that it is smaller than the space available for it. `CENTER` is the default. Others available are `NORTH`, `SOUTH`, `EAST`, `WEST`, `NORTHEAST`, `NORTHWEST`, `SOUTHEAST`, and `SOUTHWEST`.

public final static int CENTER
public final static int EAST
public final static int NORTH
public final static int NORTHEAST
public final static int NORTHWEST
public final static int SOUTH
public final static int SOUTHEAST
public final static int SOUTHWEST
public final static int WEST

Constants used to set the `anchor`.

public int fill

The value of `fill` controls the component's resize policy. If `fill` is `NONE` (the default), the layout manager tries to give the component its preferred size. If `fill` is `VERTICAL`, it resizes in height if additional space is available. If fill is `HORIZONTAL`, it resizes in width. If fill is `BOTH`, the layout manager takes advantage of all the space available in either direction. Figure 7-11 demonstrates `VERTICAL` (A), `HORIZONTAL` (B), and `NONE` (C) values; Figure 7-8 demonstrated the use of `BOTH`.

public final static int NONE
public final static int BOTH
public final static int HORIZONTAL
public final static int VERTICAL

Constants used to set `fill`.

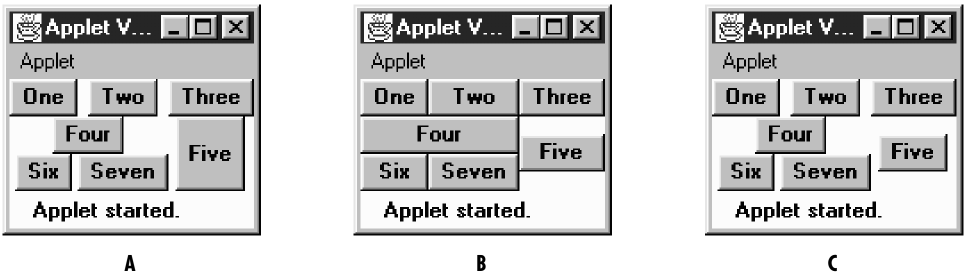


Figure 7–11: GridBagLayout with fill values of VERTICAL, HORIZONTAL, and NONE

public int gridx
public int gridy

The `gridx` and `gridy` variables specify the grid position where this component will be placed. `(0,0)` specifies the cell at the origin of the screen. Table 7-2 shows the `gridx` and `gridy` values for the screen in Figure 7-8.

It isn't necessary to set `gridx` and `gridy` to a specific location; if you set these fields to `RELATIVE` (the default), the system calculates the location for you. According to the comments in the source code, if `gridx` is `RELATIVE`, the component appears to the right of the last component added to the layout. If `gridy` is `RELATIVE`, the component appears below the last component added to the layout. However, this is misleadingly simple. `RELATIVE` placement works best if you are adding components along a row or a column. In this case, there are four possibilities to consider:

- `gridx` and `gridy` `RELATIVE`: components are placed in one row.
- `gridx` `RELATIVE`, `gridy` constant: components are placed in one row, each to the right of the previous component.
- `gridx` constant, `gridy` `RELATIVE`: components are placed in one column, each below the previous component.

- Varying `gridx` or `gridy` while setting the other field to `RELATIVE` appears to start a new row, placing the component as the first element in the row.

public int gridwidth
public int gridheight

`gridwidth` and `gridheight` set the number of rows (`gridwidth`) and columns (`gridheight`) a particular component occupies. If `gridwidth` or `gridheight` is set to `REMAINDER`, the component will be the last element of the row or column occupying any space that's remaining. Table 7-2 shows the `gridwidth` and `gridheight` values for the screen in Figure 7-8. For the components in the last column, the `gridwidth` values could be `REMAINDER`. Likewise, `gridheight` could be set to `REMAINDER` for the components in the last row.

`gridwidth` and `gridheight` may also have the value `RELATIVE`, which forces the component to be the next to last component in the row or column. Looking back to Figure 7-8: if button six has a `gridwidth` of `RELATIVE`, button seven won't appear because button five is the last item in the row, and six is already next to last. If button five has a `gridheight` of `RELATIVE`, the layout manager will reserve space below it, so the button can be the next to last item in the column.

public final static int RELATIVE

Constant used for `gridx` and `gridy` to request relative placement, and by `gridheight` and `gridwidth` to specify the next to last component in a column or row. The behavior of `RELATIVE` placement can be very counter intuitive; in most cases, you will be better off specifying `gridx`, `gridy`, `gridheight`, and `gridwidth` explicitly.

public final static int REMAINDER

Constant used for `gridwidth` and `gridheight`, to specify that a component should fill the rest of the row or column.

Table 7–2: Demonstrating gridx/gridy/gridwidth/gridheight

Component	**gridx**	**gridy**	**gridwidth**	**gridheight**
One	0	0	1	1
Two	1	0	1	1
Three	2	0	1	1
Four	0	1	2	1
Five	2	1	1	2
Six	0	2	1	1
Seven	1	2	1	3

public Insets insets

The `insets` field specifies the external padding in pixels around the component (i.e., between the component and the edge of the cell, or cells, allotted to it). An `Insets` object can specify different padding for the top, bottom, left, and right sides of the component.

public int ipadx
public int ipady

`ipadx` and `ipady` specify the internal padding within the component. `ipadx` specifies the extra space to the right and left of the component (so the minimum width increases by `2*ipadx` pixels). `ipady` specifies the extra space above and below the component (so the minimum height increases by `2*ipady` pixels).

The difference between insets (external padding) and the `ipadx`, `ipady` variables (internal padding) is confusing. The insets don't add space to the component itself; they are external to the component. `ipadx` and `ipady` change the component's minimum size, so they do add space to the component itself.

public double weightx
public double weighty

The `weightx` and `weighty` variables describe how to distribute any additional space within the container. They allow you to control how components grow (or shrink) when the user resizes the container. If `weightx` is 0, the component won't get any additional space available in its row. If one or more components in a row have `weightx` values greater than 0, any extra space is distributed proportionally between them. For example, if one component has a `weightx` value of 1 and the others are all 0, that one component will get all the additional space. If four components in a row each have `weightx` values of 1 and the other components have `weightx` values of 0, the four components each get one quarter of the additional space. `weighty` behaves similarly. Because `weightx` and `weighty` control the distribution of extra space in any row or column, setting either for one component may affect the position of other components.

Constructors

public GridBagConstraints ()

The constructor creates a `GridBagConstraints` object in which all the fields have their default values. These defaults are shown in the Table 7-3.

Table 7–3: GridBagConstraints Defaults.

Variable	Value	Description
`anchor`	`CENTER`	If the component is smaller than the space available, it will be centered within its region.
`fill`	`NONE`	The component should not resize itself if extra space is available within its region.
`gridx`	`RELATIVE`	The component associated with this constraint will be positioned relative to the last item added. If all components have `gridx` and `gridy` `RELATIVE`, they will be placed in a single row.
`gridy`	`RELATIVE`	The component associated with this constraint will be positioned relative to the last item added.
`gridwidth`	`1`	The component will occupy a single cell within the layout.
`gridheight`	`1`	The component will occupy a single cell within the layout.
`insets`	`0x0x0x0`	No extra space is added around the edges of the component.
`ipadx`	`0`	There is no internal padding for the component.
`ipady`	`0`	There is no internal padding for the component.
`weightx`	`0`	The component will not get any extra space, if it is available.
`weighty`	`0`	The component will not get any extra space, if it is available.

Miscellaneous methods

public Object clone ()

The `clone()` method creates a clone of the `GridBagConstraints` so the same `GridBagConstraints` object can be associated with multiple components.

7.8 Combining Layouts

If you can't create the display you want with any of the standard layout managers, or you are unable to figure out `GridBagLayout`, you may want to try combining several different layouts. This technique can often help you build the display you want. Figure 7-12 shows a display that uses three panels and three different layouts.

Here's the source code to generate the display in Figure 7-12:

```
import java.awt.*;
public class multi extends java.applet.Applet {
    public void init() {
        Panel s = new Panel();
        Panel e = new Panel();
        setLayout (new BorderLayout ());
        add ("North", new Label ("Enter text", Label.CENTER));
        add ("Center", new TextArea ());
        e.setLayout (new GridLayout (0,1));
        e.add (new Button ("Reformat"));
        e.add (new Button ("Spell Check"));
        e.add (new Button ("Options"));
        add ("East", e);
        s.setLayout (new FlowLayout ());
        s.add (new Button ("Save"));
        s.add (new Button ("Cancel"));
        s.add (new Button ("Help"));
        add ("South", s);
    }
}
```

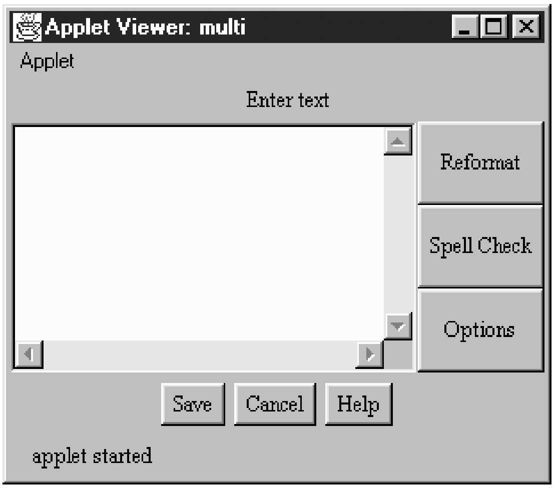


Figure 7–12: Multipanel screen using several layouts

The display in Figure 7-12 is created by adding four sections to a single `BorderLayout`. The north region contains a panel with a single `Label` in it. The panel uses its default `LayoutManager`, which is a `FlowLayout`. Why bother with this panel? Why not just add a label at the north position in the `BorderLayout`? Our strategy gives the label the position and size we want: the label is centered and displayed at its preferred size. If we had added the label directly to the `BorderLayout`, it would have been left justified and resized to fill the region.

The TextArea has no special requirements, so we added it directly to the center of the BorderLayout.

The three buttons on the right of the screen were arranged in a panel with a GridLayout; then this panel was placed in the east region of the BorderLayout.

To create the buttons at the bottom of the screen, we used another Panel with a FlowLayout. It centers the three buttons and displays them at their preferred size, with a gap between them.

With a little work, we could have created this display using a single Panel with a GridBagLayout. The result would have been more efficient; placing panels within panels has performance implications. Each container in the display has its own peer object, which uses up system resources. Furthermore, in the 1.0 version of AWT, nesting containers complicates event handling. However, using a GridBagLayout would have required much more work: figuring out the right GridBagConstraints for each component would be time consuming and result in code that is harder to understand. Sometimes, it's best to settle for the easy solution: a hybrid layout composed of several simple panels, rather than a single very complex panel.

In Java 1.1, you can make this program even more efficient in its resource usage by using a lightweight component instead of panels. This is particularly easy because the panels in the multipanel screen exist strictly to help with layout and not for partitioning event handling. Therefore, you can define a LightweightPanel that extends Container, with no methods. Use this class instead of Panel. The LightweightPanel allows you to lay out areas without creating unnecessary peers. Here's all the code for the LightweightPanel:

```
// Java 1.1 only
import java.awt.*;
public class LightweightPanel extends Container {
}
```

7.9 Disabling the LayoutManager

To create a container with no layout manager, use null as the argument to setLayout(). If you do this, you must size and position every component individually. In most cases, disabling the LayoutManager is a bad idea because what might look great on one platform could look really bad on another, due to differences in fonts, native components, and other display characteristics. Figure 7-13 displays a container with a disabled LayoutManager; both buttons were positioned by specifying their size and location explicitly.

Here's the code that produces Figure 7-13:

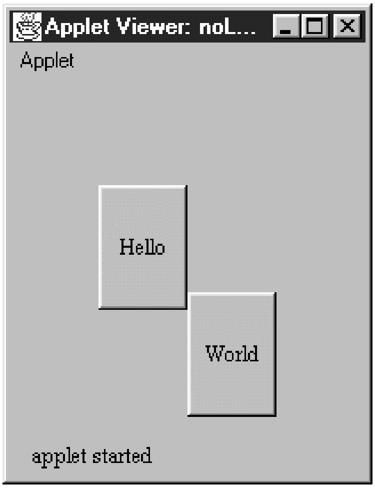


Figure 7–13: Applet with disabled layout manager

```
import java.awt.Button;
import java.applet.Applet;
public class noLayout extends Applet {
    public void init () {
        setLayout (null);
        Button x = new Button ("Hello");
        add (x);
        x.reshape (50, 60, 50, 70);
        Button y = new Button ("World");
        add (y);
        y.reshape (100, 120, 50, 70);
    }
}
```

7.10 Designing Your Own LayoutManager

What if you can't find a `LayoutManager` that fits your requirements, or you find yourself repeatedly building the same multipanel display? In cases like these, you can build your own layout manager. It's really not that difficult; you only need to implement the five methods of the `LayoutManager` interface, plus a constructor and any additional methods your design requires. In this section, we'll review the `LayoutManager` interface and then construct a custom `LayoutManager` called `CornerLayout`.

7.10.1 LayoutManager Methods

A custom LayoutManager must implement the following five methods (ten methods if you implement LayoutManager2). For many layout managers, several of these methods can be stubs that don't do anything.

public void addLayoutComponent (String name, Component component)

The addLayoutComponent() method is called by the add(name, component) method of Container. If your new LayoutManager does not have named component areas or does not pass generic positioning information via name, this method will be a stub with no code; you can let the container keep track of the components for you. Otherwise, this method must keep track of the component added, along with the information in name.

How would you implement this method? For layouts that have named component areas (like BorderLayout), you could use a private instance variable to hold the component for each area. For layouts like CardLayout, which lets you refer to individual components by name, you might want to store the components and their names in an internal Hashtable.

public void removeLayoutComponent (Component component)

This method is called by the remove() and removeAll() methods of Container. If you are storing information in internal instance variables or tables, you can remove the information about the given Component from the tables at this point. If you're not keeping track of the components yourself, this method can be a stub that does nothing.

public Dimension preferredLayoutSize (Container target)

This method is called by preferredSize() to calculate the desired size of target.* Obviously, the preferred size of the container depends on the layout strategy that you implement. To compute the preferred size, you usually need to call the preferredSize() method of every component in the container.

Computing the preferred size can be messy. However, some layout strategies let you take a shortcut. If your layout policy is "I'm going to cram all the components into the space given to me, whether they fit or not," you can compute the preferred size of your layout simply by calling target.size() or (in Java 1.1) target.getSize().

public Dimension minimumLayoutSize (Container target)

This method is called by minimumSize() to calculate the minimum size of target. The minimum size of the container depends on the layout strategy that you implement. To compute the minimum size, you usually need to call the

* This is still true in Java 1.1; the new method, getPreferredSize(), just calls the deprecated method, preferredSize().

`minimumSize()` method of every component in the container.

As with `preferredLayoutSize()`, you can sometimes save a lot of work by returning `target.size()`.

public void layoutContainer (Container target)

This method is called when target is first displayed and whenever it is resized. It is responsible for arranging the components within the container. Depending upon the type of `LayoutManager` you are creating, you will either loop through all the components in the container with the `getComponent()` method or use the named components that you saved in the `addLayoutComponent()` method. To position and size the components, call their `reshape()` or `setBounds()` methods.

7.10.2 A New LayoutManager: CornerLayout

`CornerLayout` is a simple but useful layout manager that is similar in many respects to `BorderLayout`. Like `BorderLayout`, it positions components in five named regions: "Northeast", "Northwest", "Southeast", "Southwest", and "Center". These regions correspond to the four corners of the container, plus the center. The "Center" region has three modes. `NORMAL`, the default mode, places the "Center" component in the center of the container, with its corners at the inner corner of the other four regions. `FULL_WIDTH` lets the center region occupy the full width of the container. `FULL_HEIGHT` lets the center region occupy the full height of the container. You cannot specify both `FULL_HEIGHT` and `FULL_WIDTH`; if you did, the "Center" component would overlap the corner components and take over the container. Figure 7-14 shows a `CornerLayout` in each of these modes.

Not all regions are required. If a complete side is missing, the required space for the container decreases. Ordinarily, the other components would grow to fill this vacated space. However, if the container is sized to its preferred size, so are the components. Figure 7-15 shows this behavior.

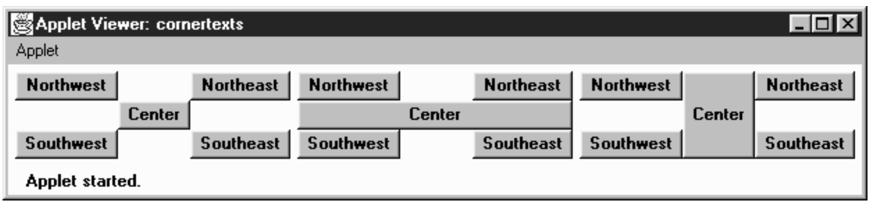


Figure 7–14: CornerLayout

Example 7-3 is the code for the `CornerLayout`. It shows the Java 1.0 version of the layout manager. At the end of this section, I show the simple change needed to adapt this manager to Java 1.1.

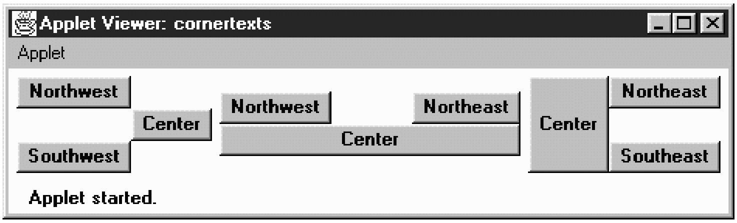


Figure 7–15: CornerLayout with missing regions

Example 7–3: The CornerLayout LayoutManager

```
import java.awt.*;
/**
 * An 'educational' layout. CornerLayout will layout a container
 * using members named "Northeast", "Northwest", "Southeast",
 * "Southwest", and "Center".
 *
 * The "Northeast", "Northwest", "Southeast" and "Southwest" components
 * get sized relative to the adjacent corner's components and
 * the constraints of the container's size. The "Center" component will
 * get any space left over.
 */

public class CornerLayout implements LayoutManager {
    int hgap;
    int vgap;
    int mode;
    public final static int NORMAL = 0;
    public final static int FULL_WIDTH = 1;
    public final static int FULL_HEIGHT = 2;
    Component northwest;
    Component southwest;
    Component northeast;
    Component southeast;
    Component center;
```

The `CornerLayout` class starts by defining instance variables to hold the gaps and mode and the components for each corner of the screen. It also defines three constants that control the behavior of the center region: `NORMAL`, `FULL_WIDTH`, and `FULL_HEIGHT`.

```
    /**
     * Constructs a new CornerLayout.
     */
    public CornerLayout() {
        this (0, 0, CornerLayout.NORMAL);
    }
    public CornerLayout(int mode) {
        this (0, 0, mode);
    }
    public CornerLayout(int hgap, int vgap) {
```

```
        this (hgap, vgap, CornerLayout.NORMAL);
    }
    public CornerLayout(int hgap, int vgap, int mode) {
        this.hgap = hgap;
        this.vgap = vgap;
        this.mode = mode;
    }
```

The constructors for `CornerLayout` are simple. The default (no arguments) constructor creates a `CornerLayout` with no gaps; the “Center” region is `NORMAL` mode. The last constructor, which is called by the other three, stores the gaps and the mode in instance variables.

```
    public void addLayoutComponent (String name, Component comp) {
        if ("Center".equals(name)) {
            center = comp;
        } else if ("Northwest".equals(name)) {
            northwest = comp;
        } else if ("Southeast".equals(name)) {
            southeast = comp;
        } else if ("Northeast".equals(name)) {
            northeast = comp;
        } else if ("Southwest".equals(name)) {
            southwest = comp;
        }
    }
```

`addLayoutComponent()` figures out which region a component has been assigned to, and saves the component in the corresponding instance variable. If the name of the component isn’t “Northeast”, “Northwest”, Southeast”, “Southwest”, or “Center”, the component is ignored.

```
    public void removeLayoutComponent (Component comp) {
        if (comp == center) {
            center = null;
        } else if (comp == northwest) {
            northwest = null;
        } else if (comp == southeast) {
            southeast = null;
        } else if (comp == northeast) {
            northeast = null;
        } else if (comp == southwest) {
            southwest = null;
        }
    }
```

`removeLayoutComponent()` searches for a given component in each region; if it finds the component, `removeLayoutComponent()` discards it by setting the instance variable to null.

```
public Dimension minimumLayoutSize (Container target) {
    Dimension dim = new Dimension(0, 0);
    Dimension northeastDim = new Dimension (0,0);
    Dimension northwestDim = new Dimension (0,0);
    Dimension southeastDim = new Dimension (0,0);
    Dimension southwestDim = new Dimension (0,0);
    Dimension centerDim    = new Dimension (0,0);
    if ((northeast != null) && northeast.isVisible ()) {
        northeastDim = northeast.minimumSize ();
    }
    if ((southwest != null) && southwest.isVisible ()) {
        southwestDim = southwest.minimumSize ();
    }
    if ((center != null) && center.isVisible ()) {
        centerDim = center.minimumSize ();
    }
    if ((northwest != null) && northwest.isVisible ()) {
        northwestDim = northwest.minimumSize ();
    }
    if ((southeast != null) && southeast.isVisible ()) {
        southeastDim = southeast.minimumSize ();
    }
    dim.width = Math.max (northwestDim.width, southwestDim.width) +
                hgap + centerDim.width + hgap +
                Math.max (northeastDim.width, southeastDim.width);
    dim.height = Math.max (northwestDim.height, northeastDim.height) +
                + vgap + centerDim.height + vgap +
                Math.max (southeastDim.height, southwestDim.height);
    Insets insets = target.insets();
    dim.width += insets.left + insets.right;
    dim.height += insets.top + insets.bottom;
    return dim;
}
```

`minimumLayoutSize()` computes the minimum size of the layout by finding the minimum sizes of all components. To compute the minimum width, `minimumLayoutSize()` adds the width of the center, plus the greater of the widths of the western regions (northwest and southwest), plus the greater of the widths of the eastern regions (northeast and southeast), then adds the appropriate gaps and insets. The minimum height is computed similarly; the method takes the greater of the minimum heights of the northern regions, the greater of the minimum heights of the southern regions, and adds them to the minimum height of the center region, together with the appropriate gaps and insets.

```
public Dimension preferredLayoutSize (Container target) {
    Dimension dim = new Dimension(0, 0);
    Dimension northeastDim = new Dimension (0,0);
    Dimension northwestDim = new Dimension (0,0);
    Dimension southeastDim = new Dimension (0,0);
    Dimension southwestDim = new Dimension (0,0);
    Dimension centerDim    = new Dimension (0,0);
    if ((northeast != null) && northeast.isVisible ()) {
```

```
            northeastDim = northeast.preferredSize ();
        }
        if ((southwest != null) && southwest.isVisible ()) {
            southwestDim = southwest.preferredSize ();
        }
        if ((center != null) && center.isVisible ()) {
            centerDim = center.preferredSize ();
        }
        if ((northwest != null) && northwest.isVisible ()) {
            northwestDim = northwest.preferredSize ();
        }
        if ((southeast != null) && southeast.isVisible ()) {
            southeastDim = southeast.preferredSize ();
        }
        dim.width = Math.max (northwestDim.width, southwestDim.width) +
                        hgap + centerDim.width + hgap +
                        Math.max (northeastDim.width, southeastDim.width);
        dim.height = Math.max (northwestDim.height, northeastDim.height) +
                        + vgap + centerDim.height + vgap +
                        Math.max (southeastDim.height, southwestDim.height);
        Insets insets = target.insets();
        dim.width += insets.left + insets.right;
        dim.height += insets.top + insets.bottom;
        return dim;
    }
```

`preferredLayoutSize()` computes the preferred size of the layout. The method is almost identical to `minimumLayoutSize()`, except that it uses the preferred dimensions of each component.

```
    public void layoutContainer (Container target) {
        Insets insets = target.insets();
        int top = insets.top;
        int bottom = target.size ().height - insets.bottom;
        int left = insets.left;
        int right = target.size ().width - insets.right;
        Dimension northeastDim = new Dimension (0,0);
        Dimension northwestDim = new Dimension (0,0);
        Dimension southeastDim = new Dimension (0,0);
        Dimension southwestDim = new Dimension (0,0);
        Dimension centerDim    = new Dimension (0,0);
        Point topLeftCorner, topRightCorner, bottomLeftCorner,
                        bottomRightCorner;
        if ((northeast != null) && northeast.isVisible ()) {
            northeastDim = northeast.preferredSize ();
        }
        if ((southwest != null) && southwest.isVisible ()) {
            southwestDim = southwest.preferredSize ();
        }
        if ((center != null) && center.isVisible ()) {
            centerDim = center.preferredSize ();
        }
        if ((northwest != null) && northwest.isVisible ()) {
            northwestDim = northwest.preferredSize ();
```

```
        }
        if ((southeast != null) && southeast.isVisible ()) {
            southeastDim = southeast.preferredSize ();
        }
        topLeftCorner = new Point (left +
                          Math.max (northwestDim.width, southwestDim.width),
                          top +
                          Math.max (northwestDim.height, northeastDim.height));
        topRightCorner = new Point (right -
                          Math.max (northeastDim.width, southeastDim.width),
                          top +
                          Math.max (northwestDim.height, northeastDim.height));
        bottomLeftCorner = new Point (left +
                          Math.max (northwestDim.width, southwestDim.width),
                          bottom -
                          Math.max (southwestDim.height, southeastDim.height));
        bottomRightCorner = new Point (right  -
                          Math.max (northeastDim.width, southeastDim.width),
                          bottom -
                          Math.max (southwestDim.height, southeastDim.height));
        if ((northwest != null) && northwest.isVisible ()) {
            northwest.reshape (left, top,
                                left + topLeftCorner.x,
                                top + topLeftCorner.y);
        }
        if ((southwest != null) && southwest.isVisible ()) {
            southwest.reshape (left, bottomLeftCorner.y,
                                bottomLeftCorner.x - left,
                                bottom - bottomLeftCorner.y);
       }
        if ((southeast != null) && southeast.isVisible ()) {
            southeast.reshape (bottomRightCorner.x,
                        bottomRightCorner.y,
                        right - bottomRightCorner.x,
                        bottom - bottomRightCorner.y);
        }
        if ((northeast != null) && northeast.isVisible ()) {
            northeast.reshape (topRightCorner.x, top,
                                right - topRightCorner.x,
                                topRightCorner.y);
        }
        if ((center != null) && center.isVisible ()) {
            int x = topLeftCorner.x + hgap;
            int y = topLeftCorner.y + vgap;
            int width = bottomRightCorner.x - topLeftCorner.x - hgap * 2;
            int height = bottomRightCorner.y - topLeftCorner.y - vgap * 2;
            if (mode == CornerLayout.FULL_WIDTH) {
                x = left;
                width = right - left;
            } else if (mode == CornerLayout.FULL_HEIGHT) {
                y = top;
                height = bottom - top;
            }
            center.reshape (x, y, width, height);
```

```
        }
    }
```

layoutContainer() does the real work: it positions and sizes the components in our layout. It starts by computing the region of the target container that we have to work with, which is essentially the size of the container minus the insets. The boundaries of the working area are stored in the variables top, bottom, left, and right. Next, we get the preferred sizes of all visible components and use them to compute the corners of the "Center" region; these are stored in the variables topLeftCorner, topRightCorner, bottomLeftCorner, and bottomRightCorner.

Once we've computed the location of the "Center" region, we can start placing the components in their respective corners. To do so, we simply check whether the component is visible; if it is, we call its reshape() method. After dealing with the corner components, we place the "Center" component, taking into account any gaps (hgap and vgap) and the layout's mode. If the mode is NORMAL, the center component occupies the region between the inner corners of the other components. If the mode is FULL_HEIGHT, it occupies the full height of the screen. If it is FULL_WIDTH, it occupies the full width of the screen.

```
    public String toString() {
        Sting str;
        switch (mode) {
            case FULL_HEIGHT: str = "tall"; break;
            case FULL_WIDTH: str = "wide"; break;
            default: str = "normal"; break;
        }
        return getClass().getName () + "[hgap=" + hgap + ",vgap=" + vgap +
            ",mode="+str+"]";
    }
}
```

toString() simply returns a string describing the layout.

Strictly speaking, there's no reason to update the CornerLayout for Java 1.1. Nothing about Java 1.1 says that new layout managers have to implement the LayoutManager2 interface. However, implementing LayoutManager2 isn't a bad idea, particularly since CornerLayout works with constraints; like BorderLayout, it has named regions. To extend CornerLayout so that it implements LayoutManager2, add the following code; we'll create a new CornerLayout2:

```
// Java 1.1 only
import java.awt.*;
public class CornerLayout2 extends CornerLayout implements LayoutManager2 {

    public void addLayoutComponent(Component comp, Object constraints) {
        if ((constraints == null) || (constraints instanceof String)) {
            addLayoutComponent((String)constraints, comp);
        } else {
```

```
            throw new IllegalArgumentException(
                "cannot add to layout: constraint must be a string (or null)");
        }
    }
    public Dimension maximumLayoutSize(Container target) {
        return new Dimension(Integer.MAX_VALUE, Integer.MAX_VALUE);
    }
    public float getLayoutAlignmentX(Container parent) {
        return Component.CENTER_ALIGNMENT;
    }
    public float getLayoutAlignmentY(Container parent) {
        return Component.CENTER_ALIGNMENT;
    }
    public void invalidateLayout(Container target) {
    }
}
```

7.11 The sun.awt Layout Collection

The `sun.awt` package defines four additional layouts. The first two, `HorizBagLayout` and `VerticalBagLayout`, are available only when used with Sun's JDK or Internet Explorer, since they are not provided with Netscape Navigator and may not be available from other vendors. Therefore, these layout managers should be used selectively within applets. The third layout manager, `VariableGridLayout`, is available with Netscape Navigator 2.0 or 3.0 and Internet Explorer. Usage of this layout manager is safer within applets but is still at your own risk. The final layout manager is introduced in Java 1.1, `OrientableFlowLayout`. Only time will tell where that one will be available. Any of these layout managers could be moved into a future version of `java.awt` if there is enough interest.

7.11.1 HorizBagLayout

In a `HorizBagLayout`, the components are all arranged in a single row, from left to right. The height of each component is the height of the container; the width of each component is its preferred width. Figure 7-16 shows `HorizBagLayout` in use.

Constructors

public HorizBagLayout ()

This constructor creates a `HorizBagLayout` with a horizontal gap of zero pixels. The gap is the space between the different components in the horizontal direction.

public HorizBagLayout (int hgap)

This constructor creates a `HorizBagLayout` using a horizontal gap of `hgap` pixels.

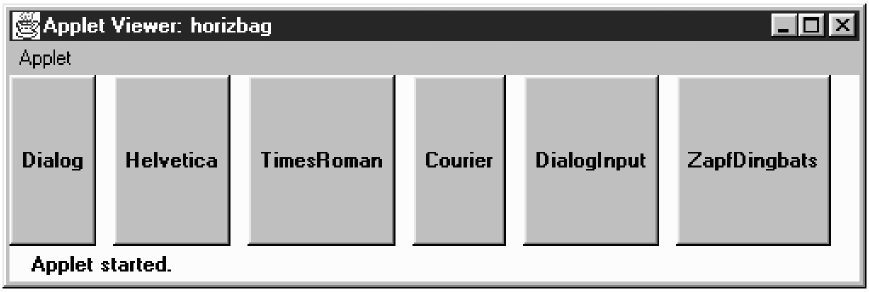


Figure 7–16: HorizBagLayout

LayoutManager methods

public void addLayoutComponent (String name, Component component)

The `addLayoutComponent()` method of `HorizBagLayout` does nothing.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `HorizBagLayout` does nothing.

public Dimension preferredLayoutSize (Container target)

The `preferredLayoutSize()` method of `HorizBagLayout` sums up the preferred widths of all the components in `target`, along with the `hgap` and right and left insets to get the width of the `target`. The height returned will be the preferred height of the tallest component.

public Dimension minimumLayoutSize (Container target)

The `minimumLayoutSize()` method of `HorizBagLayout` sums up the minimum widths of all the components in `target`, along with the `hgap` and right and left insets to get the width of the `target`. The height returned will be the minimum height of the tallest component.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen in one row. The height of each component is the height of the container. Each component's width is its preferred width, if enough space is available.

Miscellaneous methods

public String toString ()

The `toString()` method of `HorizBagLayout` returns a string with the current horizontal gap setting—for example:

```
sun.awt.HorizBagLayout[hgap=0]
```

7.11.2 VerticalBagLayout

The `VerticalBagLayout` places all the components in a single column. The width of each component is the width of the container; each component is given its preferred height. Figure 7-17 shows `VerticalBagLayout` in use.

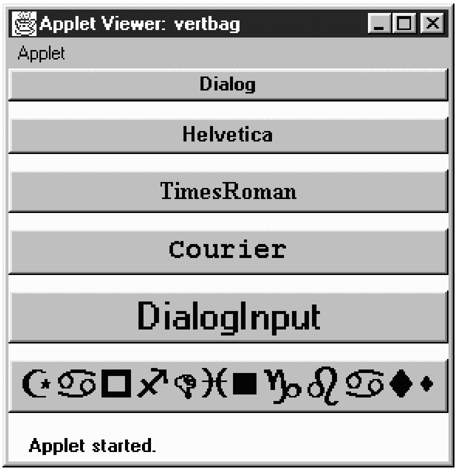


Figure 7–17: VerticalBagLayout

Constructors

public VerticalBagLayout ()

This constructor creates a `VerticalBagLayout` with a vertical gap of zero pixels. The gap is the space between components in the vertical direction. With a gap of 0, adjacent components will touch each other.

public VerticalBagLayout (int vgap)

This constructor creates a `VerticalBagLayout` with a vertical gap of `vgap` pixels.

LayoutManager methods

public void addLayoutComponent (String name, Component component)

The `addLayoutComponent()` method of `VerticalBagLayout` does nothing.

public void removeLayoutComponent (Component component)

The `removeLayoutComponent()` method of `VerticalBagLayout` does nothing.

public Dimension preferredLayoutSize (Container target)

To get the preferred height of the layout, the `preferredLayoutSize()` method sums up the preferred height of all the components in `target` along with the `vgap` and top and bottom insets. For the preferred width, `preferredLayoutSize()` returns the preferred width of the widest component.

public Dimension minimumLayoutSize (Container target)

To get the minimum height of the layout, the `minimumLayoutSize()` method sums up the minimum height of all the components in `target` along with the `vgap` and top and bottom insets. For the minimum width, `minimumLayoutSize()` returns the minimum width of the widest component.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen in one column. The width of each component is the width of the container. Each component's height is its `preferredSize()` height, if available.

Miscellaneous methods

public String toString ()

The `toString()` method of `VerticalBagLayout` returns a string with the current vertical gap setting. For example:

```
sun.awt.VerticalBagLayout[vgap=0]
```

7.11.3 VariableGridLayout

The `VariableGridLayout` builds upon the `GridLayout`. It arranges components on a grid of rows and columns. However, instead of giving all components the same size, the `VariableGridLayout` allows you to size rows and columns fractionally. Another difference between `VariableGridLayout` and `GridBagLayout` is that a `VariableGridLayout` has a fixed size. If you ask for a 3x3 grid, you will get exactly that. The layout manager throws the `ArrayIndexOutOfBoundsException` run-time exception if you try to add too many components.

Figure 7-18 shows a `VariableGridLayout` in which row one takes up 50 percent of the screen, and rows two and three take up 25 percent of the screen each. Column one takes up 50 percent of the screen; columns two and three take 25 percent each.

Here is the code that creates Figure 7-18:

```
import java.awt.*;
java.applet.Applet;
import sun.awt.VariableGridLayout;
public class vargrid extends Applet {
    public void init () {
        VariableGridLayout vgl;
```

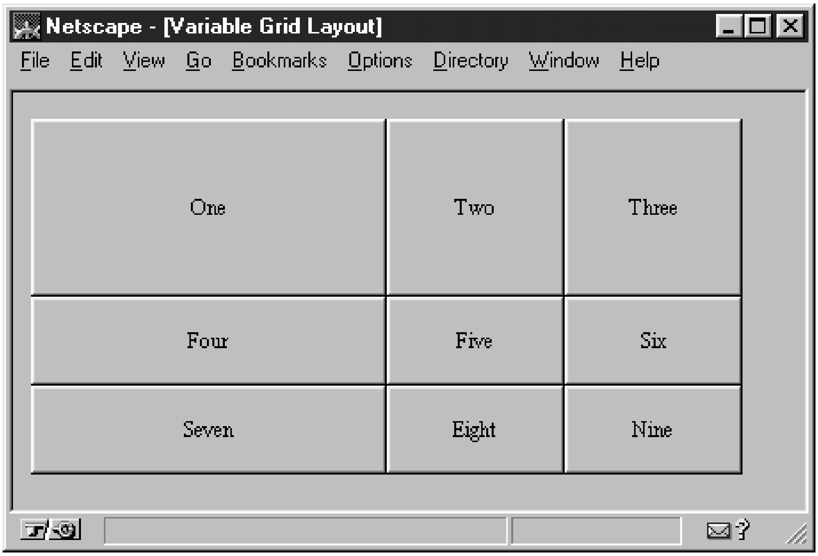


Figure 7–18: VariableGridLayout in Netscape Navigator

```
            setLayout (vgl = new VariableGridLayout (3,3));
            vgl.setRowFraction (0, 1.0/2.0);
            vgl.setRowFraction (1, 1.0/4.0);
            vgl.setRowFraction (2, 1.0/4.0);
            vgl.setColFraction (0, 1.0/2.0);
            vgl.setColFraction (1, 1.0/4.0);
            vgl.setColFraction (2, 1.0/4.0);
            add (new Button ("One"));
            add (new Button ("Two"));
            add (new Button ("Three"));
            add (new Button ("Four"));
            add (new Button ("Five"));
            add (new Button ("Six"));
            add (new Button ("Seven"));
            add (new Button ("Eight"));
            add (new Button ("Nine"));
        }
    }
```

Constructors

public VariableGridLayout (int rows, int columns)

This constructor creates a `VariableGridLayout` with the specified number of `rows` and `columns`. You cannot specify zero for one dimension. If either `rows` or `columns` is zero, the constructor throws the `NullPointerException` run-time exception. This constructor uses the default values for horizontal and vertical gaps (zero pixels), which means that components in adjacent cells will touch each other.

public VariableGridLayout (int rows, int columns, int hgap, int vgap)

This version of the constructor is called by the previous one. It creates a `VariableGridLayout` with the specified number of `rows` and `columns`, a horizontal gap of `hgap`, and a vertical gap of `vgap`. The gaps specify in pixels the space between adjacent components in the horizontal and vertical directions. It is possible to have negative gaps if you want components to overlap. You cannot specify zero for the number of rows or columns. If either `rows` or `columns` is zero, the constructor throws the run-time exception `NullPointerException`.

Support methods

The distinguishing feature of a `VariableGridLayout` is that you can tell a particular row or column to take up a certain fraction of the display. By default, the horizontal space available is split evenly among the grid's columns; vertical space is split evenly among the rows. This group of methods lets you find out how much space is allotted to each row or column and lets you change that allocation. The sum of the fractional amounts for each direction should add up to one. If greater than one, part of the display will be drawn offscreen. If less than one, additional screen real estate will be unused.

public void setRowFraction (int rowNumber, double fraction)

This method sets the percentage of space available for row `rowNumber` to `fraction`.

public void setColFraction (int colNumber, double fraction)

This method sets the percentage of space available for column `colNumber` to `fraction`.

public double getRowFraction (int rowNumber)

This method returns the current fractional setting for row `rowNumber`.

public double getColFraction (int colNumber)

This method returns the current fractional setting for column `colNumber`.

LayoutManager methods

The only method from `GridLayout` that is overridden is the `layoutContainer()` method.

public void layoutContainer (Container target)

The `layoutContainer()` method draws `target`'s components on the screen in a series of rows and columns. The size of each component within a `VariableGridLayout` is determined by the `RowFraction` and `ColFraction` settings for its row and column.

Miscellaneous methods

public String toString ()

The `toString()` method of `VariableGridLayout` returns a string with the current horizontal and vertical gap settings, the number of rows and columns, and the row and column fractional amounts. For example, the string produced by Figure 7-19 would be:

```
sun.awt.VariableGridLayout[hgap=0,vgap=0,rows=3,cols=3,
    rowFracs=[3]<0.50><0.25><0.25>,colFracs=[3]<0.50><0.25><0.25>]
```

7.11.4 OrientableFlowLayout

The `OrientableFlowLayout` is available for those who want something like a `FlowLayout` that lets you arrange components from top to bottom. Figure 7-19 shows `OrientableFlowLayout` in use.

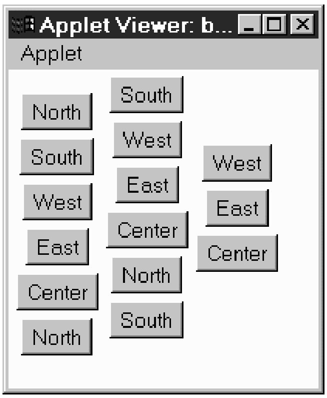


Figure 7–19: OrientableFlowLayout

Constants

Since `OrientableFlowLayout` subclasses `FlowLayout`, the `FlowLayout` constants of `LEFT`, `RIGHT`, and `CENTER` are still available.

public static final int HORIZONTAL ★

The `HORIZONTAL` constant tells the layout manager to arrange components from left to right, like the `FlowLayout` manager.

public static final int VERTICAL ★

The `VERTICAL` constant tells the layout manager to arrange components from top to bottom.

public static final int TOP ★

The `TOP` constant tells the layout manager to align the first component at the top of the screen (top justification).

public static final int BOTTOM ★

The `BOTTOM` constant tells the layout manager to align the first component at the bottom of the screen (bottom justification).

Constructors

public OrientableFlowLayout () ★

This constructor creates a `OrientableFlowLayout` that acts like the default `FlowLayout`. The objects flow from left to right and have an `hgap` and `vgap` of 5.

public OrientableFlowLayout (int direction) ★

This constructor creates a `OrientableFlowLayout` in the given `direction`. Valid values are `OrientableFlowLayout.HORIZONTAL` or `OrientableFlowLayout.VERTICAL`.

public OrientableFlowLayout (int direction, int horizAlignment, int vertAlignment) ★

This constructor creates a `OrientableFlowLayout` in the given direction. Valid values are `OrientableFlowLayout.HORIZONTAL` or `OrientableFlowLayout.VERTICAL`. `horizAlignment` provides the horizontal alignment setting. `vertAlignment` provides a vertical alignment setting; it may be `OrientableFlowLayout.TOP`, `FlowLayout.CENTER`, or `OrientableFlowLayout.BOTTOM`. If `direction` is `HORIZONTAL`, the vertical alignment is ignored. If `direction` is `VERTICAL`, the horizontal alignment is ignored.

public OrientableFlowLayout (int direction, int horizAlignment, int vertAlignment, int horizHgap, int horizVgap, int vertHgap, int vertVgap) ★

The final constructor adds separate horizontal and vertical gaps to the settings of `OrientableFlowLayout`. The `horizHgap` and `horizVgap` parameters are the gaps when horizontally aligned. The `vertHgap` and `vertVgap` parameters are the gaps when vertically aligned.

LayoutManager methods

public Dimension preferredLayoutSize (Container target) ★

The `preferredLayoutSize()` method of `OrientableFlowLayout` calculates the preferred dimensions for the `target` container. The `OrientableFlowLayout` computes the preferred size by placing all the components in one row or column, depending upon the current orientation, and adding their individual preferred sizes along with gaps and insets.

public Dimension minimumLayoutSize (Container target) ★

The `minimumLayoutSize()` method of `OrientableFlowLayout` calculates the minimum dimensions for the container by adding up the sizes of the components. The `OrientableFlowLayout` computes the minimum size by placing all the components in one row or column, depending upon the current orientation, and adding their individual minimum sizes along with gaps and insets.

public void layoutContainer (Container target) ★

The `layoutContainer()` method draws `target`'s `Components` on the screen, starting with the first row or column of the display, and going from left to right across the screen, or from top to bottom, based on the current orientation. When it reaches the margin of the container, it skips to the next row or column and continues drawing additional components.

Miscellaneous methods

public void orientHorizontally () ★

The `orientHorizontally()` method allows you to change the orientation of the `LayoutManager` to horizontal. The container must be validated before you see the effect of the change.

public void orientVertically () ★

The `orientVertically()` method allows you to change the orientation of the `LayoutManager` to vertical. The container must be validated before you see the effect of the change.

public String toString () ★

The `toString()` method of `OrientableFlowLayout` returns a string with the current orientation setting, along with the entire `FlowLayout.toString()` results. For example:

```
sun.awt.OrientableFlowLayout[orientation=vertical,
sun.awt.OrientableFlowLayout[hgap=5,vgap=5,align=center]]
```

7.12 Other Layouts Available on the Net

Many custom layout managers are available on the Internet. Many of these duplicate the layout behavior of other environments. For example, the `FractionalLayout` is based on Smalltalk's positioning mechanism; it is located at http://www.mcs.net/˜elunt/Java/FractionalLayoutDescription.html. The `RelativeLayout` allows you to position components relative to others, similar to an X Window form; you can find it at http://www-elec.enst.fr/java/RelativeLayout.java. If you like the way Tcl/Tk arranges widgets, try the `PackerLayout`; it is available at http://www.geom.umn.edu/~daeron/apps/ui/pack/gui.html. If none of these suit you, you can find a collection of links to custom layout managers at http://www.softbear.com/people/larry/javalm.htm. Gamelan (http://www.gamelan.com/) is always a good source for Java classes; try searching for `LayoutManager`.

8

In this chapter:

- *Text Component*
- *TextField*
- *TextArea*
- *Extending TextField*

Input Fields

There are two fundamental ways for users to provide input to a program: they can type on a keyboard, or they can select something (a button, a menu item, etc.) using a mouse. When you want a user to provide input to your program, you can display a list of choices to choose from or allow the user to interact with your program by typing with the keyboard. Presenting choices to the user is covered in Chapter 9, *Pick Me*. As far as keyboard input goes, the `java.awt` package provides two options. The `TextField` class is a single line input field, while the `TextArea` class is a multiline one. Both `TextField` and `TextArea` are subclasses of the class `TextComponent`, which contains all the common functionality of the two. `TextComponent` is a subclass of `Component`, which is a subclass of `Object`. So you inherit all of these methods when you work with either `TextField` or `TextArea`.

8.1 Text Component

By themselves, the `TextField` and `TextArea` classes are fairly robust. However, in order to reduce duplication between the classes, they both inherit a number of methods from the `TextComponent` class. The constructor for `TextComponent` is package private, so you cannot create an instance of it yourself. Some of the activities shared by `TextField` and `TextArea` through the `TextComponent` methods include setting the text, getting the text, selecting the text, and making it read-only.

8.1.1 TextComponent Methods

Contents

Both `TextField` and `TextArea` contain a set of characters whose content determines the current value of the `TextComponent`. The following methods are usually called in response to an external event.

public String getText ()

The `getText()` method returns the current contents of the `TextComponent` as a `String` object.

public void setText (String text)

The `setText()` method sets the content of the `TextComponent` to `text`. If the `TextComponent` is a `TextArea`, you can embed newline characters (`\n`) in the `text` so that it will appear on multiple lines.

Text selection

Users can select text in `TextComponents` by pressing a mouse button at a starting point and dragging the cursor across the text. The selected text is displayed in reverse video. Only one block of text can be selected at any given time within a single `TextComponent`. Once selected, this block could be used to provide the user with some text-related operation such as cut and paste (on a `PopupMenu`).

Depending on the platform, you might or might not be able to get selected text when a `TextComponent` does not have the input focus. In general, the component with selected text must have input focus in order for you to retrieve any information about the selection. However, in some environments, the text remains selected when the component no longer has the input focus.

public int getSelectionStart ()

The `getSelectionStart()` method returns the initial position of any selected text. The position can be considered the number of characters preceding the first selected character. If there is no selected text, `getSelectionStart()` returns the current cursor position. If the start of the selection is at beginning of the text, the return value is 0.

public int getSelectionEnd ()

The `getSelectionEnd()` method returns the ending cursor position of any selected text—that is, the number of characters preceding the end of the selection. If there is no selected text, `getSelectionEnd()` returns the current cursor position.

public String getSelectedText ()

The `getSelectedText()` method returns the currently selected text of the `TextComponent` as a `String`. If nothing is selected, `getSelectedText()` returns an empty `String`, not `null`.

public void setSelectionStart (int position) ★

The `setSelectionStart()` method changes the beginning of the current selection to `position`. If `position` is after `getSelectionEnd()`, the cursor position moves to `getSelectionEnd()`, and nothing is selected.

public void setSelectionEnd (int position) ★

The `setSelectionEnd()` method changes the end of the current selection to `position`. If `position` is before `getSelectionStart()`, the cursor position moves to `position`, and nothing is selected.

public void select (int selectionStart, int selectionEnd)

The `select()` method selects the text in the `TextComponent` from `selectionStart` to `selectionEnd`. If `selectionStart` is after `selectionEnd`, the cursor position moves to `selectionEnd`. Some platforms allow you to use `select()` to ensure that a particular position is visible on the screen.

public void selectAll ()

The `selectAll()` method selects all the text in the `TextComponent`. It basically does a `select()` call with a `selectionStart` position of 0 and a `selectionEnd` position of the length of the contents.

Carets

Introduced in Java 1.1 is the ability to set and get the current insertion position within the text object.

public int getCaretPosition () ★

The `getCaretPosition()` method returns the current text insertion position (often called the "cursor") of the `TextComponent`. You can use this position to paste text from the clipboard with the `java.awt.datatransfer` package described in Chapter 16, *Data Transfer*.

public void setCaretPosition (int position) ★

The `setCaretPosition()` method moves the current text insertion location of the `TextComponent` to `position`. If the `TextComponent` does not have a peer yet, `setCaretPosition()` throws the `IllegalComponentStateException` run-time exception. If `position` < 0, this method throws the run-time exception `IllegalArgumentException`. If `position` is too big, the text insertion point is positioned at the end.

Prior to Java version 1.1, the insertion location was usually set by calling `select(position, position)`.

Read-only text

By default, a `TextComponent` is editable. If a user types while the component has input focus, its contents will change. A `TextComponent` can also be used in an output-only (read-only) mode.

public void setEditable (boolean state)

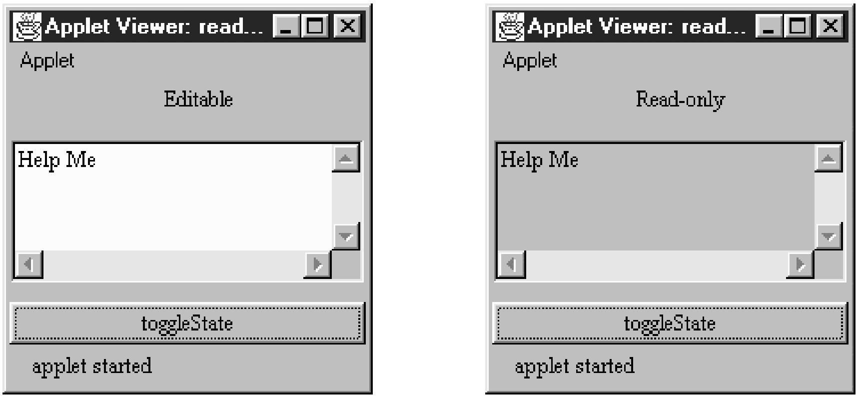
The `setEditable()` method allows you to change the current editable state of the `TextComponent` to `state`. `true` means the component is editable; `false` means read-only.

public boolean isEditable ()

The `isEditable()` method tells you if the `TextComponent` is editable (`true`) or read-only (`false`).

The following listing is an applet that toggles the editable status for a `TextArea` and sets a label to show the current status. As you can see in Figure 8-1, platforms can change the display characteristics of the `TextComponent` to reflect whether the component is editable. (Windows 95 darkens the background. Motif and Windows NT do nothing.)

```
import java.awt.*;
import java.applet.*;
public class readonly extends Applet {
    TextArea area;
    Label label;
    public void init () {
        setLayout (new BorderLayout (10, 10));
        add ("South", new Button ("toggleState"));
        add ("Center", area = new TextArea ("Help Me", 5, 10));
        add ("North", label = new Label ("Editable", Label.CENTER));
    }
    public boolean action (Event e, Object o) {
        if (e.target instanceof Button) {
            if ("toggleState".equals(o)) {
               area.setEditable (!area.isEditable ());
               label.setText ((area.isEditable () ? "Editable" : "Read-only"));
               return true;
            }
        }
        return false;
    }
}
```



Editable **Read only** *(darker)*

Figure 8–1: Editable and read-only TextAreas

Miscellaneous methods

public synchronized void removeNotify ()

The `removeNotify()` method destroys the peer of the `TextComponent` and removes it from the screen. Prior to the `TextComponent` peer's destruction, the current state is saved so that a subsequent call to `addNotify()` will put it back. (`TextArea` and `TextField` each have their own `addNotify()` methods.) These methods deal with the peer object, which hides the native platform's implementation of the component. If you override this method for a specific `TextComponent`, put in the customizations for your new class first, and call `super.removeNotify()` last.

protected String paramString ()

When you call the `toString()` method of a `TextField` or `TextArea`, the default `toString()` method of `Component` is called. This in turn calls `paramString()`, which builds up the string to display. The `TextComponent` level potentially adds four items. The first is the current contents of the `TextComponent` (`getText()`). If the text is editable, `paramString()` adds the word *editable* to the string. The last two items included are the current selection range (`getSelectionStart()` and `getSelectionEnd()`).

8.1.2 TextComponent Events

With the 1.1 event model, you can register listeners for text events. A text event occurs when the component's content changes, either because the user typed something or because the program called a method like `setText()`. Listeners are registered with the addTextListener() method. When the content changes, the TextListener.textValueChanges() method is called through the protected method processTextEvent(). There is no equivalent to TextEvent in Java 1.0; you would have to direct keyboard changes and all programmatic changes to a common method yourself.

In addition to TextEvent listeners, Key, mouse, and focus listeners are registered through the Component methods addKeyListener(), addMouseListener(), addMouseMotionListener(), and addFocusListener(), respectively.

Listeners and 1.1 event handling

public synchronized void addTextListener(TextListener listener) ★

The addTextListener() method registers listener as an object interested in receiving notifications when a TextEvent passes through the EventQueue with this TextComponent as its target. The listener.textValueChanged() method is called when these events occur. Multiple listeners can be registered.

The following applet, text13, demonstrates how to use a TextListener to handle the events that occur when a TextField is changed. Whenever the user types into the TextField, a TextEvent is delivered to the textValueChanged() method, which prints a message on the Java console. The applet includes a button that, when pressed, modifies the text field tf by calling setText(). These changes also generate a TextEvent.

```
// Java 1.1 only
import java.applet.*;
import java.awt.*;
import java.awt.event.*;
class TextFieldSetter implements ActionListener {
    TextField tf;
    TextFieldSetter (TextField tf) {
        this.tf = tf;
    }
    public void actionPerformed(ActionEvent e) {
        if (e.getActionCommand().equals ("Set")) {
            tf.setText ("Hello");
        }
    }
}
public class text13 extends Applet implements TextListener {
    TextField tf;
    int i=0;
    public void init () {
        Button b;
        tf = new TextField ("Help Text", 20);
        add (tf);
        tf.addTextListener (this);
        add (b = new Button ("Set"));
        b.addActionListener (new TextFieldSetter (tf));
```

```
    }
    public void textValueChanged(TextEvent e) {
        System.out.println (++i + ": " + e);
    }
}
```

public void removeTextListener(TextListener listener) ★

The `removeTextListener()` method removes `listener` as an interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvents` with this `TextComponent` as its target. `processEvent()` then passes the events along to any listeners for processing. When you subclass `TextComponent`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processTextEvent(TextEvent e) ★

The `processTextEvent()` method receives all `TextEvents` with this `TextComponent` as its target. `processTextEvent()` then passes them along to any listeners for processing. When you subclass `TextField` or `TextArea`, overriding the `processTextEvent()` method allows you to process all text events yourself, before sending them to any listeners. There is no equivalent to `processTextEvent()` within the 1.0 event model.

If you override `processTextEvent()`, remember to call the method `super.processTextEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

8.2 TextField

`TextField` is the `TextComponent` for single-line input. Some constructors permit you to set the width of the `TextField` on the screen, but the current `LayoutManager` may change it. The text in the `TextField` is left justified, and the justification is not customizable. To change the font and size of text within the `TextField`, call `setFont()` as shown in Chapter 3, *Fonts and Colors*.

The width of the field does not limit the number of characters that the user can type into the field. It merely suggests how wide the field should be. To limit the number of characters, it is necessary to override the `keyDown()` method for the `Component`. Section 8.4 contains an example showing how to do this.

8.2.1 TextField Methods

Constructors

public TextField ()

This constructor creates an empty `TextField`. The width of the `TextField` is zero columns, but it will be made wide enough to display just about one character, depending on the current font and size.

public TextField (int columns)

This constructor creates an empty `TextField`. The `TextField` width is `columns`. The `TextField` will try to be wide enough to display `columns` characters in the current font and size. As I mentioned previously, the layout manager may change the size.

public TextField (String text)

This constructor creates a `TextField` with `text` as its content. In Java 1.0 systems, the `TextField` is 0 columns wide (the `getColumns()` result), but the system will size it to fit the length of text. With Java 1.1, `getColumns()` actually returns `text.length`.

public TextField (String text, int columns)

This constructor creates a `TextField` with `text` as its content and a width of `columns`.

The following example uses all four constructors; the results are shown in Figure 8-2. With the third constructor, you see that the `TextField` is not quite wide enough for our text. The system uses an average width per character to try to determine how wide the field should be. If you want to be on the safe side, specify the field's length explicitly, and add a few extra characters to ensure that there is enough room on the screen for the entire text.

```
import java.awt.TextField;
public class texts extends java.applet.Applet {
   public void init () {
        add (new TextField ());                 // A
        add (new TextField (15));               // B
        add (new TextField ("Empty String"));     // C
        add (new TextField ("Empty String", 20)); // D
   }
}
```

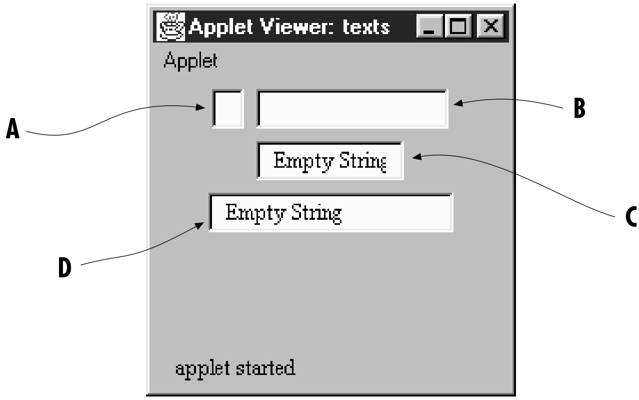


Figure 8–2: Using the TextField constructors

Sizing

public int getColumns ()

The `getColumns()` method returns the number of columns set with the constructor or a later call to `setColumns()`. This could be different from the displayed width of the `TextField`, depending upon the current `LayoutManager`.

public void setColumns (int columns) ★

The `setColumns()` method changes the preferred number of columns for the `TextField` to display to `columns`. Because the current `LayoutManager` will do what it wants, the new setting may be completely ignored. If `columns` < 0, `setColumns()` throws the run-time exception `IllegalArgumentException`.

public Dimension getPreferredSize (int columns) ★
public Dimension preferredSize (int columns) ☆

The `getPreferredSize()` method returns the `Dimension` (width and height) for the preferred size of a `TextField` with a width of `columns`. The `columns` specified may be different from the number of columns designated in the constructor.

`preferredSize()` is the Java 1.0 name for this method.

public Dimension getPreferredSize () ★
public Dimension preferredSize () ☆

The `getPreferredSize()` method returns the `Dimension` (width and height) for the preferred size of the `TextField`. Without the `columns` parameter, this `getPreferredSize()` uses the constructor's number of columns (or the value from a subsequent call to `setColumns()`) to calculate the `TextField`'s preferred size.

`preferredSize()` is the Java 1.0 name for this method.

public Dimension getMinimumSize (int columns) ★
public Dimension minimumSize (int columns) ☆

The `getMinimumSize()` method returns the minimum `Dimension` (width and height) for the size of a `TextField` with a width of `columns`. The `columns` specified may be different from the columns designated in the constructor.

`minimumSize()` is the Java 1.0 name for this method.

public Dimension getMinimumSize () ★
public Dimension minimumSize ()

The `getMinimumSize()` method returns the minimum `Dimension` (width and height) for the size of the `TextField`. Without the columns parameter, this `getMinimumSize()` uses the constructor's number of columns (or the value from a subsequent call to `setColumns()`) to calculate the `TextField`'s minimum size.

`minimumSize()` is the Java 1.0 name for this method.

Echoing character

It is possible to change the character echoed back to the user when he or she types. This is extremely useful for implementing password entry fields.

public char getEchoChar ()

The `getEchoChar()` method returns the currently echoed character. If the `TextField` is echoing normally, `getEchoChar()` returns zero.

public void setEchoChar (char c) ★
public void setEchoCharacter (char c) ☆

The `setEchoChar()` method changes the character that is displayed to the user to `c` for every character in the `TextField`. It is possible to change the echo character on the fly so that existing characters will be replaced. A `c` of zero, `(char)0`, effectively turns off any change and makes the `TextField` behave normally.

`setEchoCharacter()` is the Java 1.0 name for this method.

public boolean echoCharIsSet ()

The `echoCharIsSet()` method returns `true` if the echo character is set to a nonzero value. If the `TextField` is displaying input normally, this method returns `false`.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `TextField` peer. If you override this method, first call `super.addNotify()`, then add your customizations for the new class. Then you will be able to do everything you need with the information about the newly created peer.

protected String paramString ()

When you call the `toString()` method of `TextField`, the default `toString()` method of `Component` is called. This in turn calls `paramString()`, which builds up the string to display. The `TextField` level can add only one item. If the echo character is nonzero, the current echo character is added (the method `getEchoChar()`). Using `new TextField ("Empty String", 20)`, the results displayed could be:

```
java.awt.TextField[0,0,0x0,invalid,text="Empty String",editable,selection=0-0]
```

8.2.2 TextField Events

With the 1.0 event model, `TextField` components can generate `KEY_PRESS` and `KEY_ACTION` (which calls `keyDown()`), `KEY_RELEASE` and `KEY_ACTION_RELEASE` (which calls `keyUp()`), and `ACTION_EVENT` (which calls `action()`).

With the 1.1 event model, you register an `ActionListener` with the method `addActionListener()`. Then when the user presses Return within the `TextField` the `ActionListener.actionPerformed()` method is called through the protected `TextField.processActionEvent()` method. Key, mouse, and focus listeners are registered through the three `Component` methods of `addKeyListener()`, `addMouseListener()`, and `addFocusListener()`, respectively.

Action

public boolean action (Event e, Object o)

The `action()` method for a `TextField` is called when the input focus is in the `TextField` and the user presses the Return key. `e` is the `Event` instance for the specific event, while `o` is a `String` representing the current contents (the `getText()` method).

Keyboard

public boolean keyDown (Event e, int key)

The `keyDown()` method is called whenever the user presses a key. `keyDown()` may be called many times in succession if the key remains pressed. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyDown()` could be either `Event.KEY_PRESS` for a regular key or `Event.KEY_ACTION` for an action-oriented key (i.e., an arrow or function key). Some of the things you can do through this method are validate input, convert each character to uppercase, and limit the number or type of characters entered. The technique is simple: you just need to remember that the user's keystroke is actually displayed by the `TextField` peer, which receives the event after the `TextField` itself. Therefore, a `TextField` subclass can modify the character displayed by modifying the `key` field (`e.key`) of the `Event` and returning `false`, which passes the `Event` on down the chain; remember that returning `false` indicates that the `Event` has not been completely processed. The following method uses this technique to convert all input to uppercase.

```
public boolean keyDown (Event e, int key) {
    e.key = Character.toUppercase (char(key));
    return false;
}
```

If `keyDown()` returns `true`, it indicates that the `Event` has been completely processed. In this case, the `Event` never propagates to the peer, and the keystroke is never displayed.

public boolean keyUp (Event e, int key)

The `keyUp()` method is called whenever the user releases a key. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyUp()` could be either `Event.KEY_RELEASE` for a regular key or `Event.KEY_ACTION_RELEASE` for an action-oriented key (i.e., an arrow or function key). Among other things, `keyUp()` may be used to determine how long the key has been pressed.

Mouse

Ordinarily, the `TextField` component does not trigger any mouse events.

NOTE Mouse events are not generated for `TextField` with JDK 1.0.2. Your run-time environment may behave differently. See Appendix C for more information about platform dependencies.

Focus

The `TextField` component does not reliably generate focus events.

NOTE The `GOT_FOCUS` and `LOST_FOCUS` events can be generated by `TextFields`, but these events are not reliable across platforms. With Java 1.0, they are generated on most UNIX platforms but not on Windows NT/95 platforms. They are generated on all platforms under Java 1.1. See Appendix C for more information about platform dependencies.

---

public boolean gotFocus (Event e, Object o)

The `gotFocus()` method is triggered when the `TextField` gets the input focus. `e` is the `Event` instance for the specific event, while `o` is a `String` representation of the current contents (`getText()`).

public boolean lostFocus (Event e, Object o)

The `lostFocus()` method is triggered when the input focus leaves the `TextField`. `e` is the `Event` instance for the specific event, while `o` is a `String` representation of the current contents (`getText()`).

Listeners and 1.1 event handling

With the 1.1 event model, you register event listeners that are told when an event occurs. You can register text event listeners by calling the method `TextComponent.addTextListener()`.

public void addActionListener(ActionListener listener) ★

The `addActionListener()` method registers `listener` as an object interested in receiving notifications when an `ActionEvent` passes through the `EventQueue` with this `TextField` as its target. The `listener.actionPerformed()` method is called when these events occur. Multiple listeners can be registered. The following code demonstrates how to use an `ActionListener` to reverse the text in the `TextField`.

```
// Java 1.1 only
import java.applet.*;
import java.awt.*;
import java.awt.event.*;

class MyAL implements ActionListener {
    public void actionPerformed(ActionEvent e) {
        System.out.println ("The current text is: " +
            e.getActionCommand());
        if (e.getSource() instanceof TextField) {
            TextField tf = (TextField)e.getSource();
            StringBuffer sb = new StringBuffer (e.getActionCommand());
            tf.setText (sb.reverse().toString());
        }
    }
}
```

```
public class text11 extends Applet {
    public void init () {
        TextField tf = new TextField ("Help Text", 20);
        add (tf);
        tf.addActionListener (new MyAL());
    }
}
```

public void removeActionListener(ActionListener listener) ★

The `removeActionListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvents` with this `TextField` as its target. `processEvent()` then passes them along to any listeners for processing. When you subclass `TextField`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processActionEvent(ActionEvent e) ★

The `processActionEvent()` method receives all `ActionEvents` with this `TextField` as its target. `processActionEvent()` then passes them along to any listeners for processing. When you subclass `TextField`, overriding the method `processActionEvent()` allows you to process all action events yourself, before sending them to any listeners. In a way, overriding `processActionEvent()` is like overriding `action()` using the 1.0 event model.

If you override the `processActionEvent()` method, remember to call `super.processActionEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

The following applet is equivalent to the previous example, except that it overrides `processActionEvent()` to receive events, eliminating the need for an `ActionListener`. The constructor calls `enableEvents()` to make sure that events are delivered, even if no listeners are registered.

```
// Java 1.1 only
import java.applet.*;
import java.awt.*;
```

```
import java.awt.event.*;

class MyTextField extends TextField {
    public MyTextField (String s, int len) {
        super (s, len);
        enableEvents (AWTEvent.ACTION_EVENT_MASK);
    }
    protected void processActionEvent(ActionEvent e) {
        System.out.println ("The current text is: " +
            e.getActionCommand());
        TextField tf = (TextField)e.getSource();
        StringBuffer sb = new StringBuffer (e.getActionCommand());
        tf.setText (sb.reverse().toString());
        super.processActionEvent(e)
    }
}
public class text12 extends Applet {
   public void init () {
        TextField tf = new MyTextField ("Help Text", 20);
        add (tf);
   }
}
```

8.3 TextArea

TextArea is the TextComponent for multiline input. Some constructors permit you to set the rows and columns of the TextArea on the screen. However, the LayoutManager may change your settings. As with TextField, the only way to limit the number of characters that a user can enter is to override the keyDown() method. The text in a TextArea appears left justified, and the justification is not customizable.

In Java 1.1, you can control the appearance of a TextArea scrollbar; earlier versions gave you no control over the scrollbars. When visible, the vertical scrollbar is on the right of the TextArea, and the horizontal scrollbar is on the bottom. You can remove either scrollbar with the help of several new TextArea constants; you can't move them to another side. When the horizontal scrollbar is not present, the text wraps automatically when the user reaches the right side of the TextArea. Prior to Java 1.1, there was no way to enable word wrap.

8.3.1 TextArea Variables

Constants

The constants for TextArea are new to Java 1.1; they allow you to control the visibility and word wrap policy of a TextArea scrollbar. There is no way to listen for the events when a user scrolls a TextArea.

public static final int SCROLLBARS_BOTH ★

The `SCROLLBARS_BOTH` mode is the default for `TextArea`. It shows both scrollbars all the time and does no word wrap.

public static final int SCROLLBARS_HORIZONTAL_ONLY ★

The `SCROLLBARS_HORIZONTAL_ONLY` mode displays a scrollbar along the bottom of the `TextArea`. When this scrollbar is present, word wrap is disabled.

public static final int SCROLLBARS_NONE ★

The `SCROLLBARS_NONE` mode displays no scrollbars around the `TextArea` and enables word wrap. If the text is too long, the `TextArea` displays the lines surrounding the cursor. You can use the cursor to move up and down within the `TextArea`, but you cannot use a scrollbar to navigate. Because this mode has no horizontal scrollbar, word wrap is enabled.

public static final int SCROLLBARS_VERTICAL_ONLY ★

The `SCROLLBARS_VERTICAL_ONLY` mode displays a scrollbar along the right edge of the `TextArea`. If the text is too long to display, you can scroll within the area. Because this mode has no horizontal scrollbar, word wrap is enabled.

8.3.2 TextArea Methods

Constructors

public TextArea ()

This constructor creates an empty `TextArea` with both scrollbars. The `TextArea` is 0 rows high and 0 columns wide. Depending upon the platform, the `TextArea` could be really small (and useless) or rather large. It is a good idea to use one of the other constructors to control the size of the `TextArea`.

public TextArea (int rows, int columns)

This constructor creates an empty `TextArea` with both scrollbars. The `TextArea` is `rows` high and `columns` wide.

public TextArea (String text)

This constructor creates a `TextArea` with an initial content of `text` and both scrollbars. The `TextArea` is 0 rows high and 0 columns wide. Depending upon the platform, the `TextArea` could be really small (and useless) or rather large. It is a good idea to use one of the other constructors to control the size of the `TextArea`.

public TextArea (String text, int rows, int columns)

This constructor creates a `TextArea` with an initial content of `text`. The `TextArea` is `rows` high and `columns` wide and has both scrollbars.

The following example uses the first four constructors. The results are shown in Figure 8-3. With the size-less constructors, notice that Windows 95 creates a rather large TextArea. UNIX systems create a much smaller area. Depending upon the LayoutManager, the TextAreas could be resized automatically.

```
import java.awt.TextArea;
public class textas extends java.applet.Applet {
    public void init () {
        add (new TextArea ());                    // A
        add (new TextArea (3, 10));               // B
        add (new TextArea ("Empty Area"));        // C
        add (new TextArea ("Empty Area", 3, 10)); // D
    }
}
```

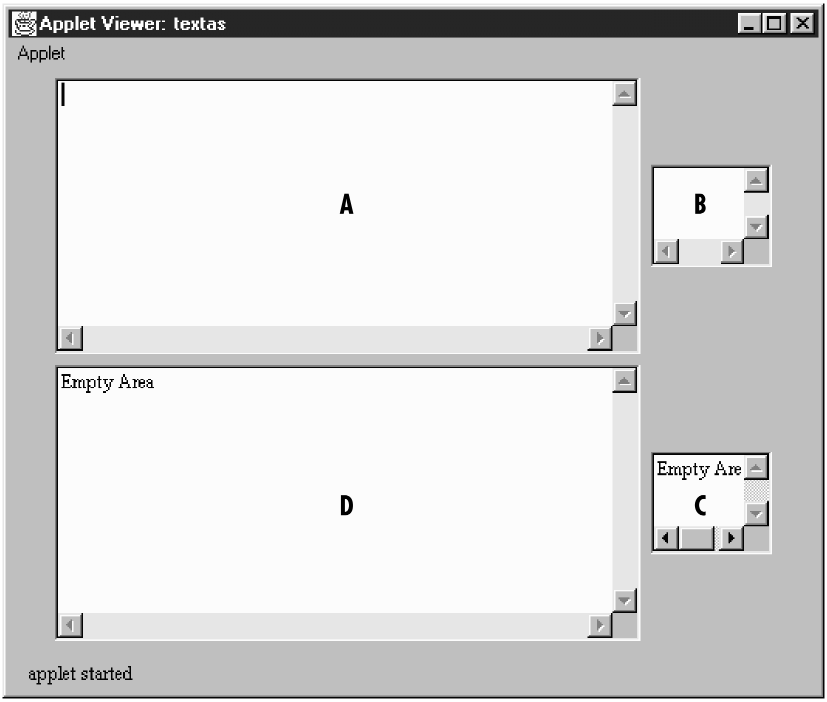


Figure 8–3: TextArea constructor

public TextArea (String text, int rows, int columns, int scrollbarPolicy) ★

The final constructor creates a TextArea with an initial content of text. The TextArea is rows high and columns wide. The initial scrollbar display policy is designated by the scrollbarPolicy parameter and is one of the TextArea constants in the previous example. This constructor is the only way provided to change the scrollbar visibility; there is no setScrollbarVisibility() method. Figure 8-4 displays the different settings.

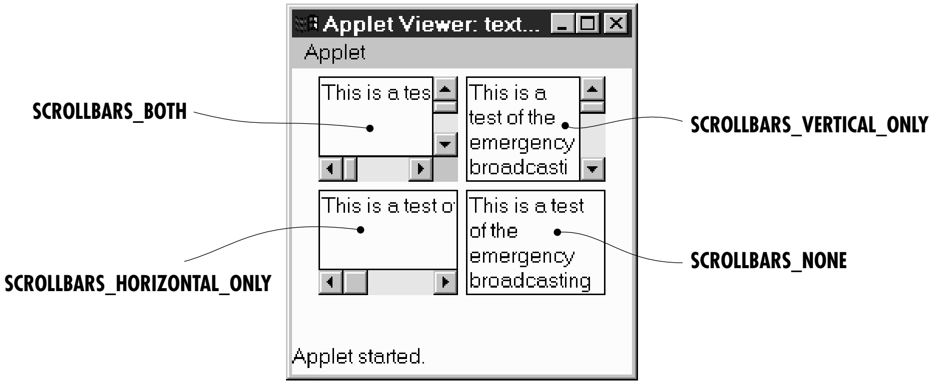


Figure 8–4: TextArea policies

Setting text

The text-setting methods are usually called in response to an external event. When you handle the insertion position, you must translate it from the visual row and column to a one-dimensional position. It is easier to position the insertion point based upon the beginning, end, or current selection (`getSelectionStart()` and `getSelectionEnd()`).

public void insert (String string, int position) ★
public void insertText (String string, int position) ☆

The `insert()` method inserts `string` at `position` into the `TextArea`. If `position` is beyond the end of the `TextArea`, `string` is appended to the end of the `TextArea`.

`insertText()` is the Java 1.0 name for this method.

public void append (String string) ★
public void appendText (String string) ☆

The `append()` method inserts `string` at the end of the `TextArea`.

`appendText()` is the Java 1.0 name for this method.

public void replaceRange (String string, int startPosition, int endPosition) ★
public void replaceText (String string, int startPosition, int endPosition) ☆

The `replaceRange()` method replaces the text in the current `TextArea` from `startPosition` to `endPosition` with `string`. If `endPosition` is before `startPosition`, it may or may not work as expected. (For instance, on a Windows 95 platform, it works fine when the `TextArea` is displayed on the screen. However, when the `TextArea` is not showing, unexpected results happen. Other platforms may vary.) If `startPosition` is 0 and `endPosition` is the length of the contents, this method functions the same as `TextComponent.setText()`.

replaceText() is the Java 1.0 name for this method.

Sizing

public int getRows ()

The getRows() method returns the number of rows set by the constructor or a subsequent call to setRows(). This could be different from the displayed height of the TextArea.

public void setRows (int rows) ★

The setRows() method changes the preferred number of rows to display for the TextField to rows. Because the current LayoutManager will do what it wants, the new setting may be ignored. If rows < 0, setRows() throws the run-time exception IllegalArgumentException.

public int getColumns ()

The getColumns() method returns the number of columns set by the constructor or a subsequent call to setColumns(). This could be different from the displayed width of the TextArea.

public void setColumns (int columns) ★

The setColumns() method changes the preferred number of columns to display for the TextArea to columns. Because the current LayoutManager will do what it wants, the new setting may be ignored. If columns < 0, setColumns() throws the run-time exception IllegalArgumentException.

public Dimension getPreferredSize (int rows, int columns) ★
public Dimension preferredSize (int rows, int columns) ☆

The getPreferredSize() method returns the Dimension (width and height) for the preferred size of the TextArea with a preferred height of rows and width of columns. The rows and columns specified may be different from the current settings.

preferredSize() is the Java 1.0 name for this method.

public Dimension getPreferredSize (int rows, int columns) ★
public Dimension preferredSize () ☆

The getPreferredSize() method returns the Dimension (width and height) for the preferred size of the TextArea. Without the rows and columns parameters, this getPreferredSize() uses the constructor's number of rows and columns to calculate the TextArea's preferred size.

preferredSize() is the Java 1.0 name for this method.

public Dimension getMinimumSize (int rows, int columns) ★
public Dimension minimumSize (int rows, int columns) ☆

The `getMinimumSize()` method returns the minimum `Dimension` (width and height) for the size of the `TextArea` with a height of `rows` and width of `columns`. The `rows` and `columns` specified may be different from the current settings.

`minimumSize()` is the Java 1.0 name for this method.

public Dimension getMinimumSize () ★
public Dimension minimumSize () ☆

The `getMinimumSize()` method returns the minimum `Dimension` (width and height) for the size of the `TextArea`. Without the rows and columns parameters, this `getMinimumSize()` uses the current settings for rows and columns to calculate the `TextArea`'s minimum size.

`minimumSize()` is the Java 1.0 name for this method.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `TextArea` peer. If you override this method, call `super.addNotify()` first, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

public int getScrollbarVisibility() ★

The `getScrollbarVisibility()` method retrieves the scrollbar visibility setting, which is set by the constructor. There is no `setScollbarVisibility()` method to change the setting. The return value is one of the `TextArea` constants: `SCROLLBARS_BOTH`, `SCROLLBARS_HORIZONTAL_ONLY`, `SCROLLBARS_NONE`, or `SCROLLBARS_VERTICAL_ONLY`.

protected String paramString ()

When you call the `toString()` method of `TextArea`, the default `toString()` method of `Component` is called. This in turn calls `paramString()`, which builds up the string to display. The `TextArea` level adds the number of rows and columns for the `TextArea`, and Java 1.1 adds the scrollbar visibility policy. Using `new TextArea("Empty Area", 3, 10)`, the results displayed could be:

```
java.awt.TextArea[text0,0,0,0x0,invalid,text="Empty Area",
editable,selection=0-0, rows=3,columns=10, scrollbarVisibility=both]
```

8.3.3 TextArea Events

With the 1.0 event model, the TextArea component can generate KEY_PRESS and KEY_ACTION (which calls keyDown()) along with KEY_RELEASE and KEY_ACTION_RELEASE (which called keyUp()). There is no ACTION_EVENT generated for TextArea.

NOTE The GOT_FOCUS and LOST_FOCUS events can be generated by this component but not reliably across platforms. Currently, they are generated on most UNIX platforms but not on Microsoft Windows NT/95 under Java 1.0. These events are generated under Java 1.1.

Similarly, the mouse events are not generated with JDK 1.0.2. See Appendix C for more information about platform dependencies.

With the Java 1.1 event model, there are no listeners specific to TextArea. You can register key, mouse, and focus listeners through the Component methods of addKeyListener(), addMouseListener(), and addFocusListener(), respectively. To register listeners for text events, call TextComponent.addTextListener().

Action

The TextArea component has no way to trigger the action event, since carriage return is a valid character. You would need to put something like a Button on the screen to cause an action for a TextArea. The following Rot13 program demonstrates this technique. The user enters text in the TextArea and selects the Rotate Me button to rotate the text. If the user selects Rotate Me again, it rotates again, back to the original position. Without the button, there would be no way to trigger the event. Figure 8-5 shows this example in action.

```
import java.awt.*;

public class Rot13 extends Frame {
    TextArea ta;
    Component rotate, done;
    public Rot13 () {
        super ("Rot-13 Example");
        add ("North", new Label ("Enter Text to Rotate:"));
        ta = (TextArea)(add ("Center", new TextArea (5, 40)));
        Panel p = new Panel ();
        rotate = p.add (new Button ("Rotate Me"));
        done = p.add (new Button ("Done"));
        add ("South", p);
    }
    public static void main (String args[]) {
        Rot13 rot = new Rot13();
        rot.pack();
```

```
        rot.show();
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            hide();
            dispose();
            System.exit (0);
            return true;
        }
        return super.handleEvent (e);
    }
    public boolean action (Event e, Object o) {
        if (e.target == rotate) {
            ta.setText (rot13Text (ta.getText()));
            return true;
        } else if (e.target == done) {
            hide();
            dispose();
            System.exit (0);
        }
        return false;
    }
    String rot13Text (String s) {
        int len = s.length();
        StringBuffer returnString = new StringBuffer (len);
        char c;
        for (int i=0;i<len;i++) {
            c = s.charAt (i);
            if (((c >= 'A') && (c <= 'M')) ||
                ((c >= 'a') && (c <= 'm')))
                c += 13;
            else if (((c >= 'N') && (c <= 'Z')) ||
                ((c >= 'n') && (c <= 'z')))
                c -= 13;
            returnString.append (c);
        }
        return returnString.toString();
    }
}
```

Keyboard

Ordinarily, the `TextArea` component generates all the key events.

public boolean keyDown (Event e, int key)

The `keyDown()` method is called whenever the user presses a key. `keyDown()` may be called many times in succession if the key remains pressed. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyDown()` could be either `Event.KEY_PRESS` for a regular key or `Event.KEY_ACTION` for an action-oriented key (i.e., an arrow or function key). Some of the things you can do through this method are validate input, convert each character to

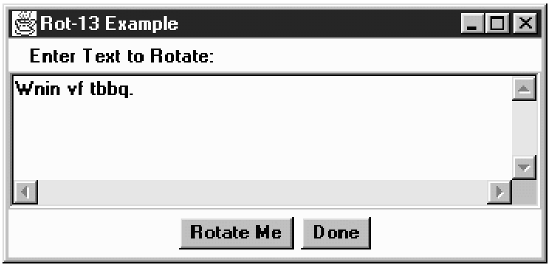


Figure 8–5: TextArea with activator button

uppercase, and limit the number or type of characters entered. The technique is simple: you just need to remember that the user's keystroke is actually displayed by the `TextArea` peer, which receives the event after the `TextArea` itself. Therefore, a `TextArea` subclass can modify the character displayed by modifying the `key` field (`e.key`) of the `Event` and returning `false`, which passes the `Event` on down the chain; remember that returning `false` indicates that the `Event` has not been completely processed. The following method uses this technique to convert all alphabetic characters to the opposite case:

```
public boolean keyDown (Event e, int key) {
    if (Character.isUpperCase ((char)key)) {
        e.key = Character.toLowerCase ((char)key);
    } else if (Character.isLowerCase ((char)key)) {
        e.key = Character.toUpperCase ((char)key);
    }
    return false;
}
```

If `keyDown()` returns `true`, it indicates that the `Event` has been completely processed. In this case, the `Event` never propagates to the peer, and the keystroke is never displayed.

public boolean keyUp (Event e, int key)

The `keyUp()` method is called whenever the user releases a key. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyUp()` could be either `Event.KEY_RELEASE` for a regular key, or `Event.KEY_ACTION_RELEASE` for an action-oriented key (i.e., an arrow or function key).

Mouse

Ordinarily, the `TextArea` component does not trigger any mouse events.

NOTE Mouse events are not generated for `TextArea` with JDK 1.0.2. See Appendix C for more information about platform dependencies.

Focus

The `TextArea` component does not reliably generate focus events.

NOTE The `GOT_FOCUS` and `LOST_FOCUS` events can be generated by this component but not reliably across platforms. With the JDK, they are generated on most UNIX platforms but not on Microsoft Windows NT/95 under JDK 1.0. These events are generated with JDK 1.1. See Appendix C for more information about platform dependencies.

---

public boolean gotFocus (Event e, Object o)

The `gotFocus()` method is triggered when the `TextArea` gets the input focus. `e` is the `Event` instance for the specific event, while `o` is a `String` representation of the current contents (`getText()`).

public boolean lostFocus (Event e, Object o)

The `lostFocus()` method is triggered when the input focus leaves the `TextArea`. `e` is the `Event` instance for the specific event, while `o` is a `String` representation of the current contents (`getText()`).

Listeners and 1.1 event handling

There are no listeners specific to the `TextArea` class. You can register Key, mouse, and focus listeners through the `Component` methods of `addKeyListener()`, `addMouseListener()`, and `addFocusListener()`, respectively. Also, you register listeners for text events by calling `TextComponent.addTextListener()`.

8.4 Extending TextField

To extend what you learned so far, Example 8-1 creates a sub-class of `TextField` that limits the number of characters a user can type into it. Other than the six constructors, all the work is in the `keyDown()` method. The entire class follows.

Example 8–1: The SizedTextField Class Limits the Number of Characters a User can Type

```
import java.awt.*;
public class SizedTextField extends TextField {
    private int size;  // size = 0 is unlimited
    public SizedTextField () {
        super ("");
        this.size = 0;
    }
    public SizedTextField (int columns) {
        super (columns);
        this.size = 0;
    }
    public SizedTextField (int columns, int size) {
        super (columns);
        this.size = Math.max (0, size);
    }
    public SizedTextField (String text) {
        super (text);
        this.size = 0;
    }
    public SizedTextField (String text, int columns) {
        super (text, columns);
        this.size = 0;
    }
    public SizedTextField (String text, int columns, int size) {
        super (text, columns);
        this.size = Math.max (0, size);
    }
    public boolean keyDown (Event e, int key) {
        if ((e.id == Event.KEY_PRESS) && (this.size > 0) &&
            (((TextField)(e.target)).getText ().length () >= this.size)) {
            // Check for backspace / delete / tab—let these pass through
            if ((key == 127) || (key == 8) || (key == 9)) {
                return false;
            }
            return true;
        }
        return false;
    }
    protected String paramString () {
        String str = super.paramString ();
        if (size != 0) {
            str += ",size=" + size;
        }
        return str;
    }
}
```

Most of the `SizedTextField` class consists of constructors; you really don't need to provide an equivalent to all the superclass's constructors, but it's not a bad idea.

The `keyDown()` method looks at what the user types before it reaches the screen and acts accordingly. It checks the length of the `TextField` and compares it to the maximum length. It then does another check to see if the user typed a Backspace, Delete, or Tab, all of which we want to allow: if the field has gotten too long, we want to allow the user to shorten it. We also want to allow tab under all circumstances, so that focus traversal works properly. The rest of the logic is simple:

- If the user typed Backspace, Delete, or Tab, return `false` to propagate the event.
- If the field is too long, return `true` to prevent the event from reaching the peer. This effectively ignores the character.

9

In this chapter:
- *Choice*
- *Lists*
- *Checkbox*
- *CheckboxGroup*
- *ItemSelectable*

Pick Me

Three AWT components let you present a list of choices to users: `Choice`, `List`, and `Checkbox`. All three components implement the `ItemSelectable` interface (Java1.1). These components are comparable to selection mechanisms in modern GUIs so most readers will be able to learn them easily, but I'll point out some special enhancements that they provide.

`Choice` and `List` are similar; both offer a list of choices for the user to select. `Choice` provides a pull-down list that offers one selection at a time, whereas `List` is a scrollable list that allows a user to make one or multiple selections. From a design standpoint, which you choose depends at least partially on screen real estate; if you want the user to select from a large group of alternatives, `Choice` requires the least space, `List` requires somewhat more, while `Checkbox` requires the most. `Choice` is the only component in this group that does not allow multiple selections. A `List` allows multiple or single selection; because each `Checkbox` is a separate component, checkboxes inherently allow multiple selection. In order to create a list of mutually exclusive checkboxes, in which only one box can be selected at a time (commonly known as radio buttons), you can put several checkboxes together into a `CheckboxGroup`, which is discussed at the end of this chapter.

9.1 Choice

The `Choice` component provides pop-up/pull-down lists. It is the equivalent of Motif's OptionMenu or Windows MFC's ComboBox. (Java 1.1 departs from the MFC world.) With the `Choice` component, you can provide a short list of choices to the user, while taking up the space of a single item on the screen. When the component is selected, the complete list of available choices appears on the screen. After the user has selected an option, the list is removed from the screen and the selected item is displayed. Selecting any item automatically deselects the previous selection.

9.1.1 Component Methods

Constructors

public Choice ()

There is only one constructor for `Choice`. When you call it, a new instance of `Choice` is created. The component is initially empty, with no items to select. Once you add some items using `addItem()` (version 1.0) or `add()` (version 1.1) and display the `Choice` on the screen, it will look something like the leftmost component in Figure 9-1. The center component shows what a `Choice` looks like when it is selected, while the one on the right shows what a `Choice` looks like before any items have been added to it.

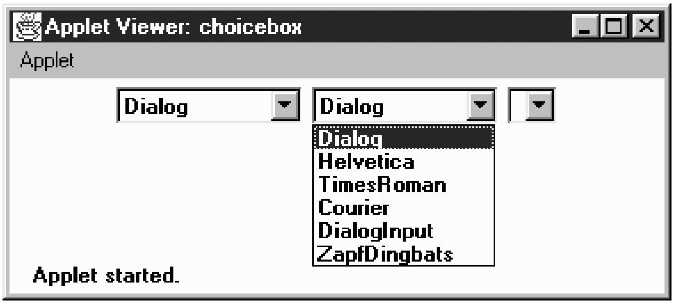


Figure 9–1: How Choices are displayed

Items

public int getItemCount () ★
public int countItems () ☆

The `getItemCount()` method returns the number of selectable items in the `Choice` object. In Figure 9-1, `getItemCount()` would return 6.

`countItems()` is the Java 1.0 name for this method.

public String getItem (int index)

The `getItem()` method returns the text for the item at position `index` in the `Choice`. If `index` is invalid—either `index < 0` or `index >= getItemCount()`—the `getItem()` method throws the `ArrayIndexOutOfBoundsException` run-time exception.

public synchronized void add (String item) ★
public synchronized void addItem (String item) ☆

`add()` adds `item` to the list of available choices. If `item` is already an option in the `Choice`, this method adds it again. If `item` is `null`, `add()` throws the run-time exception `NullPointerException`. The first `item` added to a `Choice` becomes the initial (default) selection.

`addItem()` is the Java 1.0 name for this method.

public synchronized void insert (String item, int index) ★

`insert()` adds `item` to the list of available choices at position `index`. An index of 0 adds the item at the beginning. An index larger than the number of choices adds the item at the end. If `item` is `null`, `insert()` throws the run-time exception `NullPointerException`. If `index` is negative, `insert()` throws the run-time exception `IllegalArgumentException`.

public synchronized void remove (String item) ★

`remove()` removes `item` from the list of available choices. If `item` is present in `Choice` multiple times, a call to `remove()` removes the first instance. If `item` is `null`, `remove()` throws the run-time exception `NullPointerException`. If `item` is not found in the `Choice`, `remove()` throws the `IllegalArgumentException` run-time exception.

public synchronized void remove (int position) ★

`remove()` removes the item at `position` from the list of available choices. If `position` is invalid—either `position < 0` or `position >= getItemCount()`—`remove()` throws the run-time exception `ArrayIndexOutOfBoundsException`.

public synchronized void removeAll () ★

The `removeAll()` method removes every option from the `Choice`. This allows you to refresh the list from scratch, rather than creating a new `Choice` and repopulating it.

Selection

The `Choice` has one item selected at a time. Initially, it is the first item that was added to the `Choice`.

public String getSelectedItem ()

The `getSelectedItem()` method returns the currently selected item as a `String`. The text returned is the parameter used in the `addItem()` or `add()` call that put the option in the `Choice`. If `Choice` is empty, `getSelectedItem()` returns `null`.

public Object[] getSelectedObjects () ★

The `getSelectedObjects()` method returns the currently selected item as an `Object` array, instead of a `String`. The array will either be a one-element array, or `null` if there are no items. This method is required by the `ItemSelectable` interface and allows you to use the same method to look at the items selected by a `Choice`, `List`, or `Checkbox`.

public int getSelectedIndex ()

The `getSelectedIndex()` method returns the position of the currently selected item. The `Choice` list uses zero-based indexing, so the position of the first item is zero. The position of the last item is the value of `countItems()-1`. If the list is empty, this method returns -1.

public synchronized void select (int position)

This version of the `select()` method makes the item at `position` the selected item in the `Choice`. If `position` is too big, `select()` throws the run-time exception `IllegalArgumentException`. If `position` is negative, nothing happens.

public void select (String string)

This version of `select()` makes the item with the label `string` the selected item. If `string` is in the `Choice` multiple times, this method selects the first. If `string` is not in the `Choice`, nothing happens.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Choice`'s peer. If you override this method, call `super.addNotify()` first, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

protected String paramString ()

When you call the `toString()` method of a `Choice`, the default `toString()` method of `Component` gets called. This in turn calls `paramString()` which builds up the string to display. At the `Choice` level, `paramString()` appends the currently selected item (the result of `getSelectedItem()`) to the output. Using the first `Choice` instance in Figure 9-1, the results would be:

```
java.awt.Choice[139,5,92x27,current=Dialog]
```

9.1.2 Choice Events

The primary event for a Choice occurs when the user selects an item in the list. With the 1.0 event model, selecting an item generates an ACTION_EVENT, which triggers a call to the action() method. Once the Choice has the input focus, the user can change the selection by using the arrow or keyboard keys. The arrow keys scroll through the list of choices, triggering the KEY_ACTION, ACTION_EVENT, and KEY_ACTION_RELEASE event sequence, which in turn invokes the keyDown(), action(), and keyUp() methods, respectively. If the mouse is used to choose an item, no mouse events are triggered as you scroll over each item, and an ACTION_EVENT occurs only when a specific choice is selected.

With the 1.1 event model, you register ItemListener with addItemListener(). Then when the user selects the Choice, the ItemListener.itemStateChanged() method is called through the protected Choice.processItemEvent() method. Key, mouse, and focus listeners are registered through the Component methods of addKeyListener(), addMouseListener(), and addFocusListener(), respectively.

Action

public boolean action (Event e, Object o)

The action() method for a choice signifies that the user selected an item. e is the Event instance for the specific event, while o is the String from the call to addItem() or add() that represents the current selection. Here's a trivial implementation of the method:

```
public boolean action (Event e, Object o) {
    if (e.target instanceof Choice) {
        System.out.println ("Choice is now set to " + o);
    }
    return false;
}
```

Keyboard

The keyboard events for a Choice can be generated once the Choice has the input focus. In addition to the KEY_ACTION and KEY_ACTION_RELEASE events you get with the arrow keys, an ACTION_EVENT is generated over each entry.

public boolean keyDown (Event e, int key)

The keyDown() method is called whenever the user presses a key and the Choice has the input focus. e is the Event instance for the specific event, while key is the integer representation of the character pressed. The identifier for the event (e.id) for keyDown() could be either Event.KEY_PRESS for a regular key or Event.KEY_ACTION for an action-oriented key (i.e., arrow or function key). If you check the current selection in this method through the method getSelectedItem() or getSelectedIndex(), you will be given the previously selected item because the Choice's selection has not changed yet. keyDown() is not called when the Choice is changed by using the mouse.

public boolean keyUp (Event e, int key)

The keyUp() method is called whenever the user releases a key. e is the Event instance for the specific event, while key is the integer representation of the character pressed. The identifier for the event (e.id) for keyUp() could be either KEY_RELEASE for a regular key or KEY_ACTION_RELEASE for an action oriented key (i.e., arrow or function key).

Mouse

Ordinarily, the Choice component does not trigger any mouse events.

Focus

Ordinarily, the Choice component does not trigger any focus events.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners for different event types; the listeners are told when the event happens. These methods register listeners, and let the Choice component inspect its own events.

public void addItemListener(ItemListener listener) ★

The addItemListener() method registers listener as an object interested in being notified when an ItemEvent passes through the EventQueue with this Choice as its target. The listener.itemStateChanged() method is called when an event occurs. Multiple listeners can be registered.

public void removeItemListener(ItemListener listener) ★

The removeItemListener() method removes listener as a interested listener. If listener is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The processEvent() method receives all AWTEvents with this Choice as its target. processEvent() then passes them along to any listeners for processing. When you subclass Choice, overriding processEvent() allows you to process all events yourself, before sending them to any listeners. In a way, overriding processEvent() is like overriding handleEvent() using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processItemEvent(ItemEvent e) ★

The `processItemEvent()` method receives all `ItemEvents` with this `Choice` as its target. `processItemEvent()` then passes them along to any listeners for processing. When you subclass `Choice`, overriding `processItemEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processItemEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processItemEvent()`, remember to call the method `super.processItemEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

The following simple applet below demonstrates how a component can receive its own events by overriding `processItemEvent()`, while still allowing other objects to register as listeners. `MyChoice11` is a subclass of `Choice` that processes its own item events. `choice11` is an applet that uses the `MyChoice11` component and registers itself as a listener for item events.

```
// Java 1.1 only
import java.awt.*;
import java.applet.*;
import java.awt.event.*;
class MyChoice11 extends Choice {
    MyChoice11 () {
        super ();
        enableEvents (AWTEvent.ITEM_EVENT_MASK);
    }
    protected void processItemEvent(ItemEvent e) {
        ItemSelectable ie = e.getItemSelectable();
        System.out.println ("Item Selected: " + ie.getSelectedObjects()[0]);
        // If you do not call super.processItemEvent()
        // no listener will be notified
        super.processItemEvent (e);
    }
}

public class choice11 extends Applet implements ItemListener {
    Choice c;
    public void init () {
        String []fonts;
        fonts = Toolkit.getDefaultToolkit().getFontList();
```

```
            c = new MyChoice11();
            for (int i = 0; i < fonts.length; i++) {
                c.add (fonts[i]);
            }
            add (c);
            c.addItemListener (this);
        }
        public void itemStateChanged(ItemEvent e)  {
            ItemSelectable ie = e.getItemSelectable();
            System.out.println ("State Change: " + ie.getSelectedObjects()[0]);
        }
    }
```

A few things are worth noticing. MyChoice11 calls enableEvents() in its constructor to make sure that item events are delivered, even if nobody registers as a listener: MyChoice11 needs to make sure that it receives events, even in the absence of listeners. Its processItemEvent() method ends by calling the superclass's processItemEvent() method, with the original item event. This call ensures that normal item event processing occurs; super.processItemEvent() is responsible for distributing the event to any registered listeners. The alternative would be to implement the whole registration and event distribution mechanism inside myChoice11, which is precisely what object-oriented programming is supposed to avoid, or being absolutely sure that you will only use MyChoice11 in situations in which there won't be any listeners, drastically limiting the usefulness of this class.

choice11 doesn't contain many surprises. It implements ItemListener, the listener interface for item events; provides the required itemStateChanged() method, which is called whenever an item event occurs; and calls MyChoice11's method addItemListener() to register as a listener for item events. (MyChoice11 inherits this method from the Choice class.)

9.2 Lists

Like the Choice component, the List provides a way to present your user with a fixed sequence of choices to select. However, with List, several items can be displayed at a time on the screen. A List can also allow multiple selection, so that more than one choice can be selected.

Normally, a scrollbar is associated with the List to enable the user to move to the items that do not fit on the screen. On some platforms, the List may not display the scrollbar if there is enough room to display all choices. A List can be resized by the LayoutManager according to the space available. Figure 9-2 shows two lists, one of which has no items to display.

9.2.1 List Methods

Constructors

public List ()

This constructor creates an empty `List` with four visible lines. You must rely on the current `LayoutManager` to resize the `List` or override the `preferredSize()` (version 1.0) or `getPreferredSize()` (version 1.1) method to affect the size of the displayed `List`. A `List` created with this constructor is in single-selection mode, so the user can select only one item at a time.

public List (int rows)

This constructor creates a `List` that has `rows` visible lines. This is just a request; the `LayoutManager` is free to adjust the height of the `List` to some other amount based upon available space. A `List` created with this constructor is in single-selection mode, so the user will be able to select only one item at a time.

public List (int rows, boolean multipleSelections)

The final constructor for `List` creates a `List` that has `rows` visible lines. This is just a request; the `LayoutManager` is free to adjust the height of the `List` to some other amount based upon available space. If `multipleSelections` is `true`, this `List` permits multiple items to be selected. If `false`, this is a single-selection list.

Figure 9–2: Two lists; the list on the right is empty

Content control

public int getItemCount () ★
public int countItems () ☆

The `getItemCount()` method returns the length of the list. The length of the list is the number of items in the list, not the number of visible rows.

countItems() is the Java 1.0 name for this method.

public String getItem (int index)

The getItem() method returns the String representation for the item at position index. The String is the parameter passed to the addItem() or add() method.

public String[] getItems () ★

The getItems() method returns a String array that contains all the elements in the List. This method does not care if an item is selected or not.

public synchronized void add (String item) ★
public synchronized void addItem (String item) ☆

The add() method adds item as the last entry in the List. If item already exists in the list, this method adds it again.

addItem() is the Java 1.0 name for this method.

public synchronized void add (String item, int index) ★
public synchronized void addItem (String item, int index) ☆

This version of the add() method has an additional parameter, index, which specifies where to add item to the List. If index < 0 or index >= getItemCount(), item is added to the end of the List. The position count is zero based, so if index is 0, it will be added as the first item.

addItem() is the Java 1.0 name for this method.

public synchronized void replaceItem (String newItem, int index)

The replaceItem() method replaces the contents at position index with newItem. If the item at index has been selected, newItem will not be selected.

public synchronized void removeAll () ★
public synchronized void clear () ☆

The removeAll() method clears out all the items in the list.

clear() is the Java 1.0 name for this method.

NOTE Early versions (Java1.0) of the clear() method did not work reliably across platforms. You were better off calling the method listVar.delItems(0, listVar.countItems()-1), where listVar is your List instance.

---

public synchronized void remove (String item) ★

The remove() method removes item from the list of available choices. If item appears in the List several times, only the first instance is removed. If item is null, remove() throws the run-time exception NullPointerException. If item is not found in the List, remove() throws the IllegalArgumentException run-time exception.

public synchronized void remove (int position) ★
public synchronized void delItem (int position) ☆

The remove() method removes the entry at position from the List. If position is invalid—either position < 0 or position >= getItemCount()—remove() throws the ArrayIndexOutOfBoundsException run-time exception with a message indicating that position was invalid.

delItem() is the Java 1.0 name for this method.

public synchronized void delItems (int start, int end) ☆

The delItems() method removes entries from position start to position end from the List. If either parameter is invalid—either start < 0 or end >= getItemCount()—delItems() throws the ArrayIndexOutOfBoundsException run-time exception with a message indicating which position was invalid. If start is greater than end, nothing happens.

Selection and positioning

public synchronized int getSelectedIndex ()

The getSelectedIndex() method returns the position of the selected item. If nothing is selected in the List, getSelectedIndex() returns -1. The value -1 is also returned if the List is in multiselect mode and multiple items are selected. For multiselection lists, use getSelectedIndexes() instead.

public synchronized int[] getSelectedIndexes ()

The getSelectedIndexes() method returns an integer array of the selected items. If nothing is selected, the array will be empty.

public synchronized String getSelectedItem ()

The getSelectedItem() method returns the label of the selected item. The label is the string used in the add() or addItem() call. If nothing is selected in the List, getSelectedItem() returns null. The return value is also null if List is in multiselect mode and multiple items are selected. For multiselection lists, use getSelectedItems() instead.

public synchronized String[] getSelectedItems ()

The getSelectedItems() method returns a String array of the selected items. If nothing is selected, the array is empty.

public synchronized Object[] getSelectedObjects ()

The `getSelectedObjects()` method returns the results of the method `getSelectedItems()` as an `Object` array instead of a `String` array, to conform to the `ItemSelectable` interface. If nothing is selected, the returned array is empty.

public synchronized void select (int index)

The `select()` method selects the item at position `index`, which is zero based. If the `List` is in single-selection mode, any other selected item is deselected. If the `List` is in multiple-selection mode, calling this method has no effect on the other selections. The item at position `index` is made visible.

NOTE A negative index seems to select everything within the `List`. This seems more like an irregularity than a feature to rely upon.

---

public synchronized void deselect (int index)

The `deselect()` method deselects the item at position `index`, which is zero based. `deselect()` does not reposition the visible elements.

public boolean isIndexSelected (int index) ★
public boolean isSelected (int index) ☆

The `isIndexSelected()` method checks whether `index` is currently selected. If it is, `isIndexSelected()` returns `true`; otherwise, it returns `false`.

`isSelected()` is the Java 1.0 name for this method.

public boolean isMultipleMode () ★
public boolean allowsMultipleSelections () ☆

The `isMultipleMode()` method returns the current state of the `List`. If the `List` is in multiselection mode, `isMultipleMode()` returns `true`; otherwise, it returns `false`.

`allowsMultipleSelections()` is the Java 1.0 name for this method.

public void setMultipleMode (boolean value) ★
public void setMultipleSelections (boolean value) ☆

The `setMultipleMode()` method allows you to change the current state of a `List` from one selection mode to the other. The currently selected items change when this happens. If `value` is `true` and the `List` is going from single- to multiple-selection mode, the selected item gets deselected. If `value` is `false` and the `List` is going from multiple to single, the last item physically selected remains selected (the last item clicked on in the list, not the item with the highest index). If there was no selected item, the first item in the list becomes selected, or the last item that was deselected becomes selected. If staying within the same mode, `setMultipleMode()` has no effect on the selected items.

`setMultipleSelections()` is the Java 1.0 name for this method.

public void makeVisible (int index)

The `makeVisible()` method ensures that the item at position `index` is displayed on the screen. This is useful if you want to make sure a certain entry is displayed when another action happens on the screen.

public int getVisibleIndex ()

The `getVisibleIndex()` method returns the last index from a call to the method `makeVisible()`. If `makeVisible()` was never called, -1 is returned.

Sizing

public int getRows ()

The `getRows()` method returns the number of rows passed to the constructor of the `List`. It does not return the number of visible rows. To get a rough idea of the number of visible rows, compare the `getSize()` of the component with the results of `getPreferredSize(getRows())`.

public Dimension getPreferredSize (int rows) ★
public Dimension preferredSize (int rows) ☆

The `getPreferredSize()` method returns the preferable `Dimension` (width and height) for the size of a `List` with a height of `rows`. The `rows` specified may be different from the rows designated in the constructor.

`preferredSize()` is the Java 1.0 name for this method.

public Dimension getPreferredSize () ★
public Dimension preferredSize () ☆

The `getPreferredSize()` method returns the `Dimension` (width and height) for the preferred size of the `List`. Without the rows parameter, this version of `getPreferredSize()` uses the constructor's number of rows to calculate the `List`'s preferred size.

`preferredSize()` is the Java 1.0 name for this method.

public Dimension getMiminumSize (int rows) ★
public Dimension minimumSize (int rows) ☆

The `getMinimumSize()` method returns the minimum `Dimension` (width and height) for the size of a `List` with a height of `rows`. The `rows` specified may be different from the rows designated in the constructor. For a `List`, `getMinimumSize()` and `getPreferredSize()` should return the same dimensions.

`minimumSize()` is the Java 1.0 name for this method.

public Dimension getMiminumSize () ★
public Dimension minimumSize () ☆

The getMinimumSize() method returns the minimum Dimension (width and height) for the size of the List. Without the rows parameter, this getMinimumSize() uses the constructor's number of rows to calculate the List's minimum size.

minimumSize() is the Java 1.0 name for this method.

Miscellaneous methods

public synchronized void addNotify ()

The addNotify() method creates the List peer. If you override this method, call super.addNotify() first, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

public synchronized void removeNotify ()

The removeNotify() method destroys the peer of the List and removes it from the screen. Prior to the List peer's destruction, the last selected entry is saved. If you override this method for a specific List, issue the particular commands that you need for your new object, then call super.removeNotify() last.

protected String paramString ()

When you call the toString() method of List, the default toString() method of Component is called. This in turn calls paramString(), which builds up the string to display. At the List level, the currently selected item (getSelectedItem()) is appended to the output. Using Figure 9-2 as an example, the results would be the following:

```
java.awt.List[0,34,107x54,selected=null]
```

9.2.2 List Events

The primary event for a List occurs when the user selects an item in the list. With the 1.0 event model, double-clicking a selection causes an ACTION_EVENT and triggers the action() method, while single-clicking causes a LIST_SELECT or LIST_DESELECT event. Once the List has the input focus, it is possible to change the selection by using the arrow or keyboard keys. The arrow keys scroll through the list of choices, triggering the KEY_ACTION, LIST_SELECT, LIST_DESELECT, and KEY_ACTION_RELEASE events, and thus the keyDown(), handleEvent(), and keyUp() methods (no specific method gets called for LIST_SELECT and LIST_DESELECT). action() is called only when the user double-clicks on an item with the mouse. If the mouse is used to scroll through the list, no mouse events are triggered; ACTION_EVENT is generated only when the user double-clicks on an item.

With the 1.1 event model, you register an ItemListener with addItemListener() or an ActionListener with the addActionListener() method. When the user selects the List, either the ItemListener.itemStateChanged() method or the ActionListener.actionPerformed() method is called through the protected List.processItemEvent() method or List.processActionEvent() method. Key, mouse, and focus listeners are registered through the three Component methods of addKeyListener(), addMouseListener(), and addFocusListener(), respectively.

Action

public boolean action (Event e, Object o)

The action() method for a List is called when the user double-clicks on any item in the List. e is the Event instance for the specific event, while o is the label for the item selected, from the add() or addItem() call. If List is in multiple-selection mode, you might not wish to catch this event because it's not clear whether the user wanted to choose the item just selected or all of the items selected. You can solve this problem by putting a multi-selecting list next to a Button that the user presses when the selection process is finished. Capture the event generated by the Button. The following example shows how to set up and handle a list in this manner, with the display shown in Figure 9-3. In this example, I just print out the selections to prove that I captured them.

```
import java.awt.*;
import java.applet.*;
public class list3 extends Applet {
   List l;
   public void init () {
        String fonts[];
        fonts = Toolkit.getDefaultToolkit().getFontList();
        l = new List(4, true);
        for (int i = 0; i < fonts.length; i++) {
            l.addItem (fonts[i]);
        }
        setLayout (new BorderLayout (10, 10));
        add ("North", new Label ("Pick Font Set"));
        add ("Center", l);
        add ("South", new Button ("Submit"));
        resize (preferredSize());
        validate();
   }
   public boolean action (Event e, Object o) {
        if (e.target instanceof Button) {
             String chosen[] = l.getSelectedItems();
             for (int i=0;i<chosen.length;i++)
                System.out.println (chosen[i]);
        }
        return false;
   }
}
```

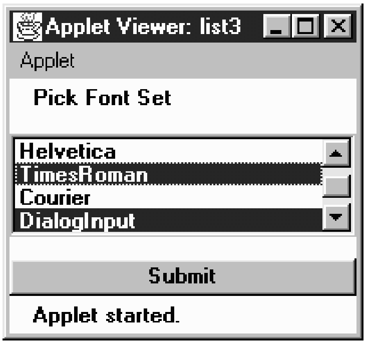


Figure 9–3: Multiselect List

Keyboard

Ordinarily, `List` generates all the `KEY` events once it has the input focus. But the way it handles keyboard input differs slightly depending upon the selection mode of the list. Furthermore, each platform offers slightly different behavior, so code that depends on keyboard events in `List` is not portable. One strategy is to take advantage of the keyboard events when they are available but allow for another way of managing the list in case they are not.

public boolean keyDown (Event e, int key)

The `keyDown()` method is called whenever the user presses a key while the `List` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyDown()` could be either `KEY_PRESS` for a regular key or `KEY_ACTION` for an action-oriented key (i.e., arrow or function key). If you check the current selection in this method through `getSelectedItem()` or `getSelectedIndex()`, you will actually be told the previously selected item because the `List`'s selection has not changed yet. `keyDown()` is not called when the user selects items with the mouse.

public boolean keyUp (Event e, int key)

The `keyUp()` method is called whenever the user releases a key while the `List` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyUp()` could be either `KEY_RELEASE` for a regular key or `KEY_ACTION_RELEASE` for an action-oriented key (i.e., arrow or function key).

Mouse

Ordinarily, the `List` component does not trigger any mouse events. Double-clicking the mouse over any element in the list generates an ACTION_EVENT. Single-clicking could result in either a LIST_SELECT or LIST_DESELECT, depending on the mode of the List and the current state of the item chosen. When the user changes the selection with the mouse, the ACTION_EVENT is posted only when an item is double-clicked.

List

There is a special pair of events for lists: LIST_SELECT and LIST_DESELECT. No special method is called when these events are triggered. However, you can catch them in the handleEvent() method. If the List is in single-selection mode, a LIST_SELECT event is generated whenever the user selects one of the items in the List. In multiple-selection mode, you will get a LIST_SELECT event when an element gets selected and a LIST_DESELECT event when it is deselected. The following code shows how to use this event type.

```
public boolean handleEvent (Event e) {
    if (e.id == Event.LIST_SELECT) {
        System.out.println ("Selected item: " + e.arg);
        return true;
    } else {
        return super.handleEvent (e);
    }
}
```

Focus

Normally, the List component does not reliably trigger any focus events.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners, and they are told when the event happens.

public void addItemListener(ItemListener listener) ★

The addItemListener() method registers listener as an object interested in being notified when an ItemEvent passes through the EventQueue with this List as its target. The listener.itemStateChanged() method is called when these events occur. Multiple listeners can be registered.

public void removeItemListener(ItemListener listener) ★

The removeItemListener() method removes listener as an interested listener. If listener is not registered, nothing happens.

public void addActionListener(ActionListener listener) ★

The `addActionListener()` method registers `listener` as an object interested in being notified when an `ActionEvent` passes through the `EventQueue` with this `List` as its target. The `listener.actionPerformed()` method is called when these events occur. Multiple listeners can be registered.

public void removeActionListener(ActionListener listener) ★

The `removeActionListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvents` with this `List` as its target. `processEvent()` then passes them along to any listeners for processing. When you subclass `List`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding the method `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processItemEvent(ItemEvent e) ★

The `processItemEvent()` method receives all `ItemEvents` with this `List` as its target. `processItemEvent()` then passes them along to any listeners for processing. When you subclass `List`, overriding `processItemEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processItemEvent()` is like overriding `handleEvent()` to deal with `LIST_SELECT` and `LIST_DESELECT` using the 1.0 event model.

If you override `processItemEvent()`, remember to call the method `super.processItemEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processActionEvent(ActionEvent e) ★

The `processActionEvent()` method receives all `ActionEvents` with this `List` as its target. `processActionEvent()` then passes them along to any listeners for processing. When you subclass `List`, overriding `processActionEvent()` allows you to process all action events yourself, before sending them to any listeners. In a way, overriding `processActionEvent()` is like overriding `action()` using the 1.0 event model.

If you override `processActionEvent()`, remember to call the method `super.processActionEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

9.3 Checkbox

The `Checkbox` is a general purpose way to record a `true` or `false` state. When several checkboxes are associated in a `CheckboxGroup` (Section 9.4), only one can be selected at a time; selecting each `Checkbox` causes the previous selection to become deselected. The `CheckboxGroup` is Java's way of offering the interface element known as radio buttons or a radio box. When you create a `Checkbox`, you decide whether to place it into a `CheckboxGroup` by setting the proper argument in its constructor.

Every `Checkbox` has both a label and a state, although the label could be empty. You can change the label based on the state of the `Checkbox`. Figure 9-4 shows what several `Checkbox` components might look like. The two on the left are independent, while the five on the right are in a `CheckboxGroup`. Note that the appearance of a `Checkbox` varies quite a bit from platform to platform. However, the appearance of a `CheckboxGroup` is always different from the appearance of an ungrouped `Checkbox`, and the appearance of a checked `Checkbox` is different from an unchecked `Checkbox`.

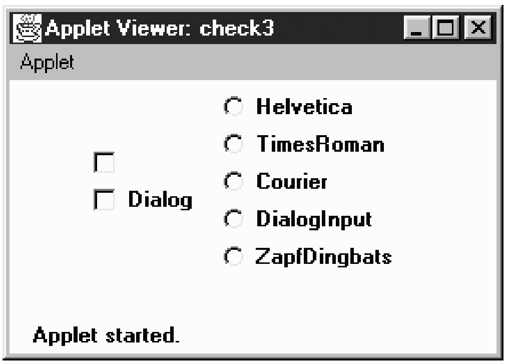


Figure 9–4: Two separate checkboxes and a CheckboxGroup

9.3.1 Checkbox Methods

Constructors

public Checkbox ()

This constructor for `Checkbox` creates a new instance with no label or grouping. The initial state of the item is `false`. A checkbox doesn't necessarily need a label; however, a checkbox without a label might be confusing, unless it is being used as a column in a table or a spreadsheet.

public Checkbox (String label)

The second constructor creates a new `Checkbox` with a label of `label` and no grouping. The initial state of the item is `false`. If you want a simple yes/no choice and plan to make no the default, use this constructor. If the `Checkbox` will be in a group or you want its initial value to be `true`, use the next constructor.

public Checkbox (String label, boolean state) ★

This constructor allows you to specify the `Checkbox`'s initial state. With it you create a `Checkbox` with a label of `label` and an initial state of `state`.

public Checkbox (String label, boolean state, CheckboxGroup group) ★
public Checkbox (String label, CheckboxGroup group, boolean state)

The final constructor for `Checkbox` is the most flexible. With this constructor you create a `Checkbox` with a label of `label`, a `CheckboxGroup` of `group`, and an initial state of `state`. If `group` is `null`, the `Checkbox` is independent.

In Java 1.0, you created an independent `Checkbox` with an initial value of `true` by using `null` as the group:

```
Checkbox cb = new Checkbox ("Help", null, true)
```

The shape of the `Checkbox` reflects whether it's in a `CheckboxGroup` or independent. On Microsoft Windows, grouped checkboxes are represented as circles. On a UNIX system, they are diamonds. On both systems, independent checkboxes are squares.

Label

public String getLabel ()

The `getLabel()` method retrieves the current label on the `Checkbox` and returns it as a `String` object.

public synchronized void setLabel (String label)

The `setLabel()` method changes the label of the `Checkbox` to `label`. If the new label is a different size than the old one, you have to `validate()` the container after the change to ensure the entire label will be seen.

State

A state of `true` means the `Checkbox` is selected. A state of `false` means that the `Checkbox` is not selected.

public boolean getState ()

The `getState()` method retrieves the current state of the `Checkbox` and returns it as a boolean.

public void setState (boolean state)

The `setState()` method changes the state of the `Checkbox` to `state`. If the `Checkbox` is in a `CheckboxGroup` and `state` is true, the other items in the group become false.

ItemSelectable method

public Objects[] getSelectedObjects () ★

The `getSelectedObjects()` method returns the `Checkbox` label as a one-element `Object` array if it is currently selected, or `null` if the `Checkbox` is not selected. Because this method is part of the `ItemSelectable` interface, you can use it to look at the selected items in a `Choice`, `List`, or `Checkbox`.

CheckboxGroup

This section lists methods that you issue to `Checkbox` to affect its relationship to a `CheckboxGroup`. Methods provided by the `CheckboxGroup` itself can be found later in this chapter.

public CheckboxGroup getCheckboxGroup ()

The `getCheckboxGroup()` method returns the current `CheckboxGroup` for the `Checkbox`. If the `Checkbox` is not in a group, this method returns `null`.

public void setCheckboxGroup (CheckboxGroup group)

The `setCheckboxGroup()` method allows you to insert a `Checkbox` into a different `CheckboxGroup`. To make the `Checkbox` independent, pass a `group` argument of `null`. The method sets every `Checkbox` in the original `CheckboxGroup` to `false` (`cb.getCheckboxGroup().setCurrent(null)`), then the `Checkbox` is added to the new group without changing any values in the new group.

Checkbox components take on a different shape when they are in a Checkbox-Group. If the checkbox was originally not in a CheckboxGroup, the shape of the checkbox does not change automatically when you put it in one with setCheckboxGroup(). (This also holds when you remove a Checkbox from a CheckboxGroup and make it independent or vice versa.) In order for the Checkbox to look right once added to group, you need to destroy and create (removeNotify() and addNotify(), respectively) the Checkbox peer to correct the shape. Also, it is possible to get multiple true Checkbox components in group this way, since the new CheckboxGroup's current selection does not get adjusted. To avoid this problem, make sure it is grouped properly the first time, or be sure to clear the selections with a call to getCheckbox-Group().setCurrent(null).

Miscellaneous methods

public synchronized void addNotify ()

The addNotify() method will create the Checkbox peer in the appropriate shape. If you override this method, call super.addNotify() first, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

protected String paramString ()

When you call the toString() method of Checkbox, the default toString() method of Component is called. This in turn calls paramString() which builds up the string to display. At the Checkbox level, the label (if non-null) and the state of the item are appended. Assuming the Dialog Checkbox in Figure 9-4 was selected, the results would be:

```
java.awt.Checkbox[85,34,344x32,label=Dialog,state=true]
```

9.3.2 Checkbox Events

The primary event for a Checkbox occurs when the user selects it. With the 1.0 event model, this generates an ACTION_EVENT and triggers the action() method. Once the Checkbox has the input focus, the various keyboard events can be generated, but they do not serve any useful purpose because the Checkbox doesn't change. The sole key of value for a Checkbox is the spacebar. This may generate the ACTION_EVENT after KEY_PRESS and KEY_RELEASE; thus the sequence of method calls would be keyDown(), keyUp(), and then action().

With the version 1.1 event model, you register an ItemListener with the method addItemListener(). Then when the user selects the Checkbox, the method Item-Listener.itemStateChanged() is called through the protected

Checkbox.processItemEvent() method. Key, mouse, and focus listeners are registered through the Component methods of addKeyListener(), addMouseListener(), and addFocusListener(), respectively.

Action

public boolean action (Event e, Object o)

The action() method for a Checkbox is called when the user selects it. e is the Event instance for the specific event, while o is the opposite of the old state of the toggle. If the Checkbox was true when it was selected, o will be false. Likewise, if it was false, o will be true. This incantation sounds unnecessarily complex, and for a single Checkbox, it is: o is just the new state of the Checkbox. The following code uses action() with a single Checkbox.

```
public boolean action (Event e, Object o) {
    if (e.target instanceof Checkbox) {
        System.out.println ("Checkbox is now " + o);
    }
    return false;
}
```

On the other hand, if the Checkbox is in a CheckboxGroup, o is still the opposite of the old state of the toggle, which may or may not be the new state of the Checkbox. If the Checkbox is initially false, o will be true, and the Checkbox's new state will be true. However, if the Checkbox is initially true, selecting the Checkbox doesn't change anything because one Checkbox in the group must always be true. In this case, o is false (the opposite of the old state), though the Checkbox's state remains true.

Therefore, if you're working with a CheckboxGroup and need to do something once when the selection changes, perform your action only when o is true. To find out which Checkbox was actually chosen, you need to call the getLabel() method for the target of event e. (It would be nice if o gave us the label of the Checkbox that was selected, but it doesn't.) An example of this follows:

```
public boolean action (Event e, Object o) {
    if (e.target instanceof Checkbox) {
        System.out.println (((Checkbox)(e.target)).getLabel() +
            " was selected.");
        if (new Boolean (o.toString()).booleanValue()) {
            System.out.println ("New option chosen");
        } else {
            System.out.println ("Use re-selected option");
        }
    }
    return false;
}
```

One other unfortunate twist of `CheckboxGroup`: it would be nice if there was some easy way to find out about checkboxes that change state without selection—for example, if you could find out which `Checkbox` was deselected when a new `Checkbox` was selected. Unfortunately, you can't, except by keeping track of the state of all your checkboxes at all times. When a `Checkbox` state becomes `false` because another `Checkbox` was selected, no additional event is generated, in either Java 1.0 or 1.1.

Keyboard

`Checkboxes` are able to capture keyboard-related events once the `Checkbox` has the input focus, which happens when it is selected. If you can find a use for this, you can use `keyDown()` and `keyUp()`. For most interface designs I can think of, `action()` is sufficient. A possible use for keyboard events is to jump to other `Checkbox` options in a `CheckboxGroup`, but I think that is more apt to confuse users than help.

public boolean keyDown (Event e, int key)

The `keyDown()` method is called whenever the user presses a key while the `Checkbox` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyDown()` could be either `KEY_PRESS` for a regular key or `KEY_ACTION` for an action-oriented key (i.e., arrow or function key). There is no visible indication that the user has pressed a key over the checkbox.

public boolean keyUp (Event e, int key)

The `keyUp()` method is called whenever the user releases a key while the `Checkbox` has the input focus. `e` is the `Event` instance for the specific event, while `key` is the integer representation of the character pressed. The identifier for the event (`e.id`) for `keyUp()` could be either `KEY_RELEASE` for a regular key or `KEY_ACTION_RELEASE` for an action-oriented key (i.e., arrow or function key). `keyUp()` may be used to determine how long `key` has been pressed.

Mouse

Ordinarily, the `Checkbox` component does not reliably trigger any mouse events.

Focus

Ordinarily, the `Checkbox` component does not reliably trigger any focus events.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners, and they are told when the event happens.

public void addItemListener(ItemListener listener) ★

The `addItemListener()` method registers `listener` as an object interested in being notified when an `ItemEvent` passes through the `EventQueue` with this `Checkbox` as its target. Then, the `listener.itemStateChanged()` method will be called. Multiple listeners can be registered.

public void removeItemListener(ItemListener listener) ★

The `removeItemListener()` method removes `listener` as a interested listener. If listener is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives every `AWTEvent` with this `Checkbox` as its target. `processEvent()` then passes it along to any listeners for processing. When you subclass `Checkbox`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processItemEvent(ItemEvent e) ★

The `processItemEvent()` method receives every `ItemEvent` with this `Checkbox` as its target. `processItemEvent()` then passes it along to any listeners for processing. When you subclass `Checkbox`, overriding `processItemEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processItemEvent()` is like overriding `action()` using the 1.0 event model.

If you override `processItemEvent()`, remember to call the method `super.processItemEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

9.4 CheckboxGroup

The `CheckboxGroup` lets multiple checkboxes work together to provide a mutually exclusion choice (at most one `Checkbox` can be selected at a time). Because the `CheckboxGroup` is neither a `Component` nor a `Container`, you should normally put all the `Checkbox` components associated with a `CheckboxGroup` in their own `Panel` (or other `Container`). The `LayoutManager` of the `Panel` should be `GridLayout (0, 1)` if you want them in one column. Figure 9-5 shows both a good way and bad way of positioning a set of `Checkbox` items in a `CheckboxGroup`. The image on the left is preferred because the user can sense that the items are grouped; the image on the right suggests three levels of different checkboxes and can therefore surprise the user when checkboxes are deselected.

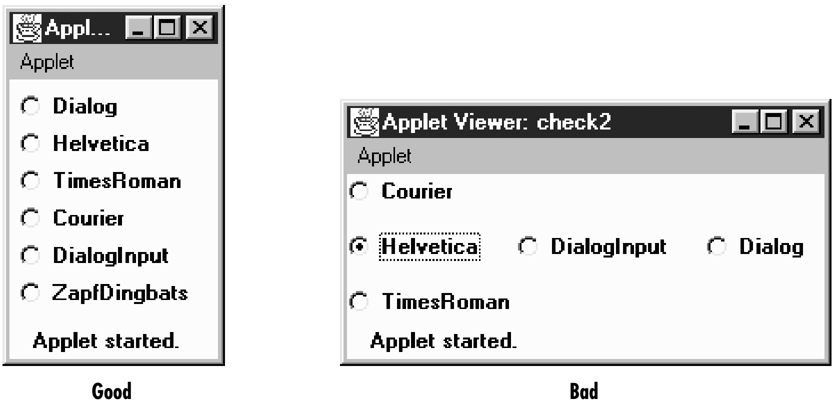


Figure 9–5: Straightforward and confusing layouts of Checkbox components

9.4.1 CheckboxGroup Methods

Constructors

public CheckboxGroup ()

This constructor creates an instance of `CheckboxGroup`.

Miscellaneous methods

public int getSelectedCheckbox () ★
public Checkbox getCurrent () ☆

The `getSelectedCheckbox()` method returns the `Checkbox` within the `CheckboxGroup` whose value is `true`. If no item is selected, `null` is returned.

`getCurrent()` is the Java 1.0 name for this method.

public synchronized void setSelectedCheckbox (Checkbox checkbox) ★
public synchronized void setCurrent (Checkbox checkbox) ☆

The `setSelectedCheckbox()` method makes `checkbox` the currently selected `Checkbox` within the `CheckboxGroup`. If `checkbox`is `null`, the method deselects all the items in the `CheckboxGroup`. If `checkbox` is not within the `CheckboxGroup`, nothing happens.

`setCurrent()` is the Java 1.0 name for this method.

public String toString ()

The `toString()` method of `CheckboxGroup` creates a `String` representation of the current choice (as returned by `getSelectedCheckbox()`). Using the "straightforward" layout in Figure 9-5 as an example, the results would be:

```
java.awt.CheckboxGroup[current=java.awt.Checkbox[0,31,85x21,
    label=Helvetica,state=true]]
```

If there is no currently selected item, the results within the square brackets would be `current=null`.

9.5 ItemSelectable

In Java 1.1, the classes `Checkbox`, `Choice`, `List`, and `CheckboxMenuItem` (covered in the next chapter) share a common interface that defines a method for getting the currently selected item or items. This means that you can use the same methods to retrieve the selection from any of these classes. More important, it means that you can write code that doesn't know what kind of selectable item it's working with. For example, you could write a method that returns the selectable component from some user interface. This method might have the signature:

```
public ItemSelectable getChooser();
```

After you call this method, you can read selections from the user interface without knowing exactly what you're dealing with.

9.5.1 Methods

public Object[] getSelectedObjects () ★

The `getSelectedObjects()` method returns the currently selected item or items as an `Object` array. The return value is `null` if there is nothing selected.

In this chapter:

- *MenuComponent*
- *MenuContainer*
- *MenuShortcut*
- *MenuItem*
- *Menu*
- *CheckboxMenuItem*
- *MenuBar*
- *Putting It All Together*
- *PopupMenu*

10

Would You Like to Choose from the Menu?

In Chapter 6, *Containers*, I mentioned that a `Frame` can have a menu. Indeed, to offer a menu in the AWT, you have to attach it to a `Frame`. With versions 1.0.2 and 1.1, Java does not support menu bars within an applet or any other container. We hope that future versions of Java will allow menus to be used with other containers. Java 1.1 goes partway toward solving this problem by introducing a `PopupMenu` that lets you attach context menus to any `Component`. Java 1.1 also adds `MenuShortcut` events, which represent keyboard accelerator events for menus.

Implementing a menu in a `Frame` involves connections among a number of different objects: `MenuBar`, `Menu`, `MenuItem`, and the optional `CheckboxMenuItem`. Several of these classes implement the `MenuContainer` interface. Once you've created a few menus, you'll probably find the process quite natural, but it's hard to describe until you see what all the objects are. So this chapter describes most of the menu classes first and then shows an example demonstrating their use.

All the components covered in previous chapters were subclasses of `Component`. Most of the objects in this chapter subclass `MenuComponent`, which encapsulates the common functionality of menu objects. The `MenuComponent` class hierarchy is shown in Figure 10-1.

To display a `Menu`, you must first put it in a `MenuBar`, which you add to a `Frame`. (Pop-up menus are different in that they don't need a `Frame`.) A `Menu` can contain `MenuItem` as well as other menus that form submenus. `CheckboxMenuItem` is a specialized `MenuItem` that (as you might guess) the user can toggle like a `Checkbox`. One way to visualize how all these things work together is to imagine a set of curtains. The different `MenuItem` components are the fabrics and panels that make up the curtains. The `Menus` are the curtains. They get hung from the `MenuBar`, which is

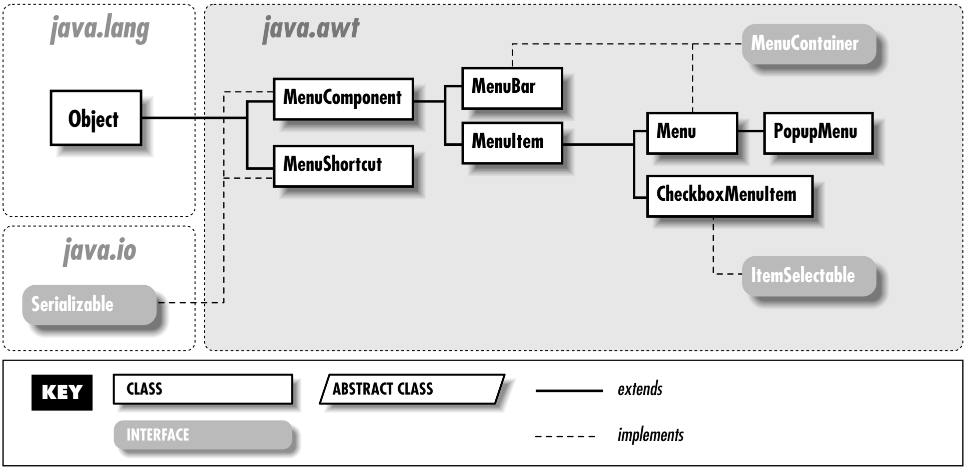


Figure 10–1: MenuComponent class hierarchy

like a curtain rod. Then you place the `MenuBar` curtain rod into the `Frame` (the window, in our metaphor), curtains and all.

It might puzzle you that a `Menu` is a subclass of `MenuItem`, not the other way around. This is because a `Menu` can appear on a `Menu` just like another `MenuItem`, which would not be possible if the hierarchy was the other way around. Figure 10-2 points out the different pieces involved in the creation of a menu: the `MenuBar` and various kinds of menu items, including a submenu.

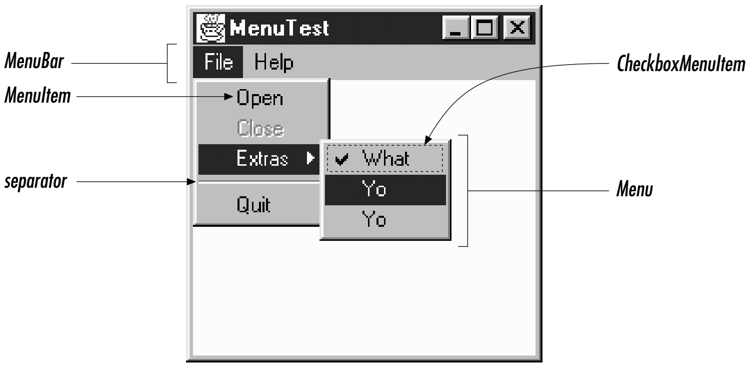


Figure 10–2: The pieces that make up a Menu

10.1 MenuComponent

`MenuComponent` is an abstract class that is the parent of all menu-related objects. You will never create an instance of the object. Nor are you likely to subclass it yourself—to make the subclass work, you'd have to provide your own peer on every platform where you want the application to run.

10.1.1 MenuComponent Methods

Constructor

public MenuComponent ()—cannot be called directly

Since `MenuComponent` is an abstract class, you cannot create an instance of the object. This method is called when you create an instance of one of its children.

Fonts

public Font getFont ()

The `getFont()` method retrieves the font associated with the `MenuComponent` from `setFont()`. If the current object's font has not been set, the parent menu's font is retrieved. If there is no parent and the current object's font has not been set, `getFont()` returns `null`.

public void setFont (Font f)

The `setFont()` method allows you to change the font of the particular menu-related component to `f`. When a `MenuComponent` is first created, the initial font is `null`, so the parent menu's font is used.

NOTE Some platforms do not support changing the fonts of menu items. Where supported, it can make some pretty ugly menus.

Names

The name serves as an alternative, nonlocalized reference identifier for menu components. If your event handlers compare menu label strings to an expected value and labels are localized for a new environment, the approach fails.

public String getName ()

The `getName()` method retrieves the name of the menu component. Every instance of a subclass of `MenuComponent` is named when it is created.

public void setName (String name)

The `setName()` method changes the current name of the component to `name`.

Peers

public MenuComponentPeer getPeer () ☆

The `getPeer()` method returns a reference to the `MenuComponent` peer as a `MenuComponentPeer`.

public synchronized void removeNotify ()

The `removeNotify()` method destroys the peer of the `MenuComponent` and removes it from the screen. `addNotify()` will be specific to the subclass.

Events

Event handling is slightly different between versions. If using the 1.0 event model, use `postEvent()`. Otherwise, use `dispatchEvent()` to post an event to this `MenuComponent` or `processEvent()` to receive and handle an event. Remember not to mix versions within your programs.

public boolean postEvent (Event e) ☆

The `postEvent()` method posts `Event e` to the `MenuComponent`. The event is delivered to the `Frame` at the top of the object hierarchy that contains the selected `MenuComponent`. The only way to capture this event before it gets handed to the `Frame` is to override this method. There are no helper functions as there are for `Components`. Find out which `MenuComponent` triggered the event by checking `e.arg`, which contains its label, or `((MenuItem)e.target).getName()` for the nonlocalized name of the target.

```
public boolean postEvent (Event e) {
    // Use getName() vs. e.arg for localization possibility
    if ("About".equals (((MenuItem)e.target).getName()))
        playLaughingSound(); // Help request
    return super.postEvent (e);
}
```

If you override this method, in order for this `Event` to propagate to the `Frame` that contains the `MenuComponent`, you must call the original `postEvent()` method (`super.postEvent(e)`).

The actual value returned by `postEvent()` is irrelevant.

public final void dispatchEvent(AWTEvent e) ★

The `dispatchEvent()` method allows you to post new AWT events to this menu component's listeners. `dispatchEvent()` tells the `MenuComponent` to deal with the `AWTEvent e` by calling its `processEvent()` method. This method is similar to Java 1.0's `postEvent()` method. Events delivered in this way bypass the system's event queue. It's not clear why you would want to bypass the event queue, except possibly to deliver some kind of high priority event.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvents` with a subclass of `MenuComponent` as its target. `processEvent()` then passes them along for processing. When you subclass a child class, overriding `processEvent()` allows you to process all events without having to provide listeners. However, remember to call `super.processEvent(e)` last to ensure regular functionality is still executed. This is like overriding `postEvent()` using the 1.0 event model.

Miscellaneous methods

public MenuContainer getParent ()

The `getParent()` method returns the parent `MenuContainer` for the `MenuComponent`. `MenuContainer` is an interface that is implemented by `Component` (in 1.1 only), `Frame`, `Menu`, and `MenuBar`. This means that `getParent()` could return any one of the four.

protected String paramString ()

The `paramString()` method of `MenuComponent` helps build up the string to display when `toString()` is called for a subclass. At the `MenuComponent` level, the current name of the object is appended to the output.

public String toString ()—can be called by user for subclass

The `toString()` method at the `MenuComponent` level cannot be called directly. This `toString()` method is called when you call a subclass's `toString()` and the specifics of the subclass is added between the brackets ([and]). At this level, the results would be:

```
java.awt.MenuComponent[aname1]
```

10.2 MenuContainer

`MenuContainer` is an interface implemented by the three menu containers: `Frame`, `Menu`, and `MenuBar`; Java 1.1 adds a fourth, `Component`. You should never need to worry about the interface since it does all its work behind the scenes for you. You will notice that the interface does not define an `add()` method. Each type of `MenuContainer` defines its own `add()` method to add menus to itself.

10.2.1 MenuContainer Methods

public abstract Font getFont ()

The `getFont()` method should provide an object's font. `MenuItem` implements this method, so all of its subclasses inherit it. `MenuBar` implements it, too, while `Frame` gets the method from `Component`.

public abstract boolean postEvent (Event e) ☆

The `postEvent()` method should post `Event e` to the object. `MenuComponent` implements this method, so all of its subclasses inherit it. (`Frame` gets the method from `Component`.)

public abstract void remove (MenuComponent component)

The `remove()` method should remove the `MenuComponent component` from the object. If `component` was not contained within the object, nothing should happen.

10.3 MenuShortcut

`MenuShortcut` is a class used to represent a keyboard shortcut for a `MenuItem`. When these events occur, an action event is generated that triggers the menu component. When a shortcut is associated with a `MenuItem`, the `MenuItem` automatically displays a visual clue, which indicates that a keyboard accelerator is available.

10.3.1 MenuShortcut Methods

Constructors

public MenuShortcut (int key) ★

The first `MenuShortcut` constructor creates a `MenuShortcut` with `key` as its designated hot key. The `key` parameter can be any of the virtual key codes from the `KeyEvent` class (e.g., `VK_A`, `VK_B`, etc.). These constants are listed in Table 4-4. To use the shortcut, the user must combine the given `key` with a platform-specific modifier key. On Windows and Motif platforms, the modifier is the Control key; on the Macintosh, it is the Command key. For example, if the shortcut key is F1 (`VK_F1`) and you're using Windows, you would press Ctrl+F1 to execute the shortcut. To find out the platform's modifier key, call the `Toolkit.getMenuShortcutKeyMask()` method.

public MenuShortcut(int key, boolean useShiftModifier) ★

This `MenuShortcut` constructor creates a `MenuShortcut` with `key` as its designated hot key. If `useShiftModifier` is `true`, the Shift key must be depressed for this shortcut to trigger the action event (in addition to the shortcut key).

The key parameter represents the integer value of a KEY_PRESS event, so in addition to ASCII values, possible values include the various Event keyboard constants (listed in Table 4-2) like Event.F1, Event.HOME, and Event.PAUSE. For example, if key is the ASCII value for A and useShiftModifier is true, the shortcut key is Shift+Ctrl+A on a Windows/Motif platform.

Miscellaneous methods

public int getKey () ★

The getKey() method retrieves the virtual key code for the key that triggered this MenuShortcut. The virtual key codes are the VK constants defined by the KeyEvent class (see Table 4-4).

public boolean usesShiftModifier() ★

The usesShiftModifier() method returns true if this MenuShortcut requires the Shift key be pressed, false otherwise.

public boolean equals(MenuShortcut s) ★

The equals() method overrides Object's equals() method to define equality for menu shortcuts. Two MenuShortcut objects are equal if their key and useShiftModifier values are equal.

protected String paramString () ★

The paramString() method of MenuShortcut helps build up a string describing the shortcut; it appends the shortcut key and a shift modifier indicator to the string under construction. Oddly, this method is not currently used, nor can you call it; MenuShortcut has its own toString() method that does the job itself.

public String toString() ★

The toString() method of MenuShortcut builds a String to display the contents of the MenuShortcut.

10.4 MenuItem

A MenuItem is the basic item that goes on a Menu. Menus themselves are menu items, allowing submenus to be nested inside of menus. MenuItem is a subclass of MenuComponent.

10.4.1 MenuItem Methods

Constructors

public MenuItem () ★

The first `MenuItem` constructor creates a `MenuItem` with an empty label and no keyboard shortcut. To set the label at later time, use `setLabel()`.

public MenuItem (String label)

This `MenuItem` constructor creates a `MenuItem` with a label of `label` and no keyboard shortcut. A label of "–" represents a separator.

public MenuItem (String label, MenuShortcut shortcut) ★

The final `MenuItem` constructor creates a `MenuItem` with a label of `label` and a `MenuShortcut` of `shortcut`. Pressing the shortcut key is the same as selecting the menu item.

Menu labels

Each `MenuItem` has a label. This is the text that is displayed on the menu.

NOTE Prior to Java 1.1, there was no portable way to associate a hot key with a `MenuItem`. However, in Java 1.0, if you precede a character with an & on a Windows platform, it will appear underlined, and that key will act as the menu's mnemonic key (a different type of shortcut from `MenuShortcut`). Unfortunately, on a Motif platform, the user will see the &. Because the & is part of the label, even if it is not displayed, you must include it explicitly whenever you compare the label to a string.

---

public String getLabel ()

The `getLabel()` method retrieves the label associated with the `MenuItem`.

public void setLabel (String label)

The `setLabel()` method changes the label of the `MenuItem` to `label`.

Shortcuts

public MenuShortcut getMenuShortcut () ★

The `getMenuShortcut()` method retrieves the shortcut associated with this `MenuItem`.

public void setShortcut (MenuShortcut shortcut) ★

The `setShortcut()` method allows you to change the shortcut associated with a `MenuItem` to `shortcut` after the `MenuItem` has been created.

public void deleteMenuShortcut () ★

The `deleteMenuShortcut()` method removes any associated `MenuShortcut` from the `MenuItem`. If there was no shortcut, nothing happens.

Enabling

public boolean isEnabled ()

The `isEnabled()` method checks to see if the `MenuItem` is currently enabled. An enabled `MenuItem` can be selected by the user. A disabled `MenuItem`, by convention, appears grayed out on the `Menu`. Initially, each `MenuItem` is enabled.

public synchronized void setEnabled(boolean b) ★
public void enable (boolean condition) ☆

The `setEnabled()` method either enables or disables the `MenuItem` based on the value of `condition`. If `condition` is `true`, the `MenuItem` is enabled. If `condition` is `false`, it is disabled. When enabled, the user can select it, generating `ACTION_EVENT` or notifying the `ActionListener`. When disabled, the peer does not generate an `ACTION_EVENT` if the user tries to select the `MenuItem`. A disabled `MenuItem` is usually grayed out to signify its state. The way that disabling is signified is platform specific.

`enable()` is the Java 1.0 name for this method.

public synchronized void enable () ☆

The `enable()` method enables the `MenuItem`. In Java 1.1, it is better to use `setEnabled()`.

public synchronized void disable () ☆

The `disable()` method disables the component so that the user cannot select it. In Java 1.1, it is better to use `setEnabled()`.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `MenuItem` peer.

public String paramString ()

The `paramString()` method of `MenuItem` should be protected like other `paramString()` methods. However, it is public so you have access to it. When you call the `toString()` method of a `MenuItem`, the default `toString()` method of `MenuComponent` is called. This in turn calls `paramString()` which builds up the string to display. At the `MenuItem` level, the current label of the object and the shortcut (if present) is appended to the output. If the constructor for the `MenuItem` was `new MenuItem("File")`, the results of `toString()` would be:

```
java.awt.MenuItem[label=File]
```

10.4.2 MenuItem Events

Event handling

With 1.0 event handing, a `MenuItem` generates an `ACTION_EVENT` when it is selected. The argument to `action()` will be the label of the `MenuItem`. But the target of the `ACTION_EVENT` is the `Frame` containing the menu. You cannot subclass `MenuItem` and catch the `Event` within it with `action()`, but you can with `postEvent()`. No other events are generated for `MenuItem` instances.

public boolean action (Event e, Object o)—overridden by user, called by system
The `action()` method for a `MenuItem` signifies that the user selected it. `e` is the `Event` instance for the specific event, while `o` is the label of the `MenuItem`.

Listeners and 1.1 event handling

With the 1.1 event model, you register listeners, and they are told when the event happens.

public String getActionCommand() ★
The `getActionCommand()` method retrieves the command associated with this `MenuItem`. By default, it is the label. However, the default can be changed by using the `setActionCommand()` method (described next). The command acts like the second parameter to the `action()` method in the 1.0 event model.

public void setActionCommand(String command) ★
The `setActionCommand()` method changes the command associated with a `MenuItem`. When an `ActionEvent` happens, the `command` is part of the event. By default, this would be the label of the `MenuItem`. However, you can change the action command by calling this method. Using action commands is a good idea, particularly if you expect your code to run in a multilingual environment.

public void addActionListener(ItemListener listener) ★
The `addActionListener()` method registers `listener` as an object interested in being notified when an `ActionEvent` passes through the `EventQueue` with this `MenuItem` as its target. The `listener.actionPerformed()` method is called whenever these events occur. Multiple listeners can be registered.

public void removeActionListener(ItemListener listener) ★
The `removeActionListener()` method removes `listener` as an interested listener. If `listener` is not registered, nothing happens.

protected final void enableEvents(long eventsToEnable) ★

Using the `enableEvents()` method is usually not necessary. When you register an action listener, the `MenuItem` listens for action events. However, if you wish to listen for events when listeners are not registered, you must enable the events explicitly by calling this method. The settings for the `eventsToEnable` parameter are found in the `AWTEvent` class; you can use any of the `EVENT_MASK` constants like `COMPONENT_EVENT_MASK`, `MOUSE_EVENT_MASK`, and `WINDOW_EVENT_MASK` ORed together for the events you care about. For instance, to listen for action events, call:

```
enableEvents (AWTEvent.ACTION_EVENT_MASK);
```

protected final void disableEvents(long eventsToDisable) ★

Using the `disableEvents()` method is usually not necessary. When you remove an action listener, the `MenuItem` stops listening for action events if there are no more listeners. However, if you need to, you can disable events explicitly by calling `disableEvents()`. The settings for the `eventsToDisable` parameter are found in the `AWTEvent` class; you can use any of the `EVENT_MASK` constants such as `FOCUS_EVENT_MASK`, `MOUSE_MOTION_EVENT_MASK`, and `ACTION_EVENT_MASK` ORed together for the events you no longer care about.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives all `AWTEvents` with this `MenuItem` as its target. `processEvent()` then passes them along to any listeners for processing. When you subclass `MenuItem`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `postEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` to ensure that events are delivered even in the absence of registered listeners.

protected void processActionEvent(ItemEvent e) ★

The `processActionEvent()` method receives all `ActionEvents` with this `MenuItem` as its target. `processActionEvent()` then passes them along to any listeners for processing. When you subclass `MenuItem`, overriding `processActionEvent()` allows you to process all action events yourself, before sending them to any listeners. In a way, overriding `processActionEvent()` is like overriding `action()` using the 1.0 event model.

If you override `processActionEvent()`, remember to call the method `super.processActionEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` to ensure that events are delivered even in the absence of registered listeners.

10.5 Menu

`Menus` are the pull-down objects that appear on the `MenuBar` of a `Frame` or within other menus. They contain `MenuItems` or `CheckboxMenuItems` for the user to select. The `Menu` class subclasses `MenuItem` (so it can appear on a `Menu`, too) and implements `MenuContainer`. Tear-off menus are menus that can be dragged, placed elsewhere on the screen, and remain on the screen when the input focus moves to something else. Java supports tear-off menus if the underlying platform does. Motif (UNIX) supports tear-off menus; Microsoft Windows platforms do not.

10.5.1 Menu Methods

Constructors

public Menu () ★

The first constructor for `Menu` creates a menu that has no label and cannot be torn off. To set the label at a later time, use `setLabel()`.

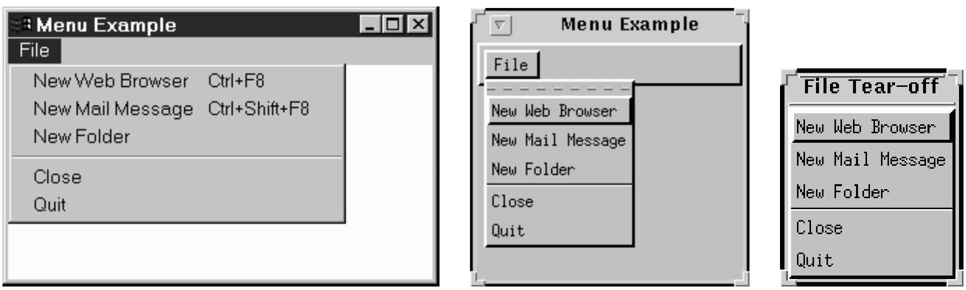
public Menu (String label)

This constructor for `Menu` creates a `Menu` with `label` displayed on it. The `Menu` cannot be torn off.

public Menu (String label, boolean tearOff)

This constructor for `Menu` creates a `Menu` with `label` displayed on it. The handling of `tearOff` is platform dependent.

Figure 10-3 shows a tear-off menu for Windows NT/95 and Motif. Since Windows does not support tear-off menus, the Windows menu looks and acts like a regular menu.



Windows **Motif** **Tear-off**

Figure 10–3: Tear-off menu

Items

public int getItemCount() ★
public int countItems () ☆

The `getItemCount()` method returns the number of items within the `Menu`. Only top-level items are counted: if an item is a submenu, this method doesn't include the items on it.

`countItems()` is the Java 1.0 name for this method.

public MenuItem getItem (int index)

The `getItem()` method returns the `MenuItem` at position `index`. If `index` is invalid, `getItem()` throws the `ArrayIndexOutOfBoundsException` run-time exception.

public synchronized MenuItem add (MenuItem item)

The `add()` method puts `item` on the menu. The label assigned to `item` when it was created is displayed on the menu. If `item` is already in another menu, it is removed from that menu. If `item` is a `Menu`, it creates a submenu. (Remember that `Menu` subclasses `MenuItem`.)

public void add (String label)

This version of `add()` creates a `MenuItem` with `label` as the text and adds that to the menu. If `label` is the `String` "-", a separator bar is added to the `Menu`.

public synchronized void insert(MenuItem item, int index) ★

The `insert()` method puts `item` on the menu at position `index`. The label assigned to `item` when it was created is displayed on the menu. Positions are zero based, and if `index` < 0, `insert()` throws the `IllegalArgumentException` run-time exception.

public synchronized void insert(String label, int index) ★

This version of `insert()` method creates a `MenuItem` with `label` as the text and adds that to the menu at position `index`. If `label` is the String "-", a separator bar is added to the `Menu`. Positions are zero based, and if `index` < 0, this method throws the `IllegalArgumentException` run-time exception.

public void addSeparator ()

The `addSeparator()` method creates a separator `MenuItem` and adds that to the menu. Separator menu items are strictly cosmetic and do not generate events when selected.

public void insertSeparator(int index) ★

The `insertSeparator()` method creates a separator `MenuItem` and adds that to the menu at position `index`. Separator menu items are strictly cosmetic and do not generate events when selected. Positions are zero based. If `index` < 0, `insertSeparator()` throws the `IllegalArgumentException` run-time exception.

public synchronized void remove (int index)

The `remove()` method removes the `MenuItem` at position `index` from the `Menu`. If `index` is invalid, `remove()` throws the `ArrayIndexOutOfBoundsException` run-time exception. `index` is zero based, so it can range from 0 to `getItemCount()-1`.

public synchronized void remove (MenuComponent component)

This version of `remove()` removes the menu item `component` from the `Menu`. If component is not in the `Menu`, nothing happens.

public synchronized void removeAll()

The `removeAll()` removes all `MenuItems` from the `Menu`.

Peers

public synchronized void addNotify ()

The `addNotify()` method creates the `Menu` peer with all the `MenuItems` on it.

public synchronized void removeNotify ()

The `removeNotify()` method destroys the peer of the `MenuComponent` and removes it from the screen. The peers of the items on the menu are also destroyed.

Miscellaneous methods

public boolean isTearOff ()

The `isTearOff()` method returns `true` if this `Menu` is a tear-off menu, and `false` otherwise. Once a menu is created, there is no way to change the tear-off setting. This method can return `true` even on platforms that do not support tear-off menus.

public String paramString () ★

The `paramString()` method of `Menu` should be protected like other `paramString()` methods. However, it is public so you have access to it. When you call the `toString()` method of a `Menu`, the default `toString()` method of `MenuComponent` is called. This in turn calls `paramString()`, which builds up the string to display. At the `Menu` level, the setting for `TearOff` (from constructor) and whether or not it is the help menu (from `MenuBar.setHelpMenu()`) for the menu bar are added. If the constructor for the `Menu` was `new Menu ("File")`, the results of `toString()` would be:

```
java.awt.Menu [menu0,label=File,tearOff=false,isHelpMenu=false]
```

10.5.2 Menu Events

A `Menu` does not generate any event when it is selected. An event is generated when a `MenuItem` on the menu is selected, as long as it is not another `Menu`. You can capture all the events that happen on a `Menu` by overriding `postEvent()`.

10.6 CheckboxMenuItem

The `CheckboxMenuItem` is a subclass of `MenuItem` that can be toggled. It is similar to a `Checkbox` but appears on a `Menu`. The appearance depends upon the platform. There may or may not be a visual indicator next to the choice. However, when the `MenuItem` is selected (`true`), a checkmark or some similar graphic will be displayed next to the label.

There is no way to put `CheckboxMenuItem` components into a `CheckboxGroup` to form a radio menu group.

An example of a `CheckboxMenuItem` is the Show Java Console menu item in Netscape Navigator.

10.6.1 CheckboxMenuItem Methods

Constructors

public CheckboxMenuItem (String label)

The first `CheckboxMenuItem` constructor creates a `CheckboxMenuItem` with no label displayed next to the check toggle. The initial value of the `CheckboxMenuItem` is `false`. To set the label at a later time, use `setLabel()`.

public CheckboxMenuItem (String label)

The next `CheckboxMenuItem` constructor creates a `CheckboxMenuItem` with `label` displayed next to the check toggle. The initial value of the `CheckboxMenuItem` is `false`.

public CheckboxMenuItem (String label, boolean state)

The final `CheckboxMenuItem` constructor creates a `CheckboxMenuItem` with `label` displayed next to the check toggle. The initial value of the `CheckboxMenuItem` is `state`.

Selection

public boolean getState ()

The `getState()` method retrieves the current state of the `CheckboxMenuItem`.

public void setState (boolean condition)

The `setState()` method changes the current state of the `CheckboxMenuItem` to `condition`. When `true`, the `CheckboxMenuItem` will have the toggle checked.

public Object[] getSelectedObjects () ★

The `getSelectedItems()` method returns the currently selected item as an `Object` array. This method, which is required by the `ItemSelectable` interface, allows you to use the same methods to retrieve the selected items of any `Checkbox`, `Choice`, or `List`. The array has at most one element, which contains the label of the selected item; if no item is selected, `getSelectedItems()` returns `null`.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `CheckboxMenuItem` peer.

public String paramString ()

The `paramString()` method of `CheckboxMenuItem` should be protected like other `paramString()` methods. However, it is public, so you have access to it. When you call the `toString()` method of a `CheckboxMenuItem`, the default `toString()` method of `MenuComponent` is called. This in turn calls `paramString()` which builds up the string to display. At the `CheckboxMenuItem` level, the current state of the object is appended to the output. If the constructor for the `CheckboxMenuItem` was `new CheckboxMenuItem("File")` the results would be:

```
java.awt.CheckboxMenuItem[label=File,state=false]
```

10.6.2 CheckboxMenuItem Events

Event handling

A `CheckboxMenuItem` generates an `ACTION_EVENT` when it is selected. The argument to `action()` is the label of the `CheckboxMenuItem`, like the method provided by `MenuItem`, not the state of the `CheckboxMenuItem` as used in `Checkbox`. The target of the `ACTION_EVENT` is the `Frame` containing the menu. You cannot subclass `CheckboxMenuItem` and handle the `Event` within the subclass unless you override `postEvent()`.

Listeners and 1.1 event handling

With the Java 1.1 event model, you register listeners, which are told when the event happens.

public void addItemListener(ItemListener listener) ★

The `addItemListener()` method registers `listener` as an object that is interested in being notified when an `ItemEvent` passes through the `EventQueue` with this `CheckboxMenuItem` as its target. When these item events occur, the `listener.itemStateChanged()` method is called. Multiple listeners can be registered.

public void removeItemListener(ItemListener listener) ★

The `removeItemListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives every `AWTEvent` with this `CheckboxMenuItem` as its target. `processEvent()` then passes it along to any listeners for processing. When you subclass `CheckboxMenuItem`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `postEvent()` using the 1.0 event model.

If you override `processEvent()`, remember to call `super.processEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` to ensure that events are delivered, even in the absence of registered listeners.

protected void processItemEvent(ItemEvent e) ★

The `processItemEvent()` method receives every `ItemEvent` with this `CheckboxMenuItem` as its target. `processItemEvent()` then passes it along to any listeners for processing. When you subclass `CheckboxMenuItem`, overriding `processItemEvent()` allows you to process all item events yourself, before sending them to any listeners. In a way, overriding `processItemEvent()` is like overriding `action()` using the 1.0 event model.

If you override `processItemEvent()`, remember to call the method `super.processItemEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` to ensure that events are delivered even in the absence of registered listeners.

10.7 MenuBar

The `MenuBar` is the component you add to the `Frame` that is displayed on the top line of the `Frame`; the `MenuBar` contains menus. A `Frame` can display only one `MenuBar` at a time. However, you can change the `MenuBar` based on the state of the program so that different menus can appear at different points. The `MenuBar` class extends `MenuComponent` and implements the `MenuContainer` interface.

A MenuBar can be used only as a child component of a Frame. An applet cannot have a MenuBar attached to it, unless you implement the whole thing yourself. Normally, you cannot modify the MenuBar of the applet holder (the browser), unless it is Java based. In other words, you cannot affect the menus of Netscape Navigator, but you can customize *appletviewer* and HotJava, as shown in the following code with the result shown in Figure 10-4. The getTopLevelParent() method was introduced in Section 6.4 with Window.

```
import java.awt.*;
public class ChangeMenu extends java.applet.Applet {
    public void init ()  {
        Frame f = ComponentUtilities.getTopLevelParent(this);
        if (f != null) {
            MenuBar mb = f.getMenuBar();
            Menu m = new Menu ("Cool");
            mb.add (m);
        }
    }
}
```

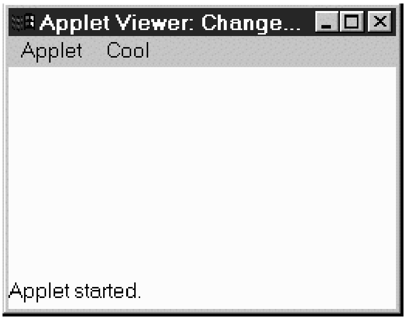


Figure 10–4: Customizing appletviewer's MenuBar

NOTE When you add a MenuBar to a Frame, it takes up space that is part of the drawing area. You need to get the top insets to find out how much space is occupied by the MenuBar and be careful not to draw under it. If you do, the MenuBar will cover what you draw.

10.7.1 MenuBar Methods

Constructors

public MenuBar()

The MenuBar constructor creates an empty MenuBar. To add menus to the MenuBar, use the add() method.

Menus

public int getMenuCount () ★
public int countMenus () ☆

The `getMenuCount()` method returns the number of top-level menus within the `MenuBar`.

`countMenus()` is the Java 1.0 name for this method.

public Menu getMenu (int index)

The `getMenu()` method returns the `Menu` at position `index`. If `index` is invalid, `getMenu()` throws the run-time exception `ArrayIndexOutOfBoundsException`.

public synchronized Menu add (Menu m)

The `add()` method puts choice `m` on the `MenuBar`. The label used to create `m` is displayed on the `MenuBar`. If `m` is already in another `MenuBar`, it is removed from it. The order of items added determines the order displayed on the `MenuBar`, with one exception: if a menu is designated as a help menu by `setHelpMenu()`, it is placed at the right end of the menu bar. Only a `Menu` can be added to a `MenuBar`; you can't add a `MenuItem`. In other words, a `MenuItem` has to lie under at least one menu.

public synchronized void remove (int index)

The `remove()` method removes the `Menu` at position `index` from the `MenuBar`. If `index` is invalid, `remove()` throws the `ArrayIndexOutOfBoundsException` run-time exception. `index` is zero based.

public synchronized void remove (MenuComponent component)

This version of `remove()` removes the menu `component` from the `MenuBar`. If `component` is not in `MenuBar`, nothing happens. The system calls this method when you add a new `Menu` to make sure it does not exist on another `MenuBar`.

Shortcuts

public MenuItem getShortcutMenuItem (MenuShortcut shortcut) ★

The `getShortcutMenuItem()` method retrieves the `MenuItem` associated with the `MenuShortcut shortcut`. If `MenuShortcut` does not exist for this `Menu`, the method returns `null`. `getShortcutMenuItem()` walks through the all submenus recursively to try to find `shortcut`.

public synchronized Enumeration shortcuts() ★

The `shortcuts()` method retrieves an `Enumeration` of all the `MenuShortcut` objects associated with this `MenuBar`.

public void deleteShortcut (MenuShortcut shortcut) ★

The `deleteShortcut()` method removes `MenuShortcut` from the associated `MenuItem` in the `MenuBar`. If the shortcut is not associated with any menu item, nothing happens.

Help menus

It is the convention on many platforms to display help menus as the last menu on the `MenuBar`. The `MenuBar` class lets you designate one of the menus as this special menu. The physical position of a help menu depends on the platform, but those giving special treatment to help menus place them on the right. A `Menu` designated as a help menu doesn't have to bear the label "Help"; the label is up to you.

public Menu getHelpMenu ()

The `getHelpMenu()` method returns the `Menu` that has been designated as the help menu with `setHelpMenu()`. If the menu bar doesn't have a help menu, `getHelpMenu()` returns `null`.

public synchronized void setHelpMenu (Menu m)

The `setHelpMenu()` method sets the menu bar's help menu to `m`. This makes `m` the rightmost menu on the `MenuBar`, possibly right justified. If `m` is not already on the `MenuBar`, nothing happens.

Peers

public synchronized void addNotify ()

The `addNotify()` method creates the `MenuBar` peer with all the menus on it, and in turn their menu items.

public synchronized void removeNotify ()

The `removeNotify()` method destroys the peer of the `MenuBar` and removes it from the screen. The peers of the items on the `MenuBar` are also destroyed.

10.7.2 MenuBar Events

A `MenuBar` does not generate any events.

10.8 Putting It All Together

Now that you know about all the different menu classes, it is time to show an example. Example 10-1 contains the code to put up a functional `MenuBar` attached to a `Frame`, using the 1.0 event model. Figure 10-2 (earlier in the chapter) displays the resulting screen. The key parts to examine are how the menus are put together in the `MenuTest` constructor and how their actions are handled within `action()`. I implement one real action in the example: the one that terminates the application when the user chooses Quit. Any other action just displays the label of the item and (if it was a CheckBoxMenuItem) the item's state, to give you an idea of how you can use the information returned in the event.

Example 10–1: MenuTest 1.0 Source Code

```
import java.awt.*;
public class MenuTest extends Frame {
    MenuTest () {
        super ("MenuTest");
        MenuItem mi;
        Menu file = new Menu ("File", true);
        file.add ("Open");
        file.add (mi = new MenuItem ("Close"));
        mi.disable();
        Menu extras = new Menu ("Extras", false);
        extras.add (new CheckboxMenuItem ("What"));
        extras.add ("Yo");
        extras.add ("Yo");
        file.add (extras);
        file.addSeparator();
        file.add ("Quit");
        Menu help = new Menu("Help");
        help.add ("About");
        MenuBar mb = new MenuBar();
        mb.add (file);
        mb.add (help);
        mb.setHelpMenu (help);
        setMenuBar (mb);
        resize (200, 200);
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            System.exit(0);
        }
        return super.handleEvent (e);
    }
    public boolean action (Event e, Object o) {
        if (e.target instanceof MenuItem) {
            if ("Quit".equals (o)) {
                dispose();
                System.exit(1);
            } else {
                System.out.println ("User selected " + o);
                if (e.target instanceof CheckboxMenuItem) {
                    CheckboxMenuItem cb = (CheckboxMenuItem)e.target;
                    System.out.println ("The value is: " + cb.getState());
                }
            }
            return true;
        }
        return false;
```

Example 10–1: MenuTest 1.0 Source Code (continued)

```
        }
        public static void main (String []args) {
            MenuTest f = new MenuTest ();
            f.show();
        }
    }
```

The MenuTest constructor builds all the menus, creates a menu bar, adds the menus to the menu bar, and adds the menu bar to the Frame. To show what is possible, I've included a submenu, a separator bar, a disabled item, and a help menu.

The handleEvent() method exists to take care of WINDOW_DESTROY events, which are generated if the user uses a native command to exit from the window.

The action() method does the work; it received the action events generated whenever the user selects a menu. We ignore most of them, but a real application would need to do more work figuring out the user's selection. As it is, action() is fairly simple. If the user selected a menu item, we check to see whether the item's label was "Quit"; if it was, we exit. If the user selected anything else, we print the selection and return true to indicate that we handled the event.

10.8.1 Using Java 1.1 Events

Example 10-2 uses the Java 1.1 event model but is otherwise very similar to Example 10-1. Take a close look at the differences and similarities. Although the code that builds the GUI is basically the same in both examples, the event handling is completely different. The helper class MyMenuItem is necessary to simplify event handling. In Java 1.1, every menu item can be an event source, so you have to register a listener for each item. Rather than calling addActionListener() explicitly for each item, we create a subclass of MenuItem that registers a listener automatically. The listener is specified in the constructor to MyMenuItem; in this example, the object that creates the menus (MenuTest12) always registers itself as the listener. An alternative would be to override processActionEvent() in MyMenuItem, but then we'd also need to write a subclass for CheckboxMenuItem.

Having said all that, the code is relatively simple. MenuTest12 implements ActionListener so it can receive action events from the menus. As I noted previously, it registers itself as the listener for every menu item when it builds the interface. The actionPerformed() method is called whenever the user selects a menu item; the logic of this method is virtually the same as it was in Example 10-1. Notice, though, that we use getActionCommand() to read the label of the menu item. (Note also that getActionCommand() doesn't necessarily return the label; you can change the command associated with the menu item by calling `setActionCommand()`.) Similarly, we call the event's `getSource()` method to get the menu item that actually generated the event; we need this to figure out whether the user selected a `CheckboxMenuItem` (which implements `ItemSelectable`).

We override `processWindowEvent()` so that we can receive `WINDOW_CLOSING` events without registering a listener. Window closings occur when the user uses the native display manager to close the application. If one of these events arrives, we shut down cleanly. To make sure that we receive window events even if there are no listeners, the `MenuTest12` constructor calls `enableEvents(WINDOW_EVENT_MASK)`.

Example 10–2: MenuTest12 Source Code, Using Java 1.1 Event Handling

```
// Java 1.1 only
import java.awt.*;
import java.awt.event.*;
public class MenuTest12 extends Frame implements ActionListener {
    class MyMenuItem extends MenuItem {
        public MyMenuItem (String s, ActionListener al) {
            super (s);
            addActionListener (al);
        }
    }
    public MenuTest12 () {
        super ("MenuTest");
        MenuItem mi;
        Menu file = new Menu ("File", true);
        file.add (new MyMenuItem ("Open", this));
        mi = file.add (new MyMenuItem ("Close", this));
        mi.setEnabled (false);
        Menu extras = new Menu ("Extras", false);
        mi = extras.add (new CheckboxMenuItem ("What"));
        mi.addActionListener(this);
        mi = extras.add (new MyMenuItem ("Yo", this));
        mi.setActionCommand ("Yo1");
        mi = extras.add (new MyMenuItem ("Yo", this));
        mi.setActionCommand ("Yo2");
        file.add (extras);
        file.addSeparator();
        file.add (new MyMenuItem ("Quit", this));
        Menu help = new Menu("Help");
        help.add (new MyMenuItem ("About", this));
        MenuBar mb = new MenuBar();
        mb.add (file);
        mb.add (help);
        mb.setHelpMenu (help);
        setMenuBar (mb);
        setSize (200, 200);
        enableEvents (AWTEvent.WINDOW_EVENT_MASK);
    }
// Cannot override processActionEvent since method of MenuItem
// Would have to subclass both MenuItem and CheckboxMenuItem
```

Example 10–2: MenuTest12 Source Code, Using Java 1.1 Event Handling (continued)

```
        public void actionPerformed(ActionEvent e) {
            if (e.getActionCommand().equals("Quit")) {
                System.exit(0);
            }
            System.out.println ("User selected " + e.getActionCommand());
            if (e.getSource() instanceof ItemSelectable) {
                ItemSelectable is = (ItemSelectable)e.getSource();
                System.out.println ("The value is: " +
                    (is.getSelectedObjects().length != 0)));
            }
        }
        protected void processWindowEvent(WindowEvent e) {
            if (e.getID() == WindowEvent.WINDOW_CLOSING) {
                // Notify others we are closing
                super.processWindowEvent(e);
                System.exit(0);
            } else {
                super.processWindowEvent(e);
            }
        }
        public static void main (String []args) {
            MenuTest12 f = new MenuTest12 ();
            f.show();
        }
    }
```

I took the opportunity when writing the 1.1 code to make one additional improvement to the program. By using action commands, you can easily differentiate between the two Yo menu items. Just call `setActionCommand()` to assign a different command to each item. (I used "Yo1" and "Yo2".) You could also differentiate between the items by saving a reference to each menu item, calling `getSource()` in the event handler, and comparing the result to the saved references. However, if the `ActionListener` is another class, it would need access to those references. Using action commands is simpler and results in a cleaner event handler.

The intent of the `setActionCommand()` and `getActionCommand()` methods is more for internationalization support. For example, you could use `setActionCommand()` to associate the command Quit with a menu item, then set the item's label to the appropriate text for the user's locality.

10.9 PopupMenu

The `PopupMenu` class is new to Java 1.1; it allows you to associate context-sensitive menus with Java components. To associate a pop-up menu with a component, create the menu, and add it to the component using the `add(PopupMenu)` method, which all components inherit from the `Component` class.

In principle, any GUI object can have a pop-up menu. In practice, there are a few exceptions. If the component's peer has its own pop-up menu (i.e., a pop-up menu provided by the run-time platform), that pop-up menu effectively overrides the pop-up menu provided by Java. For example, under Windows NT/95, a `TextArea` has a pop-up menu provided by the Windows NT/95 platforms. Java can't override this menu; although you can add a pop-up menu to a `TextArea`, you can't display that menu under Windows NT/95 with the usual mouse sequence.

10.9.1 PopupMenu Methods

Constructors

public PopupMenu() ★

The first `PopupMenu` constructor creates an untitled `PopupMenu`. Once created, the menu can be populated with menu items like any other menu.

public PopupMenu(String label) ★

This constructor creates a `PopupMenu` with a title of `label`. The title appears only on platforms that support titles for context menus. Once created, the menu can be populated with menu items like any other menu.

Miscellaneous methods

public void show(Component origin, int x, int y) ★

Call the `show()` method to display the `PopupMenu`. `x` and `y` specify the location at which the pop-up menu should appear; `origin` specifies the `Component` whose coordinate system is used to locate `x` and `y`. In most cases, you'll want the menu to appear at the point where the user clicked the mouse; to do this, set `origin` to the `Component` that received the mouse event, and set `x` and `y` to the location of the mouse click. It is easy to extract this information from an old-style (1.0) `Event` or a Java 1.1 `MouseEvent`. In Java 1.1, the platform-independent way to say "give me the mouse events that are supposed to trigger pop-up menus" is to call `MouseEvent.isPopupTrigger()`. If this method returns `true`, you should show the pop-up menu if one is associated with the event source. (Note that the mouse event could also be used for some other purpose.)

If the `PopupMenu` is not associated with a `Component`, `show()` throws the run-time exception `NullPointerException`. If `origin` is not the `MenuContainer` for the `PopupMenu` and `origin` is not within the `Container` that the pop-up menu belongs to, `show()` throws the run-time exception `IllegalArgumentException`. Finally, if the `Container` of `origin` does not exist or is not showing, `show()` throws a run-time exception.

public synchronized void addNotify () ★

The `addNotify()` method creates the `PopupMenu` peer with all the `MenuItems` on it.

Example 10-3 is a simple applet that raises a pop-up menu if the user clicks the appropriate mouse button anywhere within the applet. Although the program could use the 1.0 event model, under the 1.0 model, it is impossible to tell which mouse event is appropriate to display the pop-up menu.

Example 10–3: Using a PopupMenu

```
// Java 1.1 only
import java.awt.*;
import java.applet.*;
import java.awt.event.*;

public class PopupTest extends Applet implements ActionListener {
    PopupMenu popup;
    public void init() {
        MenuItem mi;
        popup = new PopupMenu("Title Goes Here");
        popup.add(mi = new MenuItem ("Undo"));
        mi.addActionListener (this);
        popup.addSeparator();
        popup.add(mi = new MenuItem("Cut")).setEnabled(false);
        mi.addActionListener (this);
        popup.add(mi = new MenuItem("Copy")).setEnabled(false);
        mi.addActionListener (this);
        popup.add(mi = new MenuItem ("Paste"));
        mi.addActionListener (this);
        popup.add(mi = new MenuItem("Delete")).setEnabled(false);
        mi.addActionListener (this);
        popup.addSeparator();
        popup.add(mi = new MenuItem ("Select All"));
        mi.addActionListener (this);
        add (popup);
        resize(200, 200);
        enableEvents (AWTEvent.MOUSE_EVENT_MASK);
    }
    protected void processMouseEvent (MouseEvent e) {
        if (e.isPopupTrigger())
            popup.show(e.getComponent(), e.getX(), e.getY());
        super.processMouseEvent (e);
    }
    public void actionPerformed(ActionEvent e) {
        System.out.println (e);
    }
}
```

In this chapter:

- *Scrollbar*
- *Scrolling An Image*
- *The Adjustable Interface*
- *ScrollPane*

11

Scrolling

This chapter describes how Java deals with scrolling. AWT provides two means for scrolling. The first is the fairly primitive `Scrollbar` object. It really provides only the means to read a value from a slider setting. Anything else is your responsibility: if you want to display the value of the setting (for example, if you're using the scrollbar as a volume control) or want to change the display (if you're using scrollbars to control an area that's too large to display), you have to do it yourself. The `Scrollbar` reports scrolling actions through the standard event mechanisms; it is up to the programmer to handle those events and perform the scrolling.

Unlike other components, which generate an `ACTION_EVENT` when something exciting happens, the `Scrollbar` generates five events: `SCROLL_LINE_UP`, `SCROLL_LINE_DOWN`, `SCROLL_PAGE_UP`, `SCROLL_PAGE_DOWN`, and `SCROLL_ABSOLUTE`. In Java 1.0, none of these events trigger a default event handler like the `action()` method. To work with them, you must override the `handleEvent()` method. With Java 1.1, you handle scrolling events by registering an `AdjustmentListener` with the `Scrollbar.addAdjustmentListener()` method; when adjustment events occur, the listener's `adjustmentValueChanged()` method is called.

Release 1.1 of AWT also includes a `ScrollPane` container object; it is a response to one of the limitations of AWT 1.0. A `ScrollPane` is like a `Panel`, but it has scrollbars and scrolling built in. In this sense, it's like `TextArea`, which contains its own scrollbars. You could use a `ScrollPane` to implement a drawing pad that could cover an arbitrarily large area. This saves you the burden of implementing scrolling yourself: generating scrollbars, handling their events, and figuring out how to redisplay the screen accordingly.

Both Scrollbar and ScrollPane take advantage of the Adjustable interface. Adjustable defines the common scrolling activities of the two classes. The Scrollbar class implements Adjustable; a ScrollPane has two methods that return an Adjustable object, one for each scrollbar. Currently, you can use the ScrollPane's "adjustables" to find out the scrollbar settings in each direction. You can't change the settings or register AdjustmentListeners; the appropriate methods exist, but they don't do anything. It's not clear whether this is appropriate behavior or a bug (remember, an interface only lists methods that must be present but doesn't require them to do anything); it may change in a later release.

11.1 Scrollbar

Scrollbars come in two flavors: horizontal and vertical. Although there are several methods for setting the page size, scrollbar range (minimum and maximum values), and so on, basically all you can do is get and set the scrollbar's value. Scrollbars don't contain any area to display their value, though if you want one, you could easily attach a label.

To work with a Scrollbar, you need to understand the pieces from which it is built. Figure 11-1 identifies each of the pieces. At both ends are arrows, which are used to change the Scrollbar value the default amount (one unit) in the direction selected. The paging areas are used to change the Scrollbar value one page (ten units by default) at a time in the direction selected. The slider can be moved to set the scrollbar to an arbitrary value within the available range.

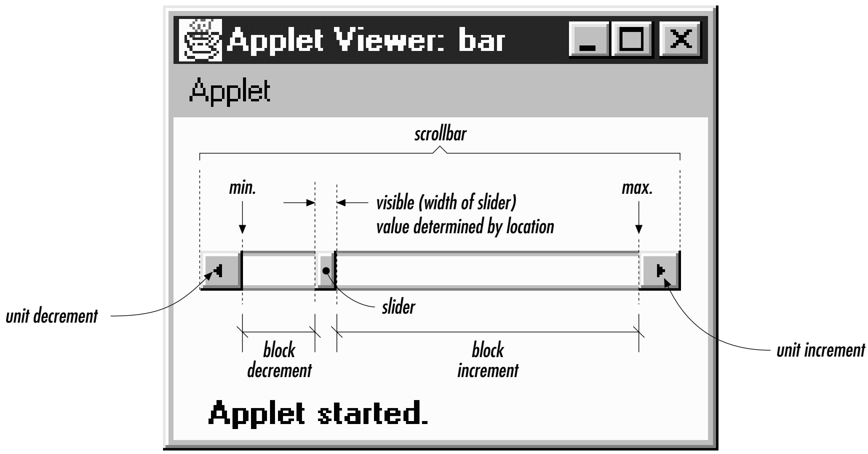


Figure 11–1: Scrollbar elements

11.1.1 Scrollbar Methods

Constants

There are two direction specifiers for `Scrollbar`. The direction tells the `Scrollbar` which way to orient itself. They are used in the constructors, as a parameter to `setOrientation()`, and as the return value for the `getOrientation()` method.

public final static int HORIZONTAL

`HORIZONTAL` is the constant for horizontal orientation.

public final static int VERTICAL

`VERTICAL` is the constant for vertical orientation.

Constructors

public Scrollbar (int orientation, int value, int visible, int minimum, int maximum)

The `Scrollbar` constructor creates a `Scrollbar` with a direction of `orientation` and initial value of `value`. `visible` is the size of the slider. `minimum` and `maximum` are the range of values that the `Scrollbar` can be. If `orientation` is not `HORIZONTAL` or `VERTICAL`, the constructor throws the run-time exception `IllegalArgumentException`. If `maximum` is below the value of `minimum`, the scrollbar's minimum and maximum values are both set to `minimum`. If `value` is outside the range of the scrollbar, it is set to the limit it exceeded. The default line scrolling amount is one. The default paging amount is ten.

If you are using the scrollbar to control a visual object, `visible` should be set to the amount of a displayed object that is on the screen at one time, relative to the entire size of the object (i.e., relative to the scrollbar's range: `maximum - minimum`). Some platforms ignore this parameter and set the scrollbar to a fixed size.

public Scrollbar (int orientation)

This constructor for `Scrollbar` creates a `Scrollbar` with the direction of `orientation`. In Java 1.0, the initial settings for `value`, `visible`, `minimum`, and `maximum` are 0. In Java 1.1, the default value for `visible` is 10, and the default for `maximum` is 100; the other values default to 0. If `orientation` is not `HORIZONTAL` or `VERTICAL`, the constructor throws the run-time exception `IllegalArgumentException`. This constructor is helpful if you want to reserve space for the `Scrollbar` on the screen, to be configured later. You would then use the `setValues()` method to configure the scrollbar.

public Scrollbar ()

This constructor creates a `VERTICAL` `Scrollbar`. In Java 1.0, the initial settings for `value`, `visible`, `minimum`, and `maximum` are 0. In Java 1.1, the default value for `visible` is 10, and the default for `maximum` is 100; the other values default to 0. You would then use the `setValues()` method to configure the scrollbar.

Figure 11-2 shows both vertical and horizontal scrollbars. It also demonstrates a problem you'll run into if you're not careful. If not constrained by the `LayoutManager`, scrollbars can get very fat. The result is rarely pleasing. The solution is to place scrollbars in layout managers that restrict width for vertical scrollbars or height for horizontal ones. The side regions (i.e., everything except the center) of a border layout are ideal. In the long term, the solution will be scrollbars that give you their maximum size and layout managers that observe the maximum size.

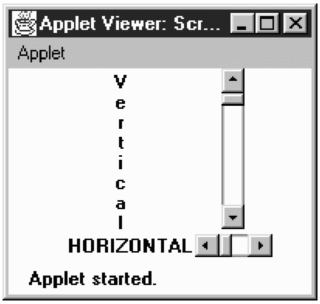


Figure 11–2: Vertical and horizontal scrollbars

Adjustable Methods

public int getOrientation ()

The `getOrientation()` method returns the current orientation of the scrollbar: either `Scrollbar.HORIZONTAL` or `Scrollbar.VERTICAL`.

public synchronized void setOrientation (int orientation) ★

The `setOrientation()` method changes the orientation of the scrollbar to `orientation`, which must be either `Scrollbar.HORIZONTAL` or `Scrollbar.VERTICAL`. If `orientation` is not `HORIZONTAL` or `VERTICAL`, this method throws the run-time exception `IllegalArgumentException`. It was not possible to change the orientation of a scrollbar prior to Java 1.1.

public int getVisibleAmount () ★
public int getVisible () ☆

The `getVisibleAmount()` method gets the `visible` setting of the `Scrollbar`. If the scrollbar's `Container` is resized, the `visible` setting is not automatically changed. `getVisible()` is the Java 1.0 name for this method.

public synchronized void setVisibleAmount (int amount) ★

The `setVisibleAmount()` method changes the current `visible` setting of the `Scrollbar` to `amount`.

public int getValue ()

The `getValue()` method is probably the most frequently called method of `Scrollbar`. It returns the current value of the scrollbar queried.

public synchronized void setValue (int value)

The `setValue()` method changes the value of the scrollbar to `value`. If `value` exceeds a scrollbar limit, the scrollbar's new value is set to that limit. In Java 1.1, this method is synchronized; it was not in earlier versions.

public int getMinimum ()

The `getMinimum()` method returns the current minimum setting for the scrollbar.

public synchronized void setMinimum (int minimum) ★

The `setMinimum()` method changes the `Scrollbar`'s minimum value to `minimum`. The current setting for the `Scrollbar` may change to `minimum` if `minimum` increases above `getValue()`.

public int getMaximum ()

The `getMaximum()` method returns the current maximum setting for the scrollbar.

public synchronized void setMaximum (int maximum) ★

The `setMaximum()` method changes the maximum value of the `Scrollbar` to `maximum`. The current setting for the `Scrollbar` may change to `maximum` if `maximum` decreases below `getValue()`.

public synchronized void setValues (int value, int visible, int minimum, int maximum)

The `setValues()` method changes the `value`, `visible`, `minimum`, and `maximum` settings all at once. In Java 1.0.2, separate methods do not exist for changing `visible`, `minimum`, or `maximum`. The scrollbar's value is set to `value`, visible to `visible`, minimum to `minimum`, and maximum to `maximum`. If `maximum` is below the value of `minimum`, it is set to `minimum`. If `value` is outside the range of the scrollbar, it is set to the limit it exceeded. In Java 1.1, this method is synchronized; it was not in earlier versions.

public int getUnitIncrement () ★
public int getLineIncrement () ☆

The `getUnitIncrement()` method returns the current line increment. This is the amount the scrollbar will scroll if the user clicks on one of the scrollbar's arrows.

`getLineIncrement()` is the Java 1.0 name for this method.

public void setUnitIncrement (int amount) ★
public void setLineIncrement (int amount) ☆

The `setUnitIncrement()` method changes the line increment amount to `amount`.

`setLineIncrement()` is the Java 1.0 name for this method.

Changing the line increment amount was not possible in Java 1.0.2. This method acted like it returned successfully, and `getLineIncrement()` returned the new value, but the `Scrollbar` changed its value by only one (the default) when you clicked on one of the arrows. However, you could work around this defect by explicitly handling the `SCROLL_LINE_UP` and `SCROLL_LINE_DOWN` events: get the correct line increment, adjust the display appropriately, and then set call `setValue()` to correct the scrollbar's value. This workaround is not needed in Java 1.1.

public int getBlockIncrement () ★
public int getPageIncrement () ☆

The `getBlockIncrement()` method returns the current paging increment. This is the amount the scrollbar will scroll if the user clicks between the slider and one of the scrollbar's arrows.

`getPageIncrement()` is the Java 1.0 name for this method.

public void setBlockIncrement (int amount) ★
public void setPageIncrement (int amount) ☆

The `setBlockIncrement()` method changes the paging increment amount to `amount`.

`setPageIncrement()` is the Java 1.0 name for this method.

Changing the paging increment amount was not possible in Java 1.0.2. This method acts like it returns successfully, and `getPageIncrement()` returns the new value, but the `Scrollbar` changes its value only by 10 (the default) when you click on one of the paging areas. However, you can work around this defect by explicitly handling the `SCROLL_PAGE_UP` and `SCROLL_PAGE_DOWN` events: get the correct page increment, adjust the display appropriately, and then set call `setValue()` to correct the scrollbar's value. This workaround is not necessary in Java 1.1.

Miscellaneous methods

public synchronized void addNotify ()

The `addNotify()` method creates the `Scrollbar`'s peer. If you override this method, call `super.addNotify()` first. You will then be able to do everything you need with the information about the newly created peer.

protected String paramString ()

`Scrollbar` doesn't have its own `toString()` method; when you call the `toString()` method of a `Scrollbar`, you are actually calling the method `Component.toString()`. This in turn calls `paramString()`, which builds the string to display. For a `Scrollbar`, `paramString()` puts the scrollbar's value, visibility, minimum, maximum, and direction into the string. In Java 1.0, there is a minor bug in the output. Instead of displaying the scrollbar's `visible` setting (an integer), `paramString()` displays the component's `visible` setting (a boolean). (This is corrected in Java 1.1.) The following `String` is the result of calling `toString()` for a horizontal `Scrollbar` that hasn't been configured yet:

```
java.awt.Scrollbar[0,0,0x0,invalid,val=0,vis=true,min=0,max=0,horz]
```

11.1.2 Scrollbar Events

With the 1.0 event model, scrollbars generate five kinds of events in response to user interaction: `SCROLL_LINE_UP`, `SCROLL_LINE_DOWN`, `SCROLL_PAGE_UP`, `SCROLL_PAGE_DOWN`, and `SCROLL_ABSOLUTE`. The event that occurs depends on what the user did, as shown in Table 11-1; the event type is specified in the `id` field of the `Event` object passed to `handleEvent()`. However, as a programmer, you often do not care which of these five events happened. You care only about the scrollbar's new value, which is always passed as the `arg` field of the `Event` object.

Table 11–1: Scrollbar Events

Event Type (Event.id)	Event Meaning
`SCROLL_ABSOLUTE`	User drags slider.
`SCROLL_LINE_DOWN`	User presses down arrow.
`SCROLL_LINE_UP`	User presses up arrow.
`SCROLL_PAGE_DOWN`	User selects down paging area.
`SCROLL_PAGE_UP`	User selects up paging area.

Because scrollbar events do not trigger any default event handlers (like `action()`), it is necessary to override the `handleEvent()` method to deal with them. Unless your version of `handleEvent()` deals with all conceivable events, you must ensure that the original `handleEvent()` method is called. The simplest way is to have the return statement call `super.handleEvent()`.

Most `handleEvent()` methods first identify the type of event that occurred. The following two code blocks demonstrate different ways of checking for the `Scrollbar` events.

```
if ((e.id == Event.SCROLL_LINE_UP) ||
    (e.id == Event.SCROLL_LINE_DOWN) ||
    (e.id == Event.SCROLL_PAGE_UP) ||
    (e.id == Event.SCROLL_PAGE_DOWN) ||
    (e.id == Event.SCROLL_ABSOLUTE)) {
    // Then determine which Scrollbar was selected and act upon it
}
```

Or more simply:

```
if (e.target instanceof Scrollbar) {
    // Then determine which Scrollbar was selected and act upon it.
}
```

Although the second code block is simpler, the first is the better choice because it is more precise. For example, what would happen if mouse events are passed to scrollbars? Different Java platforms differ most in the types of events passed to different objects; Netscape Navigator 3.0 for Windows 95 sends `MOUSE_ENTER`, `MOUSE_EXIT`, and `MOUSE_MOVE` events to the `Scrollbar`.* The second code block executes for all the mouse events—in fact, any event coming from a `Scrollbar`. Therefore, it executes much more frequently (there can be many `MOUSE_MOVE` events), leading to poor interactive performance.

Another platform-specific issue is the way the system generates `SCROLL_ABSOLUTE` events. Some platforms generate many events while the user drags the scrollbar. Others don't generate the event until the user stops dragging the scrollbar. Some implementations wait until the user stops dragging the scrollbar and then generate a flood of `SCROLL_ABSOLUTE` events for you to handle. In theory, it does not matter which is happening, as long as your event-processing code is tight. If your event-processing code is time consuming, you may wish to start another thread to perform the work. If the thread is still alive when the next event comes along, flag it down, and restart the operation.

Listeners and 1.1 event handling

With the 1.1 event model, you register an `AdjustmentListener` by calling the `addAdjustmentListener()` method. Then when the user moves the `Scrollbar` slider, the `AdjustmentListener.adjustmentValueChanged()` method is called through the protected `Scrollbar.processAdjustmentEvent()` method. Key, mouse, and focus listeners are registered through the three `Component` methods of `addKeyListener()`, `addMouseListener()`, and `addFocusListener()`, respectively. Because you need to register a separate listener for mouse events, you no longer have the problem of distinguishing between mouse events and slider events. An adjustment listener will never receive mouse events.

---

* `MOUSE_UP`, `MOUSE_DOWN`, and `MOUSE_DRAG` are not generated since these operations generate `SCROLL` events.

public void addAdjustmentListener(AdjustmentListener listener) ★

The `addAdjustmentListener()` method registers `listener` as an object interested in being notified when an `AdjustmentEvent` passes through the `EventQueue` with this `Scrollbar` as its target. The method `listener.adjustmentValueChanged()` is called when an event occurs. Multiple listeners can be registered.

public void removeAdjustmentListener(ItemListener listener) ★

The `removeAdjustmentListener()` method removes `listener` as a interested listener. If `listener` is not registered, nothing happens.

protected void processEvent(AWTEvent e) ★

The `processEvent()` method receives every `AWTEvent` with this `Scrollbar` as its target. `processEvent()` then passes it along to any listeners for processing. When you subclass `Scrollbar`, overriding `processEvent()` allows you to process all events yourself, before sending them to any listeners. In a way, overriding `processEvent()` is like overriding `handleEvent()` using the 1.0 event model.

If you override the `processEvent()` method, remember to call the `super.processEvent(e)` method last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

protected void processAdjustmentEvent(ItemEvent e) ★

The `processAdjustmentEvent()` method receives all `AdjustmentEvents` with this `Scrollbar` as its target. `processAdjustmentEvent()` then passes them along to any listeners for processing. When you subclass `Scrollbar`, overriding `processAdjustmentEvent()` allows you to process all events yourself, before sending them to any listeners.

If you override `processAdjustmentEvent()`, you must remember to call `super.processAdjustmentEvent(e)` last to ensure that regular event processing can occur. If you want to process your own events, it's a good idea to call `enableEvents()` (inherited from `Component`) to ensure that events are delivered even in the absence of registered listeners.

11.2 Scrolling An Image

Example 11-1 is a Java application that displays any image in the current directory in a viewing area. The viewing area scrolls to accommodate larger images; the user can use the scrollbars or keypad keys to scroll the image. In Java 1.1, it is trivial to implement this example with a ScrollPane; however, if you're using 1.0, you don't have this luxury. Even if you're using 1.1, this example shows a lot about how to use scrollbars.

Our application uses a Dialog to select which file to display; a FilenameFilter limits the list to image files. We use a menu to let the user request a file list or exit the program. After the user picks a file, the application loads it into the display area. Figure 11-3 shows the main scrolling window.

Figure 11–3: Scrolling an image

The code for the scrolling image consists of a ScrollingImage class, plus several helper classes. It places everything into the file *ScrollingImage.java* for compilation.

Example 11–1: Source Code for Scrolling an Image

```
import java.awt.*;
import java.io.FilenameFilter;
import java.io.File;
```

The first class contains the FilenameFilter used to select relevant filenames: that is, files that are likely to contain GIF, JPEG, or XBM images. If the filename has an appropriate ending, the accept() method returns true; otherwise, it returns false.

```
// True for files ending in jpeg/jpg/gif/xbm
class ImageFileFilter implements FilenameFilter {
    public boolean accept (File dir, String name) {
        String tempname = name.toLowerCase();
        return (tempname.endsWith ("jpg") || tempname.endsWith ("jpeg") ||
```

```
                tempname.endsWith ("gif") || tempname.endsWith ("xbm"));
    }
}
```

The ImageListDialog class displays a list of files from which the user can select. Instead of using FileDialog, we created a customized List to prevent the user from roaming around the entire hard drive; choices are limited to appropriate files in the current directory. When the user selects an entry (by double-clicking), the image is then displayed in the scrolling area.

```
class ImageListDialog extends Dialog {
    private String name = null;
    private String entries[];
    private List list;
    ImageListDialog (Frame f) {
        super (f, "Image List", true);
        File dir = new File (System.getProperty("user.dir"));
        entries = dir.list (new ImageFileFilter());
        list = new List (10, false);
        for (int i=0;i<entries.length;i++) {
            list.addItem (entries[i]);
        }
        add ("Center", list);
        pack();
    }
    public String getName () {
        return name;
    }
    public boolean action (Event e, Object o) {
        name = (String)e.arg;
        ((ScrollingImage)getParent()).processImage();
        dispose();
        return true;
    }
}
```

The code in this class is straightforward. The constructor reads the current directory from the system property list, uses the list() method of the File class to create a list of files that match our filename filter, and then creates a List object that lists these files. getName() returns the name of the selected file. action() is called when the user selects a file; it sets the name of the selected file from the arg field of the Event and then calls the processImage() method of its parent container. The parent container of our ImageListDialog is the ScrollingImage class we are defining; its processImage() method displays a scrollable image.

The next class, ImageCanvas, is the Canvas that the image is drawn onto. We use a separate Canvas rather than drawing directly onto the Frame so that the scrollbars do not overlap the edges of the image. You will notice that the paint() method uses negative x and y values. This starts the drawing outside the Canvas area; as a result, the Canvas displays only part of the image. This is how we do the actual scrolling. (xPos, yPos) are the values given to us from the scrollbars; by positioning the image at (-xPos, -yPos), we ensure that the point (xPos, yPos) appears in the upper left corner of the canvas.

```
class ImageCanvas extends Canvas {
    Image image;
    int xPos, yPos;
    public void redraw (int xPos, int yPos, Image image) {
        this.xPos = xPos;
        this.yPos = yPos;
        this.image = image;
        repaint();
    }
    public void paint (Graphics g) {
        if (image != null)
            g.drawImage (image, -xPos, -yPos, this);
    }
}
```

ScrollingImage provides the framework for the rest of the program. It provides a menu to bring up the Dialog to choose the file, the scrollbars to scroll the scrolling canvas, and the image canvas area. This class also implements event handling methods to capture the scrollbar events, paging keys, and menu events.

```
public class ScrollingImage extends Frame {
    static Scrollbar horizontal, vertical;
    ImageCanvas center;
    int xPos, yPos;
    Image image;
    ImageListDialog ild;
    ScrollingImage () {
        super ("Image Viewer");
        add ("Center", center = new ImageCanvas ());
        add ("South",  horizontal = new Scrollbar (Scrollbar.HORIZONTAL));
        add ("East", vertical = new Scrollbar (Scrollbar.VERTICAL));
        Menu m = new Menu ("File", true);
        m.add ("Open");
        m.add ("Close");
        m.add ("-");
        m.add ("Quit");
        MenuBar mb = new MenuBar();
        mb.add (m);
        setMenuBar (mb);
        resize (400, 300);
    }
    public static void main (String args[]) {
        ScrollingImage si = new ScrollingImage ();
        si.show();
    }
    public boolean handleEvent (Event e) {
```

```
        if (e.id == Event.WINDOW_DESTROY) {
            System.exit(0);
        } else if (e.target instanceof Scrollbar) {
            if (e.target == horizontal) {
                xPos = ((Integer)e.arg).intValue();
            } else if (e.target == vertical) {
                yPos = ((Integer)e.arg).intValue();
            }
            center.redraw (xPos, yPos, image);
        }
        return super.handleEvent (e);
    }
```

This `handleEvent()` method kills the program if the user used the windowing system to exit from it (`WINDOW_DESTROY`). More to the point, if a `Scrollbar` generated the event, `handleEvent()` figures out if it was the horizontal or vertical scrollbar, saves its value as the `x` or `y` position, and redraws the image in the new location. Finally, it calls `super.handleEvent()`; as we will see in the following code, other events that we care about (key events and menu events) we don't want to handle here—we would rather handle them normally, in `action()` and `keyDown()` methods.

```
    public void processImage () {
        image = getToolkit().getImage (ild.getName());
        MediaTracker tracker = new MediaTracker (this);
        tracker.addImage (image, 0);
        try {
            tracker.waitForAll();
        } catch (InterruptedException ie) {
        }
        xPos = 0;
        yPos = 0;
        int imageHeight = image.getHeight (this);
        int imageWidth = image.getWidth (this);
        vertical.setValues (0, 5, 0, imageHeight);
        horizontal.setValues (0, 5, 0, imageWidth);
        center.redraw (xPos, yPos, image);
    }
```

`processImage()` reads the image's filename, calls `getImage()`, and sets up a `MediaTracker` to wait for the image to load. Once the image has loaded, it reads the height and width, and uses these to set the maximum values for the vertical and horizontal scrollbars by calling `setValues()`. The scrollbars' minimum and initial values are both 0. The size of the scrollbar "handle" is set to 5, rather than trying to indicate the visible portion of the image.

```
    public boolean action (Event e, Object o) {
        if (e.target instanceof MenuItem) {
            if ("Open".equals (o)) {
                // If showing already, do not show again
                if ((ild == null) || (!ild.isShowing())) {
```

```
                ild = new ImageListDialog (this);
                ild.show();
            }
        } else if ("Close".equals(o)) {
            image = null;
            center.redraw (xPos, yPos, image);
        } else if ("Quit".equals(o)) {
            System.exit(0);
        }
        return true;
    }
    return false;
}
```

`action()` handles menu events. If the user selected Open, it displays the dialog box that selects a file. Close redraws the canvas with a null image; Quit exits the program. If any of these events occurred, `action()` returns `true`, indicating that the event was fully handled. If any other event occurred, `action()` returns `false`, so that the system will deliver the event to any other methods that might be interested in it.

```
public boolean keyDown (Event e, int key) {
    if (e.id == Event.KEY_ACTION) {
        Scrollbar target = null;
        switch (key) {
            case Event.HOME:
                target = vertical;
                vertical.setValue(vertical.getMinimum());
                break;
            case Event.END:
                target = vertical;
                vertical.setValue(vertical.getMaximum());
                break;
            case Event.PGUP:
                target = vertical;
                vertical.setValue(vertical.getValue()
                         - vertical.getPageIncrement());
                break;
            case Event.PGDN:
                target = vertical;
                vertical.setValue(vertical.getValue()
                         + vertical.getPageIncrement());
                break;
            case Event.UP:
                target = vertical;
                vertical.setValue(vertical.getValue()
                         - vertical.getLineIncrement());
                break;
            case Event.DOWN:
                target = vertical;
                vertical.setValue(vertical.getValue()
                         + vertical.getLineIncrement());
                break;
```

```
                case Event.LEFT:
                    target = horizontal;
                    if (e.controlDown())
                        horizontal.setValue(horizontal.getValue() -
                            horizontal.getPageIncrement());
                    else
                        horizontal.setValue(horizontal.getValue() -
                            horizontal.getLineIncrement());
                    break;
                case Event.RIGHT:
                    target = horizontal;
                    if (e.controlDown())
                        horizontal.setValue(horizontal.getValue() +
                            horizontal.getPageIncrement());
                    else
                        horizontal.setValue(horizontal.getValue() +
                            horizontal.getLineIncrement());
                    break;
                default:
                    return false;
            }
            Integer value = new Integer (target.getValue());
            postEvent (new Event ((Object)target,
                       Event.SCROLL_ABSOLUTE, (Object)value));
            return true;
        }
        return false;
    }
}
```

`keyDown()` isn't really necessary, but it adds a nice extension to our scrollbars: in addition to using the mouse, the user can scroll with the arrow keys. Pressing an arrow key generates a `KEY_ACTION` event. If we have one of these events, we check what kind of key it was, then compute a new scrollbar value, then call `setValue()` to set the appropriate scrollbar to this value. For example, if the user presses the page up key, we read the page increment, add it to the current value of the vertical scrollbar, and then set the vertical scrollbar accordingly. (Note that this works even though nondefault page and line increments aren't implemented correctly.) The one trick here is that we have to get the rest of the program to realize that the scrollbar values have changed. To do so, we create a new `SCROLL_ABSOLUTE` event, and call `postEvent()` to deliver it.

11.3 The Adjustable Interface

The `Adjustable` interface is new to Java 1.1. It provides the method signatures required for an object that lets you adjust a bounded integer value. It is currently implemented by `Scrollbar` and returned by two methods within `ScrollPane`.

11.3.1 Constants of the Adjustable Interface

There are two direction specifiers for `Adjustable`.

public final static int HORIZONTAL ★

`HORIZONTAL` is the constant for horizontal orientation.

public final static int VERTICAL ★

`VERTICAL` is the constant for vertical orientation.

11.3.2 Methods of the Adjustable Interface

public abstract int getOrientation () ★

The `getOrientation()` method is for returning the current orientation of the adjustable object, either `Adjustable.HORIZONTAL` or `Adjustable.VERTICAL`.

`setOrientation()` is not part of the interface. Not all adjustable objects need to be able to alter orientation. For example, `Scrollbar` instances can change their orientation, but each `Adjustable` instance associated with a `ScrollPane` has a fixed, unchangeable orientation.

public abstract int getVisibleAmount () ★

The `getVisibleAmount()` method lets you retrieve the size of the visible slider of the adjustable object.

public abstract void setVisibleAmount (int amount) ★

The `setVisibleAmount()` method lets you change the size of the visible slider to `amount`.

public abstract int getValue () ★

The `getValue()` method lets you retrieve the current value of the adjustable object.

public abstract void setValue (int value) ★

The `setValue()` method lets you change the value of the adjustable object to `value`.

public abstract int getMinimum ()

The `getMinimum()` method lets you retrieve the current minimum setting for the object.

public abstract void setMinimum (int minimum) ★

The `setMinimum()` method lets you change the minimum value of the adjustable object to `minimum`.

public abstract int getMaximum () ★

The getMaximum() method lets you retrieve the current maximum setting for the object.

public abstract void setMaximum (int maximum) ★

The setMaximum() method lets you change the maximum value of the adjustable object to maximum.

public abstract int getUnitIncrement () ★

The getUnitIncrement() method lets you retrieve the current line increment.

public abstract void setUnitIncrement (int amount) ★

The setUnitIncrement() method lets you change the line increment amount of the adjustable object to amount.

public abstract int getBlockIncrement () ★

The getBlockIncrement() method lets you retrieve the current page increment.

public abstract void setBlockIncrement (int amount) ★

The setBlockIncrement() method lets you change the paging increment amount of the adjustable object to amount.

public abstract void addAdjustmentListener(AdjustmentListener listener) ★

The addAdjustmentListener() method lets you register listener as an object interested in being notified when an AdjustmentEvent passes through the EventQueue with this Adjustable object as its target.

public abstract void removeAdjustmentListener(ItemListener listener) ★

The removeAdjustmentListener() method removes listener as a interested listener. If listener is not registered, nothing happens.

11.4 ScrollPane

A ScrollPane is a Container with built-in scrollbars that can be used to scroll its contents. In the current implementation, a ScrollPane can hold only one Component and has no layout manager. The component within a ScrollPane is always given its preferred size. While the scrollpane's inability to hold multiple components sounds like a deficiency, it isn't; there's no reason you can't put a Panel inside a ScrollPane, put as many components as you like inside the Panel, and give the Panel any layout manager you wish.

Scrolling is handled by the ScrollPane peer, so processing is extremely fast. In Example 11-1, the user moves a Scrollbar to trigger a scrolling event, and the peer sends the event to the Java program to find someone to deal with it. Once it identifies the target, it posts the event, then tries to find a handler. Eventually, the applet's `handleEvent()` method is called to reposition the `ImageCanvas`. The new position is then given to the peer, which finally redisplays the `Canvas`. Although most of the real work is behind the scenes, it is still happening. With `ScrollPane`, the peer generates and handles the event itself, which is much more efficient.

11.4.1 ScrollPane Methods

Constants

The `ScrollPane` class contains three constants that can be used to control its scrollbar display policy. The constants are fairly self-explanatory. The constants are used in the constructor for a `ScrollPane` instance.

public static final int SCROLLBARS_AS_NEEDED ★

`SCROLLBARS_AS_NEEDED` is the default scrollbar display policy. With this policy, the `ScrollPane` displays each scrollbar only if the `Component` is too large in the scrollbar's direction.

public static final int SCROLLBARS_ ALWAYS ★

With the `SCROLLBARS_ALWAYS` display policy, the `ScrollPane` should always display both scrollbars, whether or not they are needed.

public static final int SCROLLBARS_ NEVER ★

With the `SCROLLBARS_NEVER` display policy, the `ScrollPane` should never display scrollbars, even when the object is bigger than the `ScrollPane`'s area. When using this mode, you should provide some means for the user to scroll, either through a button outside the container or by listening for events happening within the container.

Constructors

public ScrollPane () ★

The first constructor creates an instance of `ScrollPane` with the default scrollbar display policy setting, `SCROLLBARS_AS_NEEDED`.

public ScrollPane (int scrollbarDisplayPolicy) ★

The other constructor creates an instance of `ScrollPane` with a scrollbar setting of `scrollbarDisplayPolicy`. If `scrollbarDisplayPolicy` is not one of the class constants, this constructor throws the `IllegalArgumentException` run-time exception.

Layout methods

public final void setLayout(LayoutManager mgr) ★

The setLayout() method of ScrollPane throws an AWTError. It overrides the setLayout() method of Container to prevent you from changing a ScrollPane's layout manager.

public void doLayout () ★
public void layout () ☆

The doLayout() method of ScrollPane shapes the contained object to its preferred size.

layout() is another name for this method.

public final void addImpl(Component comp, Object constraints, int index) ★

The addImpl() method of ScrollPane permits only one object to be added to the ScrollPane. It overides the addImpl() method of Container to enforce the ScrollPane's limitations on adding components. If index > 0, addImpl() throws the run-time exception IllegalArgumentException. If a component is already within the ScrollPane, it is removed before comp is added. The constraints parameter is ignored.

Scrolling methods

public int getScrollbarDisplayPolicy() ★

The getScrollbarDisplayPolicy() method retrieves the current display policy, as set by the constructor. You cannot change the policy once it has been set. The return value is one of the class constants: SCROLLBARS_AS_NEEDED, SCROLLBARS_ALWAYS, or SCROLLBARS_NEVER.

public Dimension getViewportSize() ★

The getViewportSize() method returns the current size of the ScrollPane, less any Insets, as a Dimension object. The size is given in pixels and has an initial value of 100 x 100.

public int getHScrollbarHeight() ★

The getHScrollbarHeight() method retrieves the height in pixels of a horizontal scrollbar. The value returned is without regard to the display policy; that is, you may be given a height even if the scrollbar is not displayed. This method may return 0 if the scrollbar's height cannot be calculated at this time (no peer) or if you are using the SCROLLBARS_NEVER display policy.

The width of a horizontal scrollbar is just getViewportSize().width.

public int getVScrollbarWidth() ★

The `getVScrollbarWidth()` method retrieves the width in pixels of a vertical scrollbar. The value returned is without regard to the display policy; that is, you may be given a width even if the scrollbar is not displayed. This method may return 0 if the scrollbar's width cannot be calculated at this time (no peer) or if you are using the `SCROLLBARS_NEVER` display policy.

The height of a vertical scrollbar is just `getViewportSize().height`.

public Adjustable getHAdjustable() ★

The `getHAdjustable()` method returns the adjustable object representing the horizontal scrollbar (or `null` if it is not present). Through the methods of `Adjustable`, you can get the different settings of the scrollbar.

The object that this method returns is an instance of the package private class `ScrollPaneAdjustable`, which implements the `Adjustable` interface. this class allows you to register listeners for the scrollpane's events and inquire about various properties of the pane's scrollbars. It does not let you set some scrollbar properties; the `setMinimum()`, `setMaximum()`, and `setVisibleAmount()` methods throw an `AWTError` when called.

public Adjustable getVAdjustable() ★

The `getVAdjustable()` method returns the adjustable object representing the vertical scrollbar (or `null` if it is not present). Through the methods of `Adjustable`, you can get the different settings of the scrollbar.

The object that this method returns is an instance of the package private class `ScrollPaneAdjustable`, which implements the `Adjustable` interface. this class allows you to register listeners for the scrollpane's events and inquire about various properties of the pane's scrollbars. It does not let you set some scrollbar properties; the `setMinimum()`, `setMaximum()`, and `setVisibleAmount()` methods throw an `AWTError` when called.

public void setScrollPosition(int x, int y) ★

This `setScrollPosition()` method moves the `ScrollPane` to the designated location if possible. The `x` and `y` arguments are scrollbar settings, which should be interpreted in terms of the minimum and maximum values given to you by the horizontal and vertical `Adjustable` objects (returned by the previous two methods). If the `ScrollPane` does not have a child component, this method throws the run-time exception `NullPointerException`. You can also move the `ScrollPane` by calling the `Adjustable.setValue()` method of one of the scrollpane's `Adjustable` objects.

public void setScrollPosition(Point p) ★

This `setScrollPosition()` method calls the previous with parameters of `p.x`, and `p.y`.

public Point getScrollPosition() ★

The `getScrollPosition()` method returns the current position of both the scrollpane's `Adjustable` objects as a `Point`. If there is no component within the `ScrollPane`, `getScrollPosition()` throws the `NullPointerException` runtime exception. Another way to get this information is by calling the `Adjustable.getValue()` method of each `Adjustable` object.

Miscellaneous methods

public void printComponents (Graphics g) ★

The `printComponents()` method of `ScrollPane` prints the single component it contains. This is done by clipping the context `g` to the size of the display area and calling the contained component's `printAll()` method.

public synchronized void addNotify () ★

The `addNotify()` method creates the `ScrollPane` peer. If you override this method, call `super.addNotify()` first, then add your customizations for the new class. You will then be able to do everything you need with the information about the newly created peer.

protected String paramString () ★

`ScrollPane` doesn't have its own `toString()` method; so when you call the `toString()` method of a `ScrollPane`, you are actually calling the `Component.toString()` method. This in turn calls `paramString()`, which builds the string to display. For a `ScrollPane`, `paramString()` adds the current scroll position, insets, and scrollbar display policy. For example:

```
java.awt.ScrollPane[scrollpane0,0,0,0x0,invalid,ScrollPosition=(0,0),
          Insets=(0,0,0,0),ScrollbarDisplayPolicy=always]
```

11.4.2 ScrollPane Events

The `ScrollPane` peer deals with the scrolling events for you. It is not necessary to catch or listen for these events. As with any other `Container`, you can handle the 1.0 events of the object you contain or listen for 1.1 events that happen within you.

11.4.3 Using a ScrollPane

The following applet demonstrates one way to use a `ScrollPane`. Basically, you place the object you want to scroll in the `ScrollPane` by calling the `add()` method.

This can be a `Panel` with many objects on it or a `Canvas` with an image drawn on it. You then add as many objects as you want to the `Panel` or scribble on the `Canvas` to your heart's delight. No scrolling event handling is necessary. That is all there is to it. To make this example a little more interesting, whenever you select a button, the `ScrollPane` scrolls to a randomly selected position. Figure 11-4 displays the screen.

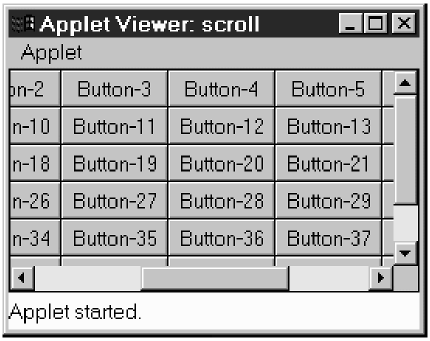


Figure 11–4: A ScrollPane containing many buttons

Here's the code:

```
// Java 1.1 only
import java.awt.*;
import java.awt.event.*;
import java.applet.*;
public class scroll extends Applet implements ActionListener, ContainerListener {
    ScrollPane sp = new ScrollPane (ScrollPane.SCROLLBARS_ALWAYS);
    public void init () {
        setLayout (new BorderLayout ());
        Panel p = new Panel(new GridLayout (7, 8));
        p.addContainerListener (this);
        for (int j=0;j<50;j++)
            p.add (new Button ("Button-" + j));
        sp.add (p);
        add (sp, "Center");
    }
    public void componentAdded(ContainerEvent e) {
        if (e.getID() == ContainerEvent.COMPONENT_ADDED) {
            if (e.getChild() instanceof Button) {
                Button b = (Button)e.getChild();
                b.addActionListener(this);
            }
        }
    }
    public void componentRemoved(ContainerEvent e) {
    }
    public void actionPerformed (ActionEvent e) {
        Component c = sp.getComponent();
```

```
                Dimension d = c.getSize();
                sp.setScrollPosition ((int)(Math.random()*d.width),
                    (int)(Math.random()*d.height));
        }
    }
```

Working with the ScrollPane itself is easy; we just create one, add a Panel to it, set the Panel's layout manager to GridLayout, and add a lot of buttons to the Panel. The applet itself is the action listener for all the buttons; when anybody clicks a button, actionPerformed() is called, which generates a new random position based on the viewport size and sets the new scrolling position accordingly by calling setScrollPosition().

The more interesting part of this applet is the way it works with buttons. Instead of directly adding a listener for each button, we add a ContainerListener to the containing panel and let it add listeners. Although this may seem like extra work here, it demonstrates how you can use container events to take actions whenever someone adds or removes a component. At first glance, you might ask why I didn't just call enableEvents(AWTEvent.CONTAINER_EVENT_MASK) and override the applet's processContainerEvent() to attach the listeners. If we were only adding our components to the applet, that would work great. Unfortunately, the applet is not notified when buttons are added to an unrelated panel. It would be notified only when the panel was added to the applet.

12

In this chapter:
- *ImageObserver*
- *ColorModel*
- *ImageProducer*
- *ImageConsumer*
- *ImageFilter*

Image Processing

The image processing parts of Java are buried within the `java.awt.image` package. The package consists of three interfaces and eleven classes, two of which are abstract. They are as follows:

- The `ImageObserver` interface provides the single method necessary to support the asynchronous loading of images. The interface implementers watch the production of an image and can react when certain conditions arise. We briefly touched on `ImageObserver` when we discussed the `Component` class (in Chapter 5, *Components*), because `Component` implements the interface.
- The `ImageConsumer` and `ImageProducer` interfaces provide the means for low level image creation. The `ImageProducer` provides the source of the pixel data that is used by the `ImageConsumer` to create an `Image`.
- The `PixelGrabber` and `ImageFilter` classes, along with the `AreaAveragingScaleFilter`, `CropImageFilter`, `RGBImageFilter`, and `ReplicateScaleFilter` subclasses, provide the tools for working with images. `PixelGrabber` consumes pixels from an `Image` into an array. The `ImageFilter` classes modify an existing image to produce another `Image` instance. `CropImageFilter` makes smaller images; `RGBImageFilter` alters pixel colors, while `AreaAveragingScaleFilter` and `ReplicateScaleFilter` scale images up and down using different algorithms. All of these classes implement `ImageConsumer` because they take pixel data as input.
- `MemoryImageSource` and `FilteredImageSource` produce new images. `MemoryImageSource` takes an array and creates an image from it. `FilteredImageSource` uses an `ImageFilter` to read and modify data from another image and produces the new image based on the original. Both `MemoryImageSource` and `FilteredImageSource` implement `ImageProducer` because they produce new pixel data.

- ColorModel and its subclasses, DirectColorModel and IndexColorModel, provide the palette of colors available when creating an image or tell you the palette used when using PixelGrabber.

The classes in the java.awt.image package let you create Image objects at run-time. These classes can be used to rotate images, make images transparent, create image viewers for unsupported graphics formats, and more.

12.1 ImageObserver

As you may recall from Chapter 2, *Simple Graphics*, the last parameter to the drawImage() method is the image's ImageObserver. However, in Chapter 2 I also said that you can use this as the image observer and forget about it. Now it's time to ask the obvious questions: what is an image observer, and what is it for?

Because getImage() acquires an image asynchronously, the entire Image object might not be fully loaded when drawImage() is called. The ImageObserver interface provides the means for a component to be told asynchronously when additional information about the image is available. The Component class implements the imageUpdate() method (the sole method of the ImageObserver interface), so that method is inherited by any component that renders an image. Therefore, when you call drawImage(), you can pass this as the final argument; the component on which you are drawing serves as the ImageObserver for the drawing process. The communication between the image observer and the image consumer happens behind the scenes; you never have to worry about it, unless you want to write your own imageUpdate() method that does something special as the image is being loaded.

If you call drawImage() to display an image created in local memory (either for double buffering or from a MemoryImageSource), you can set the ImageObserver parameter of drawImage() to null because no asynchrony is involved; the entire image is available immediately, so an ImageObserver isn't needed.

12.1.1 ImageObserver Interface

Constants

The various flags associated with the ImageObserver are used for the infoflags argument to imageUpdate(). The flags indicate what kind of information is available and how to interpret the other arguments to imageUpdate(). Two or more flags are often combined (by an OR operation) to show that several kinds of information are available.

public static final int WIDTH

When the `WIDTH` flag is set, the `width` argument to `imageUpdate()` correctly indicates the image's width. Subsequent calls to `getWidth()` for the `Image` return the valid image width. If you call `getWidth()` before this flag is set, expect it to return -1.

public static final int HEIGHT

When the `HEIGHT` flag is set, the `height` argument to `imageUpdate()` correctly indicates the image's height. Subsequent calls to `getHeight()` for the `Image` return the valid image height. If you call `getHeight()` before this flag is set, expect it to return -1.

public static final int PROPERTIES

When the `PROPERTIES` flag is set, the image's properties are available. Subsequent calls to `getProperty()` return valid image properties.

public static final int SOMEBITS

When the `SOMEBITS` flag of `infoflags` (from `imageUpdate()`) is set, the image has started loading and at least some of its content are available for display. When this flag is set, the `x`, `y`, `width`, and `height` arguments to `imageUpdate()` indicate the bounding rectangle for the portion of the image that has been delivered so far.

public static final int FRAMEBITS

When the `FRAMEBITS` flag of `infoflags` is set, a complete frame of a multi-frame image has been loaded and can be drawn. The remaining parameters to `imageUpdate()` should be ignored (`x`, `y`, `width`, `height`).

public static final int ALLBITS

When the `ALLBITS` flag of infoflags is set, the image has been completely loaded and can be drawn. The remaining parameters to `imageUpdate()` should be ignored (`x`, `y`, `width`, `height`).

public static final int ERROR

When the `ERROR` flag is set, the production of the image has stopped prior to completion because of a severe problem. `ABORT` may or may not be set when `ERROR` is set. Attempts to reload the image will fail. You might get an `ERROR` because the URL of the `Image` is invalid (file not found) or the image file itself is invalid (invalid size/content).

public static final int ABORT

When the `ABORT` flag is set, the production of the image has aborted prior to completion. If `ERROR` is not set, a subsequent attempt to draw the image may succeed. For example, an image would abort without an error if a network error occurred (e.g., a timeout on the HTTP connection).

Method

public boolean imageUpdate (Image image, int infoflags, int x, int y, int width, int height)

The `imageUpdate()` method is the sole method in the `ImageObserver` interface. It is called whenever information about an image becomes available. To register an image observer for an image, pass an object that implements the `ImageObserver` interface to `getWidth()`, `getHeight()`, `getProperty()`, `prepareImage()`, or `drawImage()`.

The `image` parameter to `imageUpdate()` is the image being rendered on the observer. The `infoflags` parameter is a set of `ImageObserver` flags ORed together to signify the current information available about `image`. The meaning of the `x`, `y`, `width`, and `height` parameters depends on the current `infoflags` settings.

Implementations of `imageUpdate()` should return `true` if additional information about the image is desired; returning `false` means that you don't want any additional information, and consequently, `imageUpdate()` should not be called in the future for this image. The default `imageUpdate()` method returns `true` if neither `ABORT` nor `ALLBITS` are set in the `infoflags`—that is, the method `imageUpdate()` is interested in further information if no errors have occurred and the image is not complete. If either flag is set, `imageUpdate()` returns `false`.

You should not call `imageUpdate()` directly—unless you are developing an `ImageConsumer`, in which case you may find it worthwhile to override the default `imageUpdate()` method, which all components inherit from the `Component` class.

12.1.2 Overriding imageUpdate

Instead of bothering with the `MediaTracker` class, you can override the `imageUpdate()` method and use it to notify you when an image is completely loaded. Example 12-1 demonstrates the use of `imageUpdate()`, along with a way to force your images to load immediately. Here's how it works: the `init()` method calls `getImage()` to request image loading at some time in the future. Instead of waiting for `drawImage()` to trigger the loading process, `init()` forces loading to start by calling `prepareImage()`, which also registers an image observer. `prepareImage()` is a method of the `Component` class discussed in Chapter 5.

The `paint()` method doesn't attempt to draw the image until the variable `loaded` is set to `true`. The `imageUpdate()` method checks the `infoflags` argument to see whether `ALLBITS` is set; when it is set, `imageUpdate()` sets `loaded` to `true`, and schedules a call to `paint()`. Thus, `paint()` doesn't call `drawImage()` until the method `imageUpdate()` has discovered that the image is fully loaded.

Example 12–1: imageUpdate Override.

```
import java.applet.*;
import java.awt.*;
import java.awt.image.ImageObserver;
public class imageUpdateOver extends Applet {
    Image image;
    boolean loaded = false;
    public void init () {
        image = getImage (getDocumentBase(), "rosey.jpg");
        prepareImage (image, -1, -1, this);
    }
    public void paint (Graphics g) {
        if (loaded)
            g.drawImage (image, 0, 0, this);
    }
    public void update (Graphics g) {
        paint (g);
    }
    public synchronized boolean imageUpdate (Image image, int infoFlags,
                        int x, int y, int width, int height) {
        if ((infoFlags & ImageObserver.ALLBITS) != 0) {
            loaded = true;
            repaint();
            return false;
        } else {
            return true;
        }
    }
}
```

Note that the call to `prepareImage()` is absolutely crucial. It is needed both to start image loading and to register the image observer. If `prepareImage()` were omitted, `imageUpdate()` would never be called, `loaded` would not be set, and `paint()` would never attempt to draw the image. As an alternative, you could use the `MediaTracker` class to force loading to start and monitor the loading process; that approach might give you some additional flexibility.

12.2 ColorModel

A color model determines how colors are represented within AWT. `ColorModel` is an abstract class that you can subclass to specify your own representation for colors. AWT provides two concrete subclasses of `ColorModel` that you can use to build your own color model; they are `DirectColorModel` and `IndexColorModel`. These two correspond to the two ways computers represent colors internally.

Most modern computer systems use 24 bits to represent each pixel. These 24 bits contain 8 bits for each primary color (red, green, blue); each set of 8 bits represents the intensity of that color for the particular pixel. This arrangement yields the familiar "16 million colors" that you see in advertisements. It corresponds closely to Java's direct color model.

However, 24 bits per pixel, with something like a million pixels on the screen, adds up to a lot of memory. In the dark ages, memory was expensive, and devoting this much memory to a screen buffer cost too much. Therefore, designers used fewer bits—possibly as few as three, but more often eight—for each pixel. Instead of representing the colors directly in these bits, the bits were an index into a color map. Graphics programs would load the color map with the colors they were interested in and then represent each pixel by using the index of the appropriate color in the map. For example, the value 1 might represent fuschia; the value 2 might represent puce. Full information about how to display each color (the red, green, and blue components that make up fuschia or puce) is contained only in the color map. This arrangement corresponds closely to Java's indexed color model.

Because Java is platform-independent, you don't need to worry about how your computer or the user's computer represents colors. Your programs can use an indexed or direct color map as appropriate. Java will do the best it can to render the colors you request. Of course, if you use 5,000 colors on a computer that can only display 256, Java is going to have to make compromises. It will decide which colors to put in the color map and which colors are close enough to the colors in the color map, but that's done behind your back.

Java's default color model uses 8 bits per pixel for red, green, and blue, along with another 8 bits for alpha (transparency) level. However, as I said earlier, you can create your own `ColorModel` if you want to work in some other scheme. For example, you could create a grayscale color model for black and white pictures, or an HSB (hue, saturation, brightness) color model if you are more comfortable working with this system. Your color model's job will be to take a pixel value in your representation and translate that value into the corresponding alpha, red, green, and blue values. If you are working with a grayscale image, your image producer could deliver grayscale values to the image consumer, plus a `ColorModel` that tells the consumer how to render these gray values in terms of ARGB components.

12.2.1 ColorModel Methods

Constructors

public ColorModel (int bits)

There is a single constructor for `ColorModel`. It has one parameter, `bits`, which describes the number of bits required per pixel of an image. Since this is an abstract class, you cannot call this constructor directly. Since each pixel value must be stored within an integer, the maximum value for `bits` is 32. If you request more, you get 32.

Pseudo-constructors

public static ColorModel getRGBdefault()

The `getRGBdefault()` method returns the default `ColorModel`, which has 8 bits for each of the components alpha, red, green, and blue. The order the pixels are stored in an integer is 0xAARRGGBB, or alpha in highest order byte, down to blue in the lowest.

Other methods

public int getPixelSize ()

The `getPixelSize()` method returns the number of bits required for each pixel as described by this color model. That is, it returns the number of bits passed to the constructor.

public abstract int getAlpha (int pixel)

The `getAlpha()` method returns the alpha component of `pixel` for a color model. Its range must be between 0 and 255, inclusive. A value of 0 means the pixel is completely transparent and the background will appear through the pixel. A value of 255 means the pixel is opaque and you cannot see the background behind it.

public abstract int getRed (int pixel)

The `getRed()` method returns the red component of `pixel` for a color model. Its range must be between 0 and 255, inclusive. A value of 0 means the pixel has no red in it. A value of 255 means red is at maximum intensity.

public abstract int getGreen (int pixel)

The `getGreen()` method returns the green component of `pixel` for a color model. Its range must be between 0 and 255, inclusive. A value of 0 means the pixel has no green in it. A value of 255 means green is at maximum intensity.

public abstract int getBlue (int pixel)

The `getBlue()` method returns the blue component of `pixel` for a color model. Its range must be between 0 and 255, inclusive. A value of 0 means the pixel has no blue in it. A value of 255 means blue is at maximum intensity.

public int getRGB(int pixel)

The `getRGB()` method returns the color of `pixel` in the default RGB color model. If a subclass has changed the ordering or size of the different color components, `getRGB()` will return the pixel in the RGB color model (0xAARRGGBB order). In theory, the subclass does not need to override this method, unless it wants to make it final. Making this method final may yield a significant performance improvement.

public void finalize ()

The garbage collector calls `finalize()` when it determines that the `ColorModel` object is no longer needed. `finalize()` frees any internal resources that the `ColorModel` object has used.

12.2.2 DirectColorModel

The `DirectColorModel` class is a concrete subclass of `ColorModel`. It specifies a color model in which each pixel contains all the color information (alpha, red, green, and blue values) explicitly. Pixels are represented by 32-bit (`int`) quantities; the constructor lets you change which bits are allotted to each component.

All of the methods in this class, except constructors, are final, because of assumptions made by the implementation. You can create subclasses of `DirectColorModel`, but you can't override any of its methods. However, you should not need to develop your own subclass. Just create an instance of `DirectColorModel` with the appropriate constructor. Any subclassing results in serious performance degradation, because you are going from fast, static final method calls to dynamic method lookups.

Constructors

public DirectColorModel (int bits, int redMask, int greenMask, int blueMask, int alphaMask)

This constructor creates a `DirectColorModel` in which `bits` represents the total number of bits used to represent a pixel; it must be less than or equal to 32. The `redMask`, `greenMask`, `blueMask`, and `alphaMask` specify where in a pixel each color component exists. Each of the bit masks must be contiguous (e.g., red cannot be the first, fourth, and seventh bits of the pixel), must be smaller than 2^{bits}, and should not exceed 8 bits. (You cannot display more than 8 bits of data for any color component, but the mask can be larger.) Combined, the masks together should be `bits` in length. The default RGB color model is:

```
new DirectColorModel (32, 0x00ff0000, 0x0000ff00, 0x000000ff, 0xff000000)
```

The run-time exception `IllegalArgumentException` is thrown if any of the following occur:

- The bits that are set in a mask are not contiguous.
- Mask bits overlap (i.e., the same bit is set in two or more masks).
- The number of mask bits exceeds `bits`.

public DirectColorModel (int bits, int redMask, int greenMask, int blueMask)

This constructor for `DirectColorModel` calls the first with an alpha mask of 0, which means that colors in this color model have no transparency component. All colors will be fully opaque with an alpha value of 255. The same restrictions for the red, green, and blue masks apply.

Methods

final public int getAlpha (int pixel)

The `getAlpha()` method returns the alpha component of `pixel` for the color model as a number from 0 to 255, inclusive. A value of 0 means the pixel is completely transparent, and the background will appear through the pixel. A value of 255 means the pixel is opaque, and you cannot see the background behind it.

final public int getRed (int pixel)

The `getRed()` method returns the red component of `pixel` for the color model. Its range is from 0 to 255. A value of 0 means the pixel has no red in it. A value of 255 means red is at maximum intensity.

final public int getGreen (int pixel)

The `getGreen()` method returns the green component of `pixel` for the color model. Its range is from 0 to 255. A value of 0 means the pixel has no green in it. A value of 255 means green is at maximum intensity.

final public int getBlue (int pixel)

The `getBlue()` method returns the blue component of `pixel` for the color model. Its range is from 0 to 255. A value of 0 means the pixel has no blue in it. A value of 255 means blue is at maximum intensity.

final public int getRGB (int pixel)

The `getRGB()` method returns the color of `pixel` in the default RGB color model. If a subclass has changed the ordering or size of the different color components, `getRGB()` will return the pixel in the RGB color model (0xAARRGGBB order). The `getRGB()` method in this subclass is identical to the method in `ColorModel` but overrides it to make it final.

Other methods

final public int getAlphaMask ()

The `getAlphaMask()` method returns the `alphaMask` from the `DirectColorModel` constructor (or 0 if constructor did not have `alphaMask`). The `alphaMask` specifies which bits in the pixel represent the alpha transparency component of the color model.

final public int getRedMask ()

The `getRedMask()` method returns the `redMask` from the `DirectColorModel` constructor. The `redMask` specifies which bits in the pixel represent the red component of the color model.

final public int getGreenMask ()

The `getGreenMask()` method returns the `greenMask` from the `DirectColorModel` constructor. The `greenMask` specifies which bits in the pixel represent the green component of the color model.

final public int getBlueMask ()

The `getBlueMask()` method returns the `blueMask` from the `DirectColorModel` constructor. The `blueMask` specifies which bits in the pixel represent the blue component of the color model.

12.2.3 IndexColorModel

The `IndexColorModel` is another concrete subclass of `ColorModel`. It specifies a `ColorModel` that uses a color map lookup table (with a maximum size of 256), rather than storing color information in the pixels themselves. Pixels are represented by an index into the color map, which is at most an 8-bit quantity. Each entry in the color map gives the alpha, red, green, and blue components of some color. One entry in the map can be designated "transparent." This is called the "transparent pixel"; the alpha component of this map entry is ignored.

All of the methods in this class, except constructors, are final because of assumptions made by the implementation. You shouldn't need to create subclasses; you can if necessary, but you can't override any of the `IndexColorModel` methods. Example 12-2 (later in this chapter) uses an `IndexColorModel`.

Constructors

There are two sets of constructors for `IndexColorModel`. The first two constructors use a single-byte array for the color map. The second group implements the color map with separate byte arrays for each color component.

public IndexColorModel (int bits, int size, byte colorMap[], int start, boolean hasalpha, int transparent)

This constructor creates an `IndexColorModel`. `bits` is the number of bits used to represent each pixel and must not exceed 8. `size` is the number of elements in the map; it must be less than 2^{bits}. `hasalpha` should be `true` if the color map includes alpha (transparency) components and `false` if it doesn't. `transparent` is the location of the transparent pixel in the map (i.e., the pixel value that is considered transparent). If there is no transparent pixel, set transparent to -1.

The colorMap describes the colors used to paint pixels. start is the index within the colorMap array at which the map begins; prior elements of the array are ignored. An entry in the map consists of three or four consecutive bytes, representing the red, green, blue, and (optionally) alpha components. If hasalpha is false, a map entry consists of three bytes, and no alpha components are present; if hasalpha is true, map entries consist of four bytes, and all four components must be present.

For example, consider a pixel whose value is p, and a color map with a hasalpha set to false. Therefore, each element in the color map occupies three consecutive array elements. The red component of that pixel will be located at colorMap[start + 3*p]; the green component will be at colorMap[start + 3*p + 1]; and so on. The value of size may be smaller than 2^{bits}, meaning that there may be pixel values with no corresponding entry in the color map. These pixel values (i.e., size ≤ p < 2^{bits}) are painted with the color components set to 0; they are transparent if hasalpha is true, opaque otherwise.

If bits is too large (greater than 8), size is too large (greater than 2^{bits}), or the colorMap array is too small to hold the map, the run-time exception ArrayIndexOutOfBoundsException will be thrown.

public IndexColorModel (int bits, int size, byte colorMap[], int start, boolean hasalpha)

This version of the IndexColorModel constructor calls the previous constructor with a transparent index of -1; that is, there is no transparent pixel. If bits is too large (greater than 8), or size is too large (greater than 2^{bits}), or the colorMap array is too small to hold the map, the run-time exception, ArrayIndexOutOfBoundsException will be thrown.

public IndexColorModel (int bits, int size, byte red[], byte green[], byte blue[], int transparent)

The second set of constructors for IndexColorModel is similar to the first group, with the exception that these constructors use three or four separate arrays (one per color component) to represent the color map, instead of a single array.

The bits parameter still represents the number of bits in a pixel. size represents the number of elements in the color map. transparent is the location of the transparent pixel in the map (i.e., the pixel value that is considered transparent). If there is no transparent pixel, set transparent to -1.

The red, green, and blue arrays contain the color map itself. These arrays must have at least size elements. They contain the red, green, and blue components of the colors in the map. For example, if a pixel is at position p, red[p] contains the pixel's red component; green[p] contains the green component; and `blue[p]` contains the blue component. The value of `size` may be smaller than 2^{bits}, meaning that there may be pixel values with no corresponding entry in the color map. These pixel values (i.e., `size` ≤ `p` < 2^{bits}) are painted with the color components set to 0.

If `bits` is too large (greater than 8), `size` is too large (greater than 2^{bits}), or the red, green, and blue arrays are too small to hold the map, the run-time exception `ArrayIndexOutOfBoundsException` will be thrown.

public IndexColorModel (int bits, int size, byte red[], byte green[], byte blue[])

This version of the `IndexColorModel` constructor calls the previous one with a `transparent` index of -1; that is, there is no transparent pixel. If `bits` is too large (greater than 8), `size` is too large (greater than 2^{bits}), or the red, green, and blue arrays are too small to hold the map, the run-time exception `ArrayIndexOutOfBoundsException` will be thrown.

public IndexColorModel (int bits, int size, byte red[], byte green[], byte blue[], byte alpha[])

Like the previous constructor, this version creates an `IndexColorModel` with no transparent pixel. It differs from the previous constructor in that it supports transparency; the array alpha contains the map's transparency values. If `bits` is too large (greater than 8), `size` is too large (greater than 2^{bits}), or the red, green, blue, and alpha arrays are too small to hold the map, the run-time exception `ArrayIndexOutOfBoundsException` will be thrown.

Methods

final public int getAlpha (int pixel)

The `getAlpha()` method returns the alpha component of `pixel` for a color model, which is a number between 0 and 255, inclusive. A value of 0 means the pixel is completely transparent and the background will appear through the pixel. A value of 255 means the pixel is opaque and you cannot see the background behind it.

final public int getRed (int pixel)

The `getRed()` method returns the red component of `pixel` for a color model, which is a number between 0 and 255, inclusive. A value of 0 means the pixel has no red in it. A value of 255 means red is at maximum intensity.

final public int getGreen (int pixel)

The `getGreen()` method returns the green component of `pixel` for a color model, which is a number between 0 and 255, inclusive. A value of 0 means the pixel has no green in it. A value of 255 means green is at maximum intensity.

final public int getBlue (int pixel)

The `getBlue()` method returns the blue component of `pixel` for a color model, which is a number between 0 and 255, inclusive. A value of 0 means the pixel has no blue in it. A value of 255 means blue is at maximum intensity.

final public int getRGB (int pixel)

The `getRGB()` method returns the color of `pixel` in the default RGB color model. If a subclass has changed the ordering or size of the different color components, `getRGB()` will return the pixel in the RGB color model (0xAARRGGBB order). This version of `getRGB` is identical to the version in the `ColorModel` class but overrides it to make it final.

Other methods

final public int getMapSize()

The `getMapSize()` method returns the size of the color map (i.e., the number of distinct colors).

final public int getTransparentPixel ()

The `getTransparentPixel()` method returns the color map index for the transparent pixel in the color model. If no transparent pixel exists, it returns -1. It is not possible to change the transparent pixel after the color model has been created.

final public void getAlphas (byte alphas[])

The `getAlphas()` method copies the alpha components of the `ColorModel` into elements 0 through `getMapSize()-1` of the `alphas` array. Space must already be allocated in the `alphas` array.

final public void getReds (byte reds[])

The `getReds()` method copies the red components of the `ColorModel` into elements 0 through `getMapSize()-1` of the `reds` array. Space must already be allocated in the `reds` array.

final public void getGreens (byte greens[])

The `getGreens()` method copies the green components of the `ColorModel` into elements 0 through `getMapSize()-1` of the `greens` array. Space must already be allocated in the `greens` array.

final public void getBlues (byte blues[])

The `getBlues()` method copies the blue components of the `ColorModel` into elements 0 through `getMapSize()-1` of the `blues` array. Space must already be allocated in the `blues` array.

12.3 ImageProducer

The `ImageProducer` interface defines the methods that `ImageProducer` objects must implement. Image producers serve as sources for pixel data; they may compute the data themselves or interpret data from some external source, like a GIF file. No matter how it generates the data, an image producer's job is to hand that data to an image consumer, which usually renders the data on the screen. The methods in the `ImageProducer` interface let `ImageConsumer` objects register their interest in an image. The business end of an `ImageProducer`—that is, the methods it uses to deliver pixel data to an image consumer—are defined by the `ImageConsumer` interface. Therefore, we can summarize the way an image producer works as follows:

- It waits for image consumers to register their interest in an image.
- As image consumers register, it stores them in a `Hashtable`, `Vector`, or some other collection mechanism.
- As image data becomes available, it loops through all the registered consumers and calls their methods to transfer the data.

There's a sense in which you have to take this process on faith; image consumers are usually well hidden. If you call `createImage()`, an image consumer will eventually show up.

Every `Image` has an `ImageProducer` associated with it; to acquire a reference to the producer, use the `getSource()` method of `Image`.

Because an `ImageProducer` must call methods in the `ImageConsumer` interface, we won't show an example of a full-fledged producer until we have discussed `ImageConsumer`.

12.3.1 ImageProducer Interface

Methods

public void addConsumer (ImageConsumer ic)

The `addConsumer()` method registers `ic` as an `ImageConsumer` interested in the `Image` information. Once an `ImageConsumer` is registered, the `ImageProducer` can deliver `Image` pixels immediately or wait until `startProduction()` has been called.

Note that one image may have many consumers; therefore, `addConsumer()` usually stores image consumers in a collection like a `Vector` or `Hashtable`. There is one notable exception: if the producer has the image data in memory, `addConsumer()` can deliver the image to the consumer immediately. When `addConsumer()` returns, it has finished with the consumer. In this case, you don't need to manage a list of consumers, because there is only one image consumer at a time. (In this case, `addConsumer()` should be implemented as a synchronized method.)

public boolean isConsumer (ImageConsumer ic)

The `isConsumer()` method checks to see if `ic` is a registered `ImageConsumer` for this `ImageProducer`. If `ic` is registered, `true` is returned. If `ic` is not registered, `false` is returned.

public void removeConsumer (ImageConsumer ic)

The `removeConsumer()` method removes `ic` as a registered `ImageConsumer` for this `ImageProducer`. If `ic` was not a registered `ImageConsumer`, nothing should happen. This is not an error that should throw an exception. Once `ic` has been removed from the registry, the `ImageProducer` should no longer send data to it.

public void startProduction (ImageConsumer ic)

The `startProduction()` method registers `ic` as an `ImageConsumer` interested in the `Image` information and tells the `ImageProducer` to start sending the `Image` data immediately. The `ImageProducer` sends the image data to `ic` and all other registered `ImageConsumer` objects, through `addConsumer()`.

public void requestTopDownLeftRightResend (ImageConsumer ic)

The `requestTopDownLeftRightResend()` method is called by the `ImageConsumer` `ic` requesting that the `ImageProducer` retransmit the `Image` data in top-down, left-to-right order. If the `ImageProducer` is unable to send the data in that order or always sends the data in that order (like with `MemoryImageSource`), it can ignore the call.

12.3.2 FilteredImageSource

The `FilteredImageSource` class combines an `ImageProducer` and an `ImageFilter` to create a new `Image`. The image producer generates pixel data for an original image. The `FilteredImageSource` takes this data and uses an `ImageFilter` to produce a modified version: the image may be scaled, clipped, or rotated, or the colors shifted, etc. The `FilteredImageSource` is the image producer for the new image. The `ImageFilter` object transforms the original image's data to yield the new image; it implements the `ImageConsumer` interface. We cover the `ImageConsumer` interface in Section 12.4 and the `ImageFilter` class in Section 12.5. Figure 12-1 shows the relationship between an `ImageProducer`, `FilteredImageSource`, `ImageFilter`, and the `ImageConsumer`.

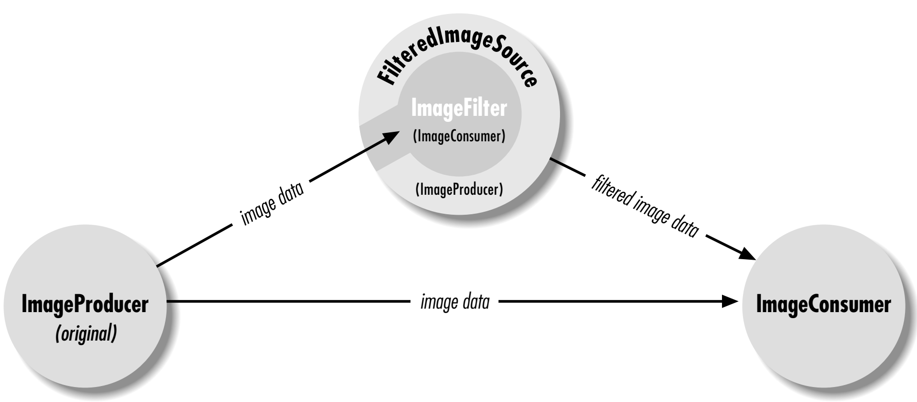


Figure 12–1: Image producers, filters, and consumers

Constructors

public FilteredImageSource (ImageProducer original, ImageFilter filter)

The `FilteredImageSource` constructor creates an image producer that combines an image, `original`, and a filter, `filter`, to create a new image. The `ImageProducer` of the original image is the constructor's first parameter; given an `Image`, you can acquire its `ImageProducer` by using the `getSource()` method. The following code shows how to create a new image from an original. Section 12.5 shows several extensive examples of image filters.

```
Image image = getImage (new URL
      ("http://www.ora.com/graphics/headers/homepage.gif"));
Image newOne = createImage (new FilteredImageSource
      (image.getSource(), new SomeImageFilter()));
```

ImageProducer interface methods

The `ImageProducer` interface methods maintain an internal table for the image consumers. Since this is private, you do not have direct access to it.

public synchronized void addConsumer (ImageConsumer ic)

The `addConsumer()` method adds `ic` as an `ImageConsumer` interested in the pixels for this image.

public synchronized boolean isConsumer (ImageConsumer ic)

The `isConsumer()` method checks to see if `ic` is a registered `ImageConsumer` for this `ImageProducer`. If `ic` is registered, `true` is returned. If not registered, `false` is returned.

public synchronized void removeConsumer (ImageConsumer ic)

The `removeConsumer()` method removes `ic` as a registered `ImageConsumer` for this `ImageProducer`.

public void startProduction (ImageConsumer ic)

The `startProduction()` method registers `ic` as an `ImageConsumer` interested in the `Image` information and tells the `ImageProducer` to start sending the `Image` data immediately.

public void requestTopDownLeftRightResend (ImageConsumer ic)

The `requestTopDownLeftRightResend()` method registers `ic` as an `ImageConsumer` interested in the `Image` information and requests the `ImageProducer` to retransmit the `Image` data in top-down, left-to-right order.

12.3.3 MemoryImageSource

The `MemoryImageSource` class allows you to create images completely in memory; you generate pixel data, place it in an array, and hand that array and a `ColorModel` to the `MemoryImageSource` constructor. The `MemoryImageSource` is an image producer that can be used with a consumer to display the image on the screen. For example, you might use a `MemoryImageSource` to display a Mandelbrot image or some other image generated by your program. You could also use a `MemoryImageSource` to modify a pre-existing image; use `PixelGrabber` to get the image's pixel data, modify that data, and then use a `MemoryImageSource` as the producer for the modified image. Finally, you can use `MemoryImageSource` to simplify implementation of a new image type; you can develop a class that reads an image in some unsupported format from a local file or the network; interprets the image file and puts pixel data into an array; and uses a `MemoryImageSource` to serve as an image producer. This is simpler than implementing an image producer yourself, but it isn't quite as flexible; you lose the ability to display partial images as the data becomes available.

In Java 1.1, `MemoryImageSource` supports multiframe images to animate a sequence. In earlier versions, it was necessary to create a dynamic `ImageFilter` to animate the image.

Constructors

There are six constructors for `MemoryImageSource`, each with slightly different parameters. They all create an image producer that delivers some array of data to an image consumer. The constructors are:

public MemoryImageSource (int w, int h, ColorModel cm, byte pix[], int off, int scan)
public MemoryImageSource (int w, int h, ColorModel cm, byte pix[], int off, int scan, Hashtable props)

public MemoryImageSource (int w, int h, ColorModel cm, int pix[], int off, int scan)
public MemoryImageSource (int w, int h, ColorModel cm, int pix[], int off, int scan, Hashtable props)
public MemoryImageSource (int w, int h, int pix[], int off, int scan)
public MemoryImageSource (int w, int h, int pix[], int off, int scan, Hashtable props)

The parameters that might be present are:

`w` Width of the image being created, in pixels.

`h` Height of the image being created, in pixels.

`cm` The `ColorModel` that describes the color representation used in the pixel data. If this parameter is not present, the `MemoryImageSource` uses the default RGB color model (`ColorModel.getRGBDefault()`).

`pix[]`
The array of pixel information to be converted into an image. This may be either a `byte` array or an `int` array, depending on the color model. If you're using a direct color model (including the default RGB color model), `pix` is usually an `int` array; if it isn't, it won't be able to represent all 16 million possible colors. If you're using an indexed color model, the array should be a `byte` array. However, if you use an `int` array with an indexed color model, the `MemoryImageSource` ignores the three high-order bytes because an indexed color model has at most 256 entries in the color map. In general: if your color model requires more than 8 bits of data per pixel, use an `int` array; if it requires 8 bits or less, use a `byte` array.

`off`
The first pixel used in the array (usually 0); prior pixels are ignored.

`scan`
The number of pixels per line in the array (usually equal to `w`). The number of pixels per scan line in the array may be larger than the number of pixels in the scan line. Extra pixels in the array are ignored.

`props`
A `Hashtable` of the properties associated with the image. If this argument isn't present, the constructor assumes there are no properties.

The pixel at location (`x`, `y`) in the image is located at `pix[y * scan + x + off]`.

ImageProducer interface methods

In Java 1.0, the `ImageProducer` interface methods maintain a single internal variable for the image consumer because the image is delivered immediately and synchronously. There is no need to worry about multiple consumers; as soon as one registers, you give it the image, and you're done. These methods keep track of this single `ImageConsumer`.

In Java 1.1, `MemoryImageSource` supports animation. One consequence of this new feature is that it isn't always possible to deliver all the image's data immediately. Therefore, the class maintains a list of image consumers that are notified when each frame is generated. Since this list is private, you do not have direct access to it.

public synchronized void addConsumer (ImageConsumer ic)

The `addConsumer()` method adds `ic` as an `ImageConsumer` interested in the pixels for this image.

public synchronized boolean isConsumer (ImageConsumer ic)

The `isConsumer()` method checks to see if `ic` is a registered `ImageConsumer` for this `ImageProducer`. If `ic` is registered, `true` is returned. If `ic` is not registered, `false` is returned.

public synchronized void removeConsumer (ImageConsumer ic)

The `removeConsumer()` method removes `ic` as a registered `ImageConsumer` for this `ImageProducer`.

public void startProduction (ImageConsumer ic)

The `startProduction()` method calls `addConsumer()`.

public void requestTopDownLeftRightResend (ImageConsumer ic)

The `requestTopDownLeftRightResend()` method does nothing since in-memory images are already in this format or are multiframed, with each frame in this format.

Animation methods

In Java 1.1, `MemoryImageSource` supports animation; it can now pass multiple frames to interested image consumers. This feature mimics GIF89a's multiframe functionality. (If you have GIF89a animations, you can display them using `getImage()` and `drawImage()`; you don't have to build a complicated creature using `MemoryImageSource`.) . An animation example follows in Example 12-3 (later in this chapter).

public synchronized void setAnimated(boolean animated) ★

The `setAnimated()` method notifies the `MemoryImageSource` if it will be in animation mode (`animated` is `true`) or not (`animated` is `false`). By default, animation is disabled; you must call this method to generate an image sequence.

To prevent losing data, call this method immediately after calling the `MemoryImageSource` constructor.

public synchronized void setFullBufferUpdates(boolean fullBuffers) ★

The `setFullBufferUpdates()` method controls how image updates are done during an animation. It is ignored if you are not creating an animation. If `fullBuffers` is `true`, this method tells the `MemoryImageSource` that it should always send all of an image's data to the consumers whenever it received new data (by a call to `newPixels()`). If `fullBuffers` is `false`, the `MemoryImageSource` sends only the changed portion of the image and notifies consumers (by a call to `ImageConsumer.setHints()`) that frames sent will be complete.

Like `setAnimated()`, `setFullBufferUpdates()` should be called immediately after calling the `MemoryImageSource` constructor, before the animation is started.

To do the actual animation, you update the image array `pix[]` that was specified in the constructor and call one of the overloaded `newPixels()` methods to tell the `MemoryImageSource` that you have changed the image data. The parameters to `newPixels()` determine whether you are animating the entire image or just a portion of the image. You can also supply a new array to take pixel data from, replacing `pix[]`. In any case, `pix[]` supplies the initial image data (i.e., the first frame of the animation).

If you have not called `setAnimated(true)`, calls to any version of `newPixels()` are ignored.

public void newPixels() ★

The version of `newPixels()` with no parameters tells the `MemoryImageSource` to send the entire pixel data (frame) to all the registered image consumers again. Data is taken from the original array `pix[]`. After the data is sent, the `MemoryImageSource` notifies consumers that a frame is complete by calling `imageComplete(ImageConsumer.SINGLEFRAMEDONE)`, thus updating the display when the image is redisplayed. Remember that in many cases, you don't need to update the entire image; updating part of the image saves CPU time, which may be crucial for your application. To update part of the image, call one of the other versions of `newPixels()`.

public synchronized void newPixels(int x, int y, int w, int h) ★

This `newPixels()` method sends part of the image in the array `pix[]` to the consumers. The portion of the image sent has its upper left corner at the point (`x`, `y`), width `w` and height `h`, all in pixels. Changing part of the image rather than the whole thing saves considerably on system resources. Obviously, it is appropriate only if most of the image is still. For example, you could use this method to animate the steam rising from a cup of hot coffee, while leaving the cup itself static (an image that should be familiar to anyone reading JavaSoft's Web site). After the data is sent, consumers are notified that a frame is complete by a call to `imageComplete(ImageConsumer.SINGLEFRAMEDONE)`, thus updating the display when the image is redisplayed.

If `setFullBufferUpdates()` was called, the entire image is sent, and the dimensions of the bounding box are ignored.

public synchronized void newPixels(int x, int y, int w, int h, boolean frameNotify) ★

This `newPixels()` method is identical to the last, with one exception: consumers are notified that new image data is available only when `frameNotify` is `true`. This method allows you to generate new image data in pieces, updating the consumers only once when you are finished.

If `setFullBufferUpdates()` was called, the entire image is sent, and the dimensions of the bounding box are ignored.

public synchronized void newPixels(byte[] newpix, ColorModel newmodel, int offset, int scansize) ★
public synchronized void newPixels(int[] newpix, ColorModel newmodel, int offset, int scansize) ★

These `newPixels()` methods change the source of the animation to the `byte` or `int` array `newpix[]`, with a `ColorModel` of `newmodel`. `offset` marks the beginning of the data in `newpix` to use, while `scansize` states the number of pixels in `newpix` per line of `Image` data. Future calls to other versions of `newPixels()` should modify `newpix[]` rather than `pix[]`.

Using MemoryImageSource to create a static image

You can create an image by generating an integer or byte array in memory and converting it to an image with `MemoryImageSource`. The following `MemoryImage` applet generates two identical images that display a series of color bars from left to right. Although the images look the same, they were generated differently: the image on the left uses the default `DirectColorModel`; the image on the right uses an `IndexColorModel`.

Because the image on the left uses a `DirectColorModel`, it stores the actual color value of each pixel in an array of integers (`rgbPixels[]`). The image on the right can use a byte array (`indPixels[]`) because the `IndexColorModel` puts the color information in its color map instead of the pixel array; elements of the pixel array need to be large enough only to address the entries in this map. Images that are based on `IndexColorModel` are generally more efficient in their use of space (integer vs. byte arrays, although `IndexColorModel` requires small support arrays) and in performance (if you filter the image).

The output from this example is shown in Figure 12-2. The source is shown in Example 12-2.

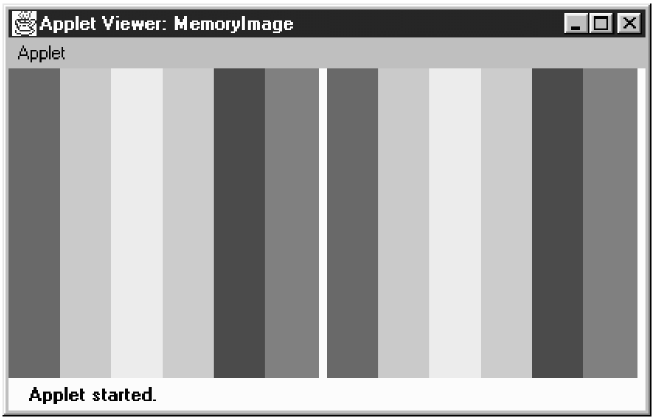


Figure 12–2: MemoryImage applet output

Example 12–2: MemoryImage Test Program

```
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
public class MemoryImage extends Applet {
    Image i, j;
    int width = 200;
    int height = 200;
    public void init () {
        int rgbPixels[] = new int [width*height];
        byte indPixels[] = new byte [width*height];
        int index = 0;
        Color colorArray[] = {Color.red, Color.orange, Color.yellow,
                Color.green, Color.blue, Color.magenta};
        int rangeSize = width / colorArray.length;
        int colorRGB;
        byte colorIndex;
        byte reds[]   = new byte[colorArray.length];
        byte greens[] = new byte[colorArray.length];
        byte blues[]  = new byte[colorArray.length];
        for (int i=0;i<colorArray.length;i++) {
            reds[i]   = (byte)colorArray[i].getRed();
            greens[i] = (byte)colorArray[i].getGreen();
            blues[i]  = (byte)colorArray[i].getBlue();
        }
        for (int y=0;y<height;y++) {
            for (int x=0;x<width;x++) {
                if (x < rangeSize) {
                    colorRGB = Color.red.getRGB();
                    colorIndex = 0;
                } else if (x < (rangeSize*2)) {
```

Example 12–2: MemoryImage Test Program (continued)

```
                    colorRGB = Color.orange.getRGB();
                    colorIndex = 1;
                } else if (x < (rangeSize*3)) {
                    colorRGB = Color.yellow.getRGB();
                    colorIndex = 2;
                } else if (x < (rangeSize*4)) {
                    colorRGB = Color.green.getRGB();
                    colorIndex = 3;
                } else if (x < (rangeSize*5)) {
                    colorRGB = Color.blue.getRGB();
                    colorIndex = 4;
                } else {
                    colorRGB = Color.magenta.getRGB();
                    colorIndex = 5;
                }
                rgbPixels[index] = colorRGB;
                indPixels[index] = colorIndex;
                index++;
            }
        }
        i = createImage (new MemoryImageSource (width, height, rgbPixels,
            0, width));
        j = createImage (new MemoryImageSource (width, height,
            new IndexColorModel (8, colorArray.length, reds, greens, blues),
            indPixels, 0, width));
    }
    public void paint (Graphics g) {
        g.drawImage (i, 0, 0, this);
        g.drawImage (j, width+5, 0, this);
    }
}
```

Almost all of the work is done in `init()` (which, in a real applet, isn't a terribly good idea; ideally `init()` should be lightweight). Previously, we explained the color model's use for the images on the left and the right. Toward the end of `init()`, we create the images `i` and `j` by calling `createImage()` with a `MemoryImageSource` as the image producer. For image `i`, we used the simplest `MemoryImageSource` constructor, which uses the default RGB color model. For `j`, we called the `IndexColorModel` constructor within the `MemoryImageSource` constructor, to create a color map that has only six entries: one for each of the colors we use.

Using MemoryImageSource for animation

As we've seen, Java 1.1 gives you the ability to create an animation using a `MemoryImageSource` by updating the image data in memory; whenever you have finished an update, you can send the resulting frame to the consumers. This technique gives you a way to do animations that consume very little memory, since you keep overwriting the original image. The applet in Example 12-3 demonstrates `MemoryImageSource`'s animation capability by creating a Mandelbrot image in memory, updating the image as new points are added. Figure 12-3 shows the results, using four consumers to display the image four times.

Example 12–3: Mandelbrot Program

```
// Java 1.1 only
import java.awt.*;
import java.awt.image.*;
import java.applet.*;

public class Mandelbrot extends Applet implements Runnable {
    Thread animator;
    Image im1, im2, im3, im4;
    public void start() {
        animator = new Thread(this);
        animator.start();
    }
    public synchronized void stop() {
        animator = null;
    }
    public void paint(Graphics g) {
        if (im1 != null)
            g.drawImage(im1, 0, 0, null);
        if (im2 != null)
            g.drawImage(im2, 0, getSize().height / 2, null);
        if (im3 != null)
            g.drawImage(im3, getSize().width / 2, 0, null);
        if (im4 != null)
            g.drawImage(im4, getSize().width / 2, getSize().height / 2, null);
    }
    public void update (Graphics g) {
        paint (g);
    }
    public synchronized void run() {
        Thread.currentThread().setPriority(Thread.MIN_PRIORITY);
        int width = getSize().width / 2;
        int height = getSize().height / 2;
        byte[] pixels = new byte[width * height];
        int index = 0;
        int iteration=0;
        double a, b, p, q, psq, qsq, pnew, qnew;
        byte[] colorMap = {(byte)255, (byte)255, (byte)255, // white
                           (byte)0, (byte)0, (byte)0};      // black
        MemoryImageSource mis = new MemoryImageSource(
            width, height,
            new IndexColorModel (8, 2, colorMap, 0, false, -1),
            pixels, 0, width);
        mis.setAnimated(true);
        im1 = createImage(mis);
        im2 = createImage(mis);
        im3 = createImage(mis);
```

Example 12–3: Mandelbrot Program (continued)

```
            im4 = createImage(mis);
            // Generate Mandelbrot
            final int ITERATIONS = 16;
            for (int y=0; y<height; y++) {
                b = ((double)(y-64))/32;
                for (int x=0; x<width; x++) {
                    a = ((double)(x-64))/32;
                    p=q=0;
                    iteration = 0;
                    while (iteration < ITERATIONS) {
                        psq = p*p;
                        qsq = q*q;
                        if ((psq + qsq) >= 4.0)
                            break;
                        pnew = psq - qsq + a;
                        qnew = 2*p*q+b;
                        p = pnew;
                        q = qnew;
                        iteration++;
                    }
                    if (iteration == ITERATIONS) {
                        pixels[index] = 1;
                        mis.newPixels(x, y, 1, 1);
                        repaint();
                    }
                    index++;
                }
            }
        }
    }
```

Most of the applet in Example 12-3 should be self-explanatory. The `init()` method starts the thread in which we do our computation. `paint()` just displays the four images we create. All the work, including the computation, is done in the thread's `run()` method. `run()` starts by setting up a color map, creating a `MemoryImageSource` with animation enabled and creating four images using that source as the producer. It then does the computation, which I won't explain; for our purposes, the interesting part is what happens when we've computed a pixel. We set the appropriate byte in our data array, `pixels[]`, and then call `newPixels()`, giving the location of the new pixel and its size (1 by 1) as arguments. Thus, we redraw the images for every new pixel. In a real application, you would probably compute a somewhat larger chunk of new data before updating the screen, but the same principles apply.

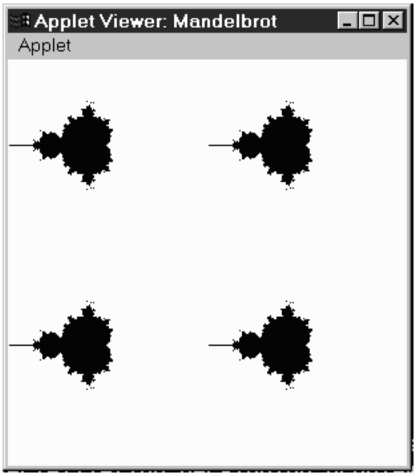


Figure 12–3: Mandelbrot output

12.4 ImageConsumer

The `ImageConsumer` interface specifies the methods that must be implemented to receive data from an `ImageProducer`. For the most part, that is the only context in which you need to know about the `ImageConsumer` interface. If you write an image producer, it will be handed a number of obscure objects, about which you know nothing except that they implement `ImageConsumer`, and that you can therefore call the methods discussed in this section to deliver your data. The chances that you will ever implement an image consumer are rather remote, unless you are porting Java to a new environment. It is more likely that you will want to subclass `ImageFilter`, in which case you may need to implement some of these methods. But most of the time, you will just need to know how to hand your data off to the next element in the chain.

The `java.awt.image` package includes two classes that implement `ImageConsumer:` `PixelGrabber` and `ImageFilter` (and its subclasses). These classes are unique in that they don't display anything on the screen. `PixelGrabber` takes the image data and stores it in a pixel array; you can use this array to save the image in a file, generate a new image, etc. `ImageFilter`, which is used in conjunction with `FilteredImageSource`, modifies the image data; the `FilteredImageSource` sends the modified image to another consumer, which can further modify or display the new image. When you draw an image on the screen, the JDK's `ImageRepresentation` class is probably doing the real work. This class is part of the `sun.awt.image` package. You really don't need to know anything about it, although you may see `ImageRepresentation` mentioned in a stack trace if you try to filter beyond the end of a pixel array.

12.4.1 ImageConsumer Interface

Constants

There are two sets of constants for `ImageConsumer`. One set represents those that can be used for the `imageComplete()` method. The other is used with the `setHints()` method. See the descriptions of those methods on how to use them.

The first set of flags is for the `imageComplete()` method:

public static final int IMAGEABORTED

The `IMAGEABORTED` flag signifies that the image creation process was aborted and the image is not complete. In the image production process, an abort could mean multiple things. It is possible that retrying the production would succeed.

public static final int IMAGEERROR

The `IMAGEERROR` flag signifies that an error was encountered during the image creation process and the image is not complete. In the image production process, an error could mean multiple things. More than likely, the image file or pixel data is invalid, and retrying won't succeed.

public static final int SINGLEFRAMEDONE

The `SINGLEFRAMEDONE` flag signifies that a frame other than the last has completed loading. There are additional frames to display, but a new frame is available and is complete. For an example of this flag in use, see the dynamic `ImageFilter` example in Example 12-8.

public static final int STATICIMAGEDONE

The `STATICIMAGEDONE` flag signifies that the image has completed loading. If this is a multiframe image, all frames have been generated. For an example of this flag in use, see the dynamic `ImageFilter` example in Example 12-8.

The following set of flags can be ORed together to form the single parameter to the `setHints()` method. Certain flags do not make sense set together, but it is the responsibility of the concrete `ImageConsumer` to enforce this.

public static final int COMPLETESCANLINES

The `COMPLETESCANLINES` flag signifies that each call to `setPixels()` will deliver at least one complete scan line of pixels to this consumer.

public static final int RANDOMPIXELORDER

The `RANDOMPIXELORDER` flag tells the consumer that pixels are not provided in any particular order. Therefore, the consumer cannot perform optimization that depends on pixel delivery order. In the absence of both `COMPLETESCANLINES` and `RANDOMPIXELORDER`, the `ImageConsumer` should assume pixels will arrive in `RANDOMPIXELORDER`.

public static final int SINGLEFRAME

The SINGLEFRAME flag tells the consumer that this image contains a single non-changing frame. This is the case with most image formats. An example of an image that does not contain a single frame is the multiframe GIF89a image.

public static final int SINGLEPASS

The SINGLEPASS flag tells the consumer to expect each pixel once and only once. Certain image formats, like progressive JPEG images, deliver a single image several times, with each pass yielding a sharper image.

public static final int TOPDOWNLEFTRIGHT

The final setHints() flag, TOPDOWNLEFTRIGHT, tells the consumer to expect the pixels in a top-down, left-right order. This flag will almost always be set.

Methods

The interface methods are presented in the order in which they are normally called by an ImageProducer.

void setDimensions (int width, int height)

The setDimensions() method should be called once the ImageProducer knows the width and height of the image. This is the actual width and height, not necessarily the scaled size. It is the consumer's responsibility to do the scaling and resizing.

void setProperties (Hashtable properties)

The setProperties() method should only be called by the ImageProducer if the image has any properties that should be stored for later retrieval with the getProperty() method of Image. Every image format has its own property set. One property that tends to be common is the "comment" property. properties represents the Hashtable of properties for the image; the name of each property is used as the Hashtable key.

void setColorModel (ColorModel model)

The setColorModel() method gives the ImageProducer the opportunity to tell the ImageConsumer that the ColorModel model will be used for the majority of pixels in the image. The ImageConsumer may use this information for optimization. However, each call to setPixels() contains its own ColorModel, which isn't necessarily the same as the color model given here. In other words, setColorModel() is only advisory; it does not guarantee that all (or any) of the pixels in the image will use this model. Using different color models for different parts of an image is possible, but not recommended.

void setHints (int hints)

An ImageProducer should call the setHints() method prior to any setPixels() calls. The hints are formed by ORing the constants COMPLETESCANLINES, RANDOMPIXELORDER, SINGLEFRAME, SINGLEPASS, and TOPDOWNLEFTRIGHT. These hints give the image consumer information about the order in which the producer will deliver pixels. When the ImageConsumer is receiving pixels, it can take advantage of these hints for optimization.

void setPixels (int x, int y, int width, int height, ColorModel model, byte pixels[], int offset, int scansize)

An ImageProducer calls the setPixels() method to deliver the image pixel data to the ImageConsumer. The bytes are delivered a rectangle at a time. (x, y) represents the top left corner of the rectangle; its dimensions are width height. model is the ColorModel used for this set of pixels; different calls to setPixels() may use different color models. The pixels themselves are taken from the byte array pixels. offset is the first element of the pixel array that will be used. scansize is the length of the scan lines in the array. In most cases, you want the consumer to render all the pixels on the scan line; in this case, scansize will equal width. However, there are cases in which you want the consumer to ignore part of the scan line; you may be clipping an image, and the ends of the scan line fall outside the clipping region. In this case, rather than copying the pixels you want into a new array, you can specify a width that is smaller than scansize.

That's a lot of information, but it's easy to summarize. A pixel located at point (x1, y1) within the rectangle being delivered to the consumer is located at position ((y1 - y) * scansize + (x1 - x) + offset) within the array pixels[]. Figure 12-4 shows how the pixels delivered by setPixels() fit into the complete image; Figure 12-5 shows how pixels are stored within the array.

void setPixels (int x, int y, int width, int height, ColorModel model, int pixels[], int offset, int scansize)

The second setPixels() method is similar to the first. pixels[] is an array of ints; this is necessary when you have more than eight bits of data per pixel.

void imageComplete (int status)

The ImageProducer calls imageComplete() to tell an ImageConsumer that it has transferred a complete image. The status argument is a flag that describes exactly why the ImageProducer has finished. It may have one of the following values: IMAGEABORTED (if the image production was aborted); IMAGEERROR (if an error in producing the image occurred); SINGLEFRAMEDONE (if a single frame of a multiframe image has been completed); or STATICIMAGEDONE (if all pixels have been delivered). When imageComplete() gets called, the ImageConsumer should call the image producer's removeConsumer() method, unless it wants to receive additional frames (status of SINGLEFRAMEDONE).

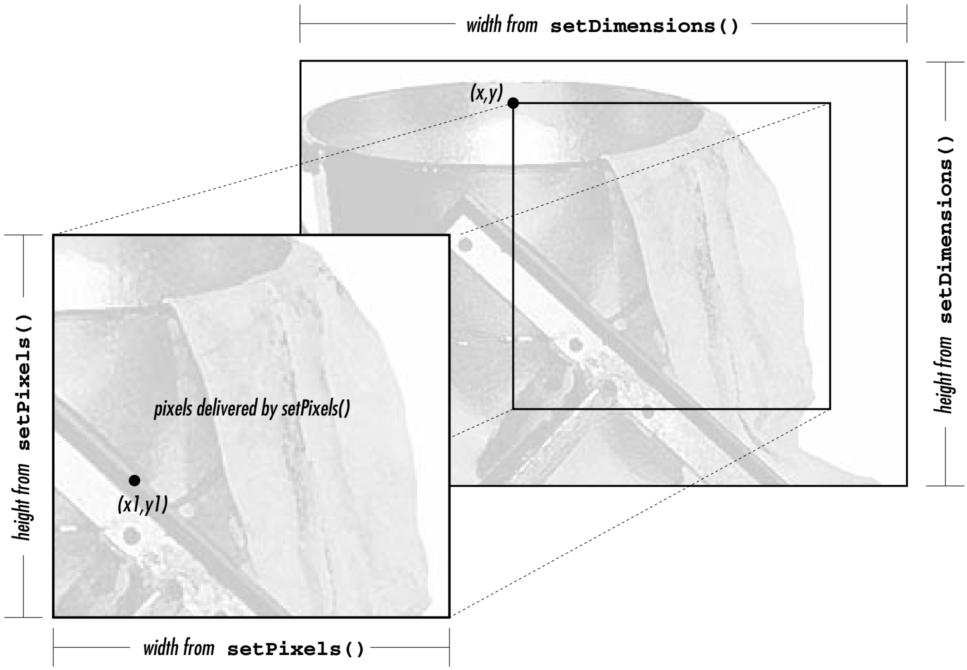


Figure 12–4: Delivering pixels for an image

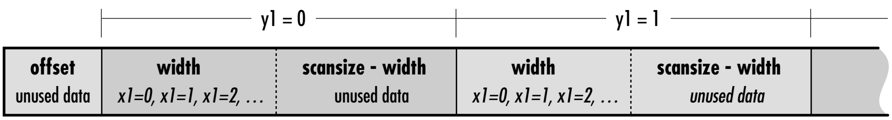


Figure 12–5: Storing pixels in an array

PPMImageDecoder

Now that we have discussed the `ImageConsumer` interface, we're finally ready to give an example of a full-fledged `ImageProducer`. This producer uses the methods of the `ImageConsumer` interface to communicate with image consumers; image consumers use the `ImageProducer` interface to register themselves with this producer.

Our image producer will interpret images in the PPM format.* PPM is a simple image format developed by Jef Poskanzer as part of the *pbmplus* image conversion package. A PPM file starts with a header consisting of the image type, the image's width and height in pixels, and the maximum value of any RGB component. The

* For more information about PPM and the *pbmplus* package, see *Encyclopedia of Graphics File Formats*, by James D. Murray and William VanRyper (from O'Reilly & Associates). See also http://www.acme.com/.

header is entirely in ASCII. The pixel data follows the header; it is either in binary (if the image type is P6) or ASCII (if the image type is P3). The pixel data is simply a series of bytes describing the color of each pixel, moving left to right and top to bottom. In binary format, each pixel is represented by three bytes: one for red, one for green, and one for blue. In ASCII format, each pixel is represented by three numeric values, separated by white space (space, tab, or newline). A comment may occur anywhere in the file, but it would be surprising to see one outside of the header. Comments start with # and continue to the end of the line. ASCII format files are obviously much larger than binary files. There is no compression on either file type.

The `PPMImageDecoder` source is listed in Example 12-4. The applet that uses this class is shown in Example 12-5. You can reuse a lot of the code in the `PPMImageDecoder` when you implement your own image producers.

Example 12–4: PPMImageDecoder Source

```
import java.awt.*;
import java.awt.image.*;
import java.util.*;
import java.io.*;

public class PPMImageDecoder implements ImageProducer {

/* Since done in-memory, only one consumer */
    private ImageConsumer consumer;
    boolean loadError = false;
    int width;
    int height;
    int store[][];
    Hashtable props = new Hashtable();
/* Format of Ppm file is single pass/frame, w/ complete scan lines in order */
    private static int PpmHints = (ImageConsumer.TOPDOWNLEFTRIGHT |
                                   ImageConsumer.COMPLETESCANLINES |
                                   ImageConsumer.SINGLEPASS |
                                   ImageConsumer.SINGLEFRAME);
```

The class starts by declaring class variables and constants. We will use the variable `PpmHints` when we call `setHints()`. Here, we set this variable to a collection of "hint" constants that indicate we will produce pixel data in top-down, left-right order; we will always send complete scan lines; we will make only one pass over the pixel data (we will send each pixel once); and there is one frame per image (i.e., we aren't producing a multiframe sequence).

The next chunk of code implements the `ImageProducer` interface; consumers use it to request image data:

```
/* There is only a single consumer. When it registers, produce image. */
/* On error, notify consumer. */

    public synchronized void addConsumer (ImageConsumer ic) {
        consumer = ic;
        try {
            produce();
        }catch (Exception e) {
            if (consumer != null)
                consumer.imageComplete (ImageConsumer.IMAGEERROR);
        }
        consumer = null;
    }

/* If consumer passed to routine is single consumer, return true, else false. */

    public synchronized boolean isConsumer (ImageConsumer ic) {
        return (ic == consumer);
    }

/* Disables consumer if currently consuming. */

    public synchronized void removeConsumer (ImageConsumer ic) {
        if (consumer == ic)
            consumer = null;
    }

/* Production is done by adding consumer. */

    public void startProduction (ImageConsumer ic) {
        addConsumer (ic);
    }

    public void requestTopDownLeftRightResend (ImageConsumer ic) {
        // Not needed.  The data is always in this format.
    }
```

The previous group of methods implements the `ImageProducer` interface. They are quite simple, largely because of the way this `ImageProducer` generates images. It builds the image in memory before delivering it to the consumer; you must call the `readImage()` method (discussed shortly) before you can create an image with this consumer. Because the image is in memory before any consumers can register their interest, we can write an `addConsumer()` method that registers a consumer and delivers all the data to that consumer before returning. Therefore, we don't need to manage a list of consumers in a `Hashtable` or some other collection object. We can store the current consumer in an instance variable `ic` and forget about any others: only one consumer exists at a time. To make sure that only one consumer exists at a time, we synchronize the `addConsumer()`, `isConsumer()`, and `removeConsumer()` methods. Synchronization prevents another consumer from registering itself before the current consumer has finished. If you write an ImageProducer that builds the image in memory before delivering it, you can probably use this code verbatim.

addConsumer() is little more than a call to the method produce(), which handles "consumer relations": it delivers the pixels to the consumer using the methods in the ImageConsumer interface. If produce() throws an exception, addConsumer() calls imageComplete() with an IMAGEERROR status code. Here's the code for the produce() method:

```
/* Production Process:
        Prerequisite: Image already read into store array. (readImage)
                      props / width / height already set (readImage)
        Assumes RGB Color Model - would need to filter to change.
        Sends Ppm Image data to consumer.
        Pixels sent one row at a time.
*/

    private void produce () {
        ColorModel cm = ColorModel.getRGBdefault();
        if (consumer != null) {
            if (loadError) {
                consumer.imageComplete (ImageConsumer.IMAGEERROR);
            } else {
                consumer.setDimensions (width, height);
                consumer.setProperties (props);
                consumer.setColorModel (cm);
                consumer.setHints (PpmHints);
                for (int j=0;j<height;j++)
                    consumer.setPixels (0, j, width, 1, cm, store[j], 0, width);
                consumer.imageComplete (ImageConsumer.STATICIMAGEDONE);
            }
        }
    }
```

produce() just calls the ImageConsumer methods in order: it sets the image's dimensions, hands off an empty Hashtable of properties, sets the color model (the default RGB model) and the hints, and then calls setPixels() once for each row of pixel data. The data is in the integer array store[][], which has already been loaded by the readImage() method (defined in the following code). When the data is delivered, the method setPixels() calls imageComplete() to indicate that the image has been finished successfully.

```
/* Allows reading to be from internal byte array, in addition to disk/socket */

    public void readImage (byte b[]) {
        readImage (new ByteArrayInputStream (b));
    }

/* readImage reads image data from Stream */
/* parses data for PPM format              */
```

```
/* closes inputstream when done           */

    public void readImage (InputStream is) {
        long tm = System.currentTimeMillis();
        boolean raw=false;
        DataInputStream dis = null;
        BufferedInputStream bis = null;
        try {
            bis = new BufferedInputStream (is);
            dis = new DataInputStream (bis);
            String word;
            word = readWord (dis);
            if ("P6".equals (word)) {
                raw = true;
            } else if ("P3".equals (word)) {
                raw = false;
            } else {
                throw (new AWTException ("Invalid Format " + word));
            }
            width = Integer.parseInt (readWord (dis));
            height = Integer.parseInt (readWord (dis));
            // Could put comments in props - makes readWord more complex
            int maxColors = Integer.parseInt (readWord (dis));
            if ((maxColors < 0) || (maxColors > 255)) {
                throw (new AWTException ("Invalid Colors " + maxColors));
            }
            store = new int[height][width];
            if (raw) {                    // binary format (raw) pixel data
                byte row[] = new byte [width*3];
                for (int i=0;i<height;i++){
                    dis.readFully (row);
                    for (int j=0,k=0;j<width;j++,k+=3) {
                        int red = row[k];
                        int green = row[k+1];
                        int blue = row[k+2];
                        if (red < 0)
                            red +=256;
                        if (green < 0)
                            green +=256;
                        if (blue < 0)
                            blue +=256;
                        store[i][j] = (0xff<< 24) | (red << 16) |
                                      (green << 8) | blue;
                    }
                }
            } else {                      // ASCII pixel data
                for (int i=0;i<height;i++) {
                    for (int j=0;j<width;j++) {
                        int red = Integer.parseInt (readWord (dis));
                        int green = Integer.parseInt (readWord (dis));
                        int blue = Integer.parseInt (readWord (dis));
                        store[i][j] = (0xff<< 24) | (red << 16) |
                                      (green << 8) | blue;
                    }
```

```
                }
            }
        } catch (IOException io) {
            loadError = true;
            System.out.println ("IO Exception " + io.getMessage());
        } catch (AWTException awt) {
            loadError = true;
            System.out.println ("AWT Exception " + awt.getMessage());
        } catch (NoSuchElementException nse) {
            loadError = true;
            System.out.println ("No Such Element Exception " + nse.getMessage());
        } finally {
            try {
                if (dis != null)
                    dis.close();
                if (bis != null)
                    bis.close();
                if (is != null)
                    is.close();
            } catch (IOException io) {
                System.out.println ("IO Exception " + io.getMessage());
            }
        }
        System.out.println ("Done in " + (System.currentTimeMillis() - tm)
                            + " ms");
    }
```

`readImage()` reads the image data from an `InputStream` and converts it into the array of pixel data that `produce()` transfers to the consumer. Code using this class must call `readImage()` to process the data before calling `createImage()`; we'll see how this works shortly. Although there is a lot of code in `readImage()`, it's fairly simple. (It would be much more complex if we were dealing with an image format that compressed the data.) It makes heavy use of `readWord()`, a utility method that we'll discuss next; `readWord()` returns a word of ASCII text as a string.

`readImage()` starts by converting the `InputStream` into a `DataInputStream`. It uses `readWord()` to get the first word from the stream. This should be either "P6" or "P3", depending on whether the data is in binary or ASCII. It then uses `readWord()` to save the image's width and height and the maximum value of any color component. Next, it reads the color data into the `store[][]` array. The ASCII case is simple because we can use `readWord()` to read ASCII words conveniently; we read red, green, and blue words, convert them into `ints`, and pack the three into one element (one pixel) of `store[][]`. For binary data, we read an entire scan line into the byte array `row[]`, using `readFully()`; then we start a loop that packs this scan line into one row of `store[][]`. A little additional complexity is in the inner loop because we must keep track of two arrays (`row[]` and `store[][]`). We read red, green, and blue components from `row[]`, converting Java's signed bytes to unsigned data by adding 256 to any negative values; finally, we pack these components into one element of `store[][]`.

```
/* readWord returns a word of text from stream          */
/* Ignores PPM comment lines.                            */
/* word defined to be something wrapped by whitespace    */

    private String readWord (InputStream is) throws IOException {
        StringBuffer buf = new StringBuffer();
        int b;
        do {// get rid of leading whitespace
            if ((b=is.read()) == -1)
                throw new EOFException();
            if ((char)b == '#') { // read to end of line - ppm comment
                DataInputStream dis = new DataInputStream (is);
                dis.readLine();
                b = ' ';  // ensure more reading
            }
        }while (Character.isSpace ((char)b));
        do {
            buf.append ((char)(b));
            if ((b=is.read()) == -1)
                throw new EOFException();
        } while (!Character.isSpace ((char)b));  // reads first space
        return buf.toString();
    }
}
```

`readWord()` is a utility method that reads one ASCII word from an `InputStream`. A word is a sequence of characters that aren't spaces; space characters include newlines and tabs in addition to spaces. This method also throws out any comments (anything between # and the end of the line). It collects the characters into a `StringBuffer`, converting the `StringBuffer` into a `String` when it returns.

Example 12–5: PPMImageDecoder Test Program

```
import java.awt.Graphics;
import java.awt.Color;
import java.awt.image.ImageConsumer;
import java.awt.Image;
import java.awt.MediaTracker;
import java.net.URL;
import java.net.MalformedURLException;
import java.io.InputStream;
import java.io.IOException;
import java.applet.Applet;
public class ppmViewer extends Applet {
    Image image = null;
    public void init () {
        try {
            String file = getParameter ("file");
            if (file != null) {
                URL imageurl = new URL (getDocumentBase(), file);
                InputStream is = imageurl.openStream();
                PPMImageDecoder ppm = new PPMImageDecoder ();
                ppm.readImage (is);
```

Example 12–5: PPMImageDecoder Test Program (continued)

```
                image = createImage (ppm);
                repaint();
            }
        } catch (MalformedURLException me) {
            System.out.println ("Bad URL");
         } catch (IOException io) {
            System.out.println ("Bad File");
        }
    }
    public void paint (Graphics g) {
        g.drawImage (image, 0, 0, this);
    }
}
```

The applet we use to test our `ImageProducer` is very simple. It creates a URL that points to an appropriate PPM file and gets an `InputStream` from that URL. It then creates an instance of our `PPMImageDecoder`; calls `readImage()` to load the image and generate pixel data; and finally, calls `createImage()` with our `ImageProducer` as an argument to create an `Image` object, which we draw in `paint()`.

12.4.2 PixelGrabber

The `PixelGrabber` class is a utility for converting an image into an array of pixels. This is useful in many situations. If you are writing a drawing utility that lets users create their own graphics, you probably want some way to save a drawing to a file. Likewise, if you're implementing a shared whiteboard, you'll want some way to transmit images across the Net. If you're doing some kind of image processing, you may want to read and alter individual pixels in an image. The `PixelGrabber` class is an `ImageConsumer` that can capture a subset of the current pixels of an `Image`. Once you have the pixels, you can easily save the image in a file, send it across the Net, or work with individual points in the array. To recreate the `Image` (or a modified version), you can pass the pixel array to a `MemoryImageSource`.

Prior to Java 1.1, `PixelGrabber` saves an array of pixels but doesn't save the image's width and height—that's your responsibility. You may want to put the width and height in the first two elements of the pixel array and use an offset of 2 when you store (or reproduce) the image.

Starting with Java 1.1, the grabbing process changes in several ways. You can ask the `PixelGrabber` for the image's size or color model. You can grab pixels asynchronously and abort the grabbing process before it is completed. Finally, you don't have to preallocate the pixel data array.

Constructors

public PixelGrabber (ImageProducer ip, int x, int y, int width, int height, int pixels[], int offset, int scansize)

The first `PixelGrabber` constructor creates a new `PixelGrabber` instance. The `PixelGrabber` uses `ImageProducer ip` to store the unscaled cropped rectangle at position (`x`, `y`) of size `width height` into the `pixels` array, starting at `offset` within `pixels`, and each row starting at increments of `scansize` from that.

As shown in Figure 12-5, the position (`x1`, `y1`) would be stored in `pixels[]` at position `(y1 - y) * scansize + (x1 - x) + offset.` Calling `grabPixels()` starts the process of writing pixels into the array.

The `ColorModel` for the pixels copied into the array is always the default RGB model: that is, 32 bits per pixel, with 8 bits for alpha, red, green, and blue components.

public PixelGrabber (Image image, int x, int y, int width, int height, int pixels[], int offset, int scansize)

This version of the `PixelGrabber` constructor gets the `ImageProducer` of the `Image image` through `getSource()`; it then calls the previous constructor to create the `PixelGrabber`.

public PixelGrabber (Image image, int x, int y, int width, int height, boolean forceRGB) ★

This version of the constructor does not require you to preallocate the pixel array and lets you preserve the color model of the original image. If `forceRGB` is `true`, the pixels of `image` are converted to the default RGB model when grabbed. If `forceRGB` is `false` and all the pixels of image use one `ColorModel`, the original color model of `image` is preserved.

As with the other constructors, the `x`, `y`, `width`, and `height` values define the bounding box to grab. However, there's one special case to consider. Setting `width` or `height` to -1 tells the `PixelGrabber` to take the `width` and `height` from the image itself. In this case, the grabber stores all the pixels below and to the right of the point (`x`, `y`). If (`x`, `y`) is outside of the image, you get an empty array.

Once the pixels have been grabbed, you get the pixel data via the `getPixels()` method described in "Other methods." To get the `ColorModel`, see the `get-ColorModel()` method.

ImageConsumer interface methods

public void setDimensions (int width, int height)

In Java 1.0, the `setDimensions()` method of `PixelGrabber` ignores the `width` and `height`, since this was set by the constructor.

With Java 1.1, `setDimensions()` is called by the image producer to give it the dimensions of the original image. This is how the `PixelGrabber` finds out the image's size if the constructor specified -1 for the image's width or height.

public void setHints (int hints)

The `setHints()` method ignores the `hints`.

public void setProperties (Hashtable properties)

The `setProperties()` method ignores the `properties`.

public void setColorModel (ColorModel model)

The `setColorModel()` method ignores the `model`.

public void setPixels (int x, int y, int w, int h, ColorModel model, byte pixels[], int offset, int scansize)

The `setPixels()` method is called by the `ImageProducer` to deliver pixel data for some image. If the pixels fall within the portion of the image that the `PixelGrabber` is interested in, they are stored within the array passed to the `PixelGrabber` constructor. If necessary, the `ColorModel` is used to convert each pixel from its original representation to the default RGB representation. This method is called when each pixel coming from the image producer is represented by a byte.

public void setPixels (int x, int y, int w, int h, ColorModel model, int pixels[], int offset, int scansize)

The second `setPixels()` method is almost identical to the first; it is used when each pixel coming from the image producer is represented by an `int`.

public synchronized void imageComplete (int status)

The `imageComplete()` method uses `status` to determine if the pixels were successfully delivered. The `PixelGrabber` then notifies anyone waiting for the pixels from a `grabPixels()` call.

Grabbing methods

public synchronized boolean grabPixels (long ms) throws InterruptedException

The `grabPixels()` method starts storing pixel data from the image. It doesn't return until all pixels have been loaded into the pixels array or until `ms` milliseconds have passed. The return value is `true` if all pixels were successfully acquired. Otherwise, it returns `false` for the abort, error, or timeout condition encountered. The exception `InterruptedException` is thrown if another thread interrupts this one while waiting for pixel data.

public boolean grabPixels () throws InterruptedException

This `grabPixels()` method starts storing pixel data from the image. It doesn't return until all pixels have been loaded into the pixels array. The return value is `true` if all pixels were successfully acquired. It returns `false` if it encountered an abort or error condition. The exception `InterruptedException` is thrown if another thread interrupts this one while waiting for pixel data.

public synchronized void startGrabbing() ★

The `startGrabbing()` method provides an asynchronous means of grabbing the pixels. This method returns immediately; it does not block like the `grabPixels()` methods described previously. To find out when the `PixelGrabber` has finished, call `getStatus()`.

public synchronized void abortGrabbing() ★

The `abortGrabbing()` method allows you to stop grabbing pixel data from the image. If a thread is waiting for pixel data from a `grabPixels()` call, it is interrupted and `grabPixels()` throws an `InterruptedException`.

Other methods

public synchronized int getStatus() ★
public synchronized int status () ☆

Call the `getStatus()` method to find out whether a `PixelGrabber` succeeded in grabbing the pixels you want. The return value is a set of `ImageObserver` flags ORed together. `ALLBITS` and `FRAMEBITS` indicate success; which of the two you get depends on how the image was created. `ABORT` and `ERROR` indicate that problems occurred while the image was being produced.

`status()` is the Java 1.0 name for this method.

public synchronized int getWidth() ★

The `getWidth()` method reports the width of the image data stored in the destination buffer. If you set width to -1 when you called the `PixelGrabber` constructor, this information will be available only after the grabber has received the information from the image producer (`setDimensions()`). If the width is not available yet, `getWidth()` returns -1.

The width of the resulting image depends on several factors. If you specified the width explicitly in the constructor, the resulting image has that width, no questions asked—even if the position at which you start grabbing is outside the image. If you specified -1 for the width, the resulting width will be the difference between the `x` position at which you start grabbing (set in the constructor) and the actual image width; for example, if you start grabbing at `x=50` and the original image width is 100, the width of the resulting image is 50. If `x` falls outside the image, the resulting width is 0.

public synchronized int getHeight() ★

The `getHeight()` method reports the height of the image data stored in the destination buffer. If you set height to -1 when you called the `PixelGrabber` constructor, this information will be available only after the grabber has received the information from the image producer (`setDimensions()`). If the height is not available yet, `getHeight()` returns -1.

The height of the resulting image depends on several factors. If you specified the height explicitly in the constructor, the resulting image has that height, no questions asked—even if the position at which you start grabbing is outside the image. If you specified -1 for the height, the resulting height will be the difference between the `y` position at which you start grabbing (set in the constructor) and the actual image height; for example, if you start grabbing at `y`=50 and the original image height is 100, the height of the resulting image is 50. If `y` falls outside the image, the resulting height is 0.

public synchronized Object getPixels() ★

The `getPixels()` method returns an array of pixel data. If you passed a pixel array to the constructor, you get back your original array object, with the data filled in. If, however, the array was not previously allocated, you get back a new array. The size of this array depends on the image you are grabbing and the portion of that image you want. If size and image format are not known yet, this method returns `null`. If the `PixelGrabber` is still grabbing pixels, this method returns an array that may change based upon the rest of the image. The type of the array you get is either `int[]` or `byte[]`, depending on the color model of the image. To find out if the `PixelGrabber` has finished, call `getStatus()`.

public synchronized ColorModel getColorModel() ★

The `getColorModel()` method returns the color model of the image. This could be the default RGB `ColorModel` if a pixel buffer was explicitly provided, `null` if the color model is not known yet, or a varying color model until all the pixel data has been grabbed. After all the pixels have been grabbed, `getColorModel()` returns the actual color model used for the `getPixels()` array. It is best to wait until grabbing has finished before you ask for the `ColorModel`; to find out, call `getStatus()`.

Using PixelGrabber to modify an image

You can modify images by combining a `PixelGrabber` with `MemoryImageSource`. Use `getImage()` to load an image from the Net; then use `PixelGrabber` to convert the image into an array. Modify the data in the array any way you please; then use `MemoryImageSource` as an image producer to display the new image.

Example 12-6 demonstrates the use of the `PixelGrabber` and `MemoryImageSource` to rotate, flip, and mirror an image. (We could also do the rotations with a subclass of `ImageFilter`, which we will discuss next.) The output is shown in Figure 12-6. When working with an image that is loaded from a local disk or the network, remember to wait until the image is loaded before grabbing its pixels. In this example, we use a `MediaTracker` to wait for the image to load.

Example 12–6: Flip Source

```
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
public class flip extends Applet {
        Image i, j, k, l;
        public void init () {
                MediaTracker mt = new MediaTracker (this);
                i = getImage (getDocumentBase(), "ora-icon.gif");
                mt.addImage (i, 0);
        try {
                mt.waitForAll();
                int width = i.getWidth(this);
                int height = i.getHeight(this);
                int pixels[] = new int [width * height];
                PixelGrabber pg = new PixelGrabber
                (i, 0, 0, width, height, pixels, 0, width);
                if (pg.grabPixels() && ((pg.status() &
                        ImageObserver.ALLBITS) !=0)) {
                        j = createImage (new MemoryImageSource (width, height,
                             rowFlipPixels (pixels, width, height), 0, width));
                        k = createImage (new MemoryImageSource (width, height,
                             colFlipPixels (pixels, width, height), 0, width));
                        l = createImage (new MemoryImageSource (height, width,
                             rot90Pixels (pixels, width, height), 0, height));
                }
        } catch (InterruptedException e) {
                e.printStackTrace();
        }
}
```

The `try` block in Example 12-6 does all the interesting work. It uses a `PixelGrabber` to grab the entire image into the array `pixels[]`. After calling `grabPixels()`, it checks the `PixelGrabber` status to make sure that the image was stored correctly. It then generates three new images based on the first by calling `createImage()` with a `MemoryImageSource` object as an argument. Instead of using the original array, the `MemoryImageSource` objects call several utility methods to manipulate the array: `rowFlipPixels()`, `colFlipPixels()`, and `rot90Pixels()`. These methods all return integer arrays.

```
public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this); // regular
        if (j != null)
```

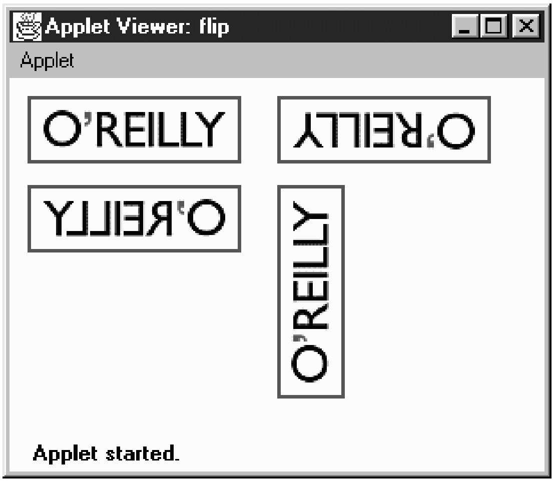


Figure 12–6: Flip output

```
                g.drawImage (j, 150, 10, this); // rowFlip
        if (k != null)
                g.drawImage (k, 10, 60, this); // colFlip
        if (l != null)
                g.drawImage (l, 150, 60, this); // rot90
    }
    private int[] rowFlipPixels (int pixels[], int width, int height) {
        int newPixels[] = null;
        if ((width*height) == pixels.length) {
                newPixels = new int [width*height];
                int newIndex=0;
                for (int y=height-1;y>=0;y--)
                        for (int x=width-1;x>=0;x--)
                                newPixels[newIndex++]=pixels[y*width+x];
        }
        return newPixels;
    }
```

rowFlipPixels() creates a mirror image of the original, flipped horizontally. It is nothing more than a nested loop that copies the original array into a new array.

```
        private int[] colFlipPixels (int pixels[], int width, int height) {
            ...
        }
    private int[] rot90Pixels (int pixels[], int width, int height) {
            ...
        }
    }
```

colFlipPixels() and rot90Pixels() are fundamentally similar to rowFlipPixels(); they just copy the original pixel array into another array, and return the result. colFlipPixels() generates a vertical mirror image; rot90Pixels() rotates the image by 90 degrees counterclockwise.

Grabbing data asynchronously

To demonstrate the new methods introduced by Java 1.1 for PixelGrabber, the following program grabs the pixels and reports information about the original image on mouse clicks. It takes its data from the image used in Figure 12-6.

```
// Java 1.1 only
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
import java.awt.event.*;
public class grab extends Applet {
    Image i;
    PixelGrabber pg;
    public void init () {
        i = getImage (getDocumentBase(), "ora-icon.gif");
        pg  = new PixelGrabber (i, 0, 0, -1, -1, false);
        pg.startGrabbing();
        enableEvents (AWTEvent.MOUSE_EVENT_MASK);
    }
    public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this);
    }
    protected void processMouseEvent(MouseEvent e) {
        if (e.getID() == MouseEvent.MOUSE_CLICKED) {
            System.out.println ("Status: " + pg.getStatus());
            System.out.println ("Width:  " + pg.getWidth());
            System.out.println ("Height: " + pg.getHeight());
            System.out.println ("Pixels: " +
               (pg.getPixels() instanceof byte[] ? "bytes" : "ints"));
            System.out.println ("Model:  " + pg.getColorModel());
        }
        super.processMouseEvent (e);
    }
}
```

This applet creates a PixelGrabber without specifying an array, then starts grabbing pixels. The grabber allocates its own array, but we never bother to ask for it since we don't do anything with the data itself: we only report the grabber's status. (If we wanted the data, we'd call getPixels().) Sample output from a single mouse click, after the image loaded, would appear something like the following:

```
Status: 27
Width:  120
Height: 38
Pixels: bytes
Model:  java.awt.image.IndexColorModel@1ed34
```

You need to convert the status value manually to the corresponding meaning by looking up the status codes in `ImageObserver`. The value 27 indicates that the 1, 2, 8, and 16 flags are set, which translates to the `WIDTH`, `HEIGHT`, `SOMEBITS`, and `FRAMEBITS` flags, respectively.

12.5 ImageFilter

Image filters provide another way to modify images. An `ImageFilter` is used in conjunction with a `FilteredImageSource` object. The `ImageFilter`, which implements `ImageConsumer` (and `Cloneable`), receives data from an `ImageProducer` and modifies it; the `FilteredImageSource`, which implements `ImageProducer`, sends the modified data to the new consumer. As Figure 12-1 shows, an image filter sits between the original `ImageProducer` and the ultimate `ImageConsumer`.

The `ImageFilter` class implements a "null" filter that does nothing to the image. To modify an image, you must use a subclass of `ImageFilter`, by either writing one yourself or using a subclass provided with AWT, like the `CropImageFilter`. Another `ImageFilter` subclass provided with AWT is the `RGBImageFilter`; it is useful for filtering an image on the basis of a pixel's color. Unlike the `CropImageFilter`, `RGBImageFilter` is an abstract class, so you need to create your own subclass to use it. Java 1.1 introduces two more image filters, `AreaAveragingScaleFilter` and `ReplicateScaleFilter`. Other filters must be created by subclassing `ImageFilter` and providing the necessary methods to modify the image as necessary.

`ImageFilters` tend to work on a pixel-by-pixel basis, so large `Image` objects can take a considerable amount of time to filter, depending on the complexity of the filtering algorithm. In the simplest case, filters generate new pixels based upon the color value and location of the original pixel. Such filters can start delivering data before they have loaded the entire image. More complex filters may use internal buffers to store an intermediate copy of the image so the filter can use adjacent pixel values to smooth or blend pixels together. These filters may need to load the entire image before they can deliver any data to the ultimate consumer.

To use an `ImageFilter`, you pass it to the `FilteredImageSource` constructor, which serves as an `ImageProducer` to pass the new pixels to their consumer. The following code runs the image *logo.jpg* through an image filter, `SomeImageFilter`, to produce a new image. The constructor for `SomeImageFilter` is called within the constructor for `FilteredImageSource`, which in turn is the only argument to `createImage()`.

```
Image image = getImage (new URL (
     "http://www.ora.com/images/logo.jpg"));
Image newOne = createImage (new FilteredImageSource (image.getSource(),
                                 new SomeImageFilter()));
```

12.5.1 ImageFilter Methods

Variables

protected ImageConsumer consumer;

The actual `ImageConsumer` for the image. It is initialized automatically for you by the `getFilterInstance()` method.

Constructor

public ImageFilter ()

The only constructor for `ImageFilter` is the default one, which takes no arguments. Subclasses can provide their own constructors if they need additional information.

ImageConsumer interface methods

public void setDimensions (int width, int height)

The `setDimensions()` method of `ImageFilter` is called when the `width` and `height` of the original image are known. It calls `consumer.setDimensions()` to tell the next consumer the dimensions of the filtered image. If you subclass `ImageFilter` and your filter changes the image's dimensions, you should override this method to compute and report the new dimensions.

public void setProperties (Hashtable properties)

The `setProperties()` method is called to provide the image filter with the property list for the original image. The image filter adds the property `filters` to the list and passes it along to the next consumer. The value given for the `filters` property is the result of the image filter's `toString()` method; that is, the `String` representation of the current filter. If `filters` is already set, information about this `ImageFilter` is appended to the end. Subclasses of `ImageFilter` may add other properties.

public void setColorModel (ColorModel model)

The `setColorModel()` method is called to give the `ImageFilter` the color model used for most of the pixels in the original image. It passes this color model on to the next consumer. Subclasses may override this method if they change the color model.

public void setHints (int hints)

The `setHints()` method is called to give the `ImageFilter` hints about how the producer will deliver pixels. This method passes the same set of hints to the next consumer. Subclasses must override this method if they need to provide different hints; for example, if they are delivering pixels in a different order.

public void setPixels (int x, int y, int width, int height, ColorModel model, byte pixels[], int offset, int scansize)
public void setPixels (int x, int y, int width, int height, ColorModel model, int pixels[], int offset, int scansize)

The `setPixels()` method receives pixel data from the `ImageProducer` and passes all the information on to the `ImageConsumer`. (`x`, `y`) is the top left corner of the bounding rectangle for the pixels. The bounding rectangle has size `width` `height`. The `ColorModel` for the new image is `model`. `pixels` is the byte or integer array of the pixel information, starting at `offset` (usually 0), with scan lines of size `scansize` (usually `width`).

public void imageComplete (int status)

The `imageComplete()` method receives the completion `status` from the `ImageProducer` and passes it along to the `ImageConsumer`.

If you subclass `ImageFilter`, you will probably override the `setPixels()` methods. For simple filters, you may be able to modify the pixel array and deliver the result to `consumer.setPixels()` immediately. For more complex filters, you will have to build a buffer containing the entire image; in this case, the call to `imageComplete()` will probably trigger filtering and pixel delivery.

Cloneable interface methods

public Object clone ()

The `clone()` method creates a clone of the `ImageFilter`. The `getFilterInstance()` function uses this method to create a copy of the `ImageFilter`. Cloning allows the same filter instance to be used with multiple `Image` objects.

Other methods

public ImageFilter getFilterInstance (ImageConsumer ic)

`FilteredImageSource` calls `getFilterInstance()` to register `ic` as the `ImageConsumer` for an instance of this filter; to do so, it sets the instance variable `consumer`. In effect, this method inserts the `ImageFilter` between the image's producer and the consumer. You have to override this method only if there are special requirements for the insertion process. This default implementation just calls `clone()`.

public void resendTopDownLeftRight (ImageProducer ip)

The `resendTopDownLeftRight()` method tells the `ImageProducer ip` to try to resend the image data in the top-down, left-to-right order. If you override this method and your `ImageFilter` has saved the image data internally, you may want your `ImageFilter` to resend the data itself, rather than asking the `ImageProducer`. Otherwise, your subclass may ignore the request or pass it along to the `ImageProducer ip`.

Subclassing ImageFilter: A blurring filter

When you subclass `ImageFilter`, there are very few restrictions on what you can do. We will create a few subclasses that show some of the possibilities. This `ImageFilter` generates a new pixel by averaging the pixels around it. The result is a blurred version of the original. To implement this filter, we have to save all the pixel data into a buffer; we can't start delivering pixels until the entire image is in hand. Therefore, we override `setPixels()` to build the buffer; we override `imageComplete()` to produce the new pixels and deliver them.

Before looking at the code, here are a few hints about how the filter works; it uses a few tricks that may be helpful in other situations. We need to provide two versions of `setPixels()`: one for integer arrays, and the other for byte arrays. To avoid duplicating code, both versions call a single method, `setThePixels()`, which takes an `Object` as an argument, instead of a pixel array; thus it can be called with either kind of pixel array. Within the method, we check whether the pixels argument is an instance of `byte[]` or `int[]`. The body of this method uses another trick: when it reads the `byte[]` version of the pixel array, it ANDs the value with 0xff. This prevents the byte value, which is signed, from being converted to a negative `int` when used as an argument to `cm.getRGB()`.

The logic inside of `imageComplete()` gets a bit hairy. This method does the actual filtering, after all the data has arrived. Its job is basically simple: compute an average value of the pixel and the eight pixels surrounding it (i.e., a 33 rectangle with the current pixel in the center). The problem lies in taking care of the edge conditions. We don't always want to average nine pixels; in fact, we may want to average as few as four. The `if` statements figure out which surrounding pixels should be included in the average. The pixels we care about are placed in `sumArray[]`, which has nine elements. We keep track of the number of elements that have been saved in the variable `sumIndex` and use a helper method, `avgPixels()`, to compute the average. The code might be a little cleaner if we used a `Vector`, which automatically counts the number of elements it contains, but it would probably be much slower.

Example 12-7 shows the code for the blurring filter.

Example 12–7: Blur Filter Source

```
import java.awt.*;
import java.awt.image.*;

public class BlurFilter extends ImageFilter {
    private int savedWidth, savedHeight, savedPixels[];
    private static ColorModel defaultCM = ColorModel.getRGBdefault();

    public void setDimensions (int width, int height) {
        savedWidth=width;
```

Example 12–7: Blur Filter Source (continued)

```
            savedHeight=height;
            savedPixels=new int [width*height];
            consumer.setDimensions (width, height);
        }
```

We override `setDimensions()` to save the original image's height and width, which we use later.

```
        public void setColorModel (ColorModel model) {
        // Change color model to model you are generating
            consumer.setColorModel (defaultCM);
        }

        public void setHints (int hintflags) {
        // Set new hints, but preserve SINGLEFRAME setting
            consumer.setHints (TOPDOWNLEFTRIGHT | COMPLETESCANLINES |
                               SINGLEPASS | (hintflags & SINGLEFRAME));
        }
```

This filter always generates pixels in the same order, so it sends the hint flags `TOPDOWNLEFTRIGHT`, `COMPLETESCANLINES`, and `SINGLEPASS` to the consumer, regardless of what the image producer says. It sends the `SINGLEFRAME` hint only if the producer has sent it.

```
        private void setThePixels (int x, int y, int width, int height,
                ColorModel cm, Object pixels, int offset, int scansize) {
            int sourceOffset = offset;
            int destinationOffset = y * savedWidth + x;
            boolean bytearray = (pixels instanceof byte[]);
            for (int yy=0;yy<height;yy++) {
                for (int xx=0;xx<width;xx++)
                    if (bytearray)
                        savedPixels[destinationOffset++]=
                            cm.getRGB(((byte[])pixels)[sourceOffset++]&0xff);
                    else
                        savedPixels[destinationOffset++]=
                            cm.getRGB(((int[])pixels)[sourceOffset++]);
                sourceOffset += (scansize - width);
                destinationOffset += (savedWidth - width);
            }
        }
```

`setThePixels()` saves the pixel data for the image in the array `savedPixels[]`. Both versions of `setPixels()` call this method. It doesn't pass the pixels along to the image consumer, since this filter can't process the pixels until the entire image is available.

```
    public void setPixels (int x, int y, int width, int height,
           ColorModel cm, byte pixels[], int offset, int scansize) {
        setThePixels (x, y, width, height, cm, pixels, offset, scansize);
    }
```

```
    public void setPixels (int x, int y, int width, int height,
           ColorModel cm, int pixels[], int offset, int scansize) {
        setThePixels (x, y, width, height, cm, pixels, offset, scansize);
    }

    public void imageComplete (int status) {
        if ((status == IMAGEABORTED) || (status == IMAGEERROR)) {
            consumer.imageComplete (status);
            return;
        } else {
            int pixels[] = new int [savedWidth];
            int position, sumArray[], sumIndex;
            sumArray = new int [9]; // maxsize - vs. Vector for performance
            for (int yy=0;yy<savedHeight;yy++) {
                position=0;
                int start = yy * savedWidth;
                for (int xx=0;xx<savedWidth;xx++) {
                    sumIndex=0;
                                                                 //  xx     yy
                    sumArray[sumIndex++] = savedPixels[start+xx];  // center center
                    if (yy != (savedHeight-1))                   // center bottom
                        sumArray[sumIndex++] = savedPixels[start+xx+savedWidth];
                    if (yy != 0)                                 // center top
                        sumArray[sumIndex++] = savedPixels[start+xx-savedWidth];
                    if (xx != (savedWidth-1))                    // right  center
                        sumArray[sumIndex++] = savedPixels[start+xx+1];
                    if (xx != 0)                                 // left   center
                        sumArray[sumIndex++] = savedPixels[start+xx-1];
                    if ((yy != 0) && (xx != 0))                  // left   top
                        sumArray[sumIndex++] = savedPixels[start+xx-savedWidth-1];
                    if ((yy != (savedHeight-1)) && (xx != (savedWidth-1)))
                        //                                         right  bottom
                        sumArray[sumIndex++] = savedPixels[start+xx+savedWidth+1];
                    if ((yy != 0) && (xx != (savedWidth-1)))     //right  top
                        sumArray[sumIndex++] = savedPixels[start+xx-savedWidth+1];
                    if ((yy != (savedHeight-1)) && (xx != 0))    //left   bottom
                        sumArray[sumIndex++] = savedPixels[start+xx+savedWidth-1];
                    pixels[position++] = avgPixels(sumArray, sumIndex);
                }
                consumer.setPixels (0, yy, savedWidth, 1, defaultCM,
                                    pixels, 0, savedWidth);
            }
            consumer.imageComplete (status);
        }
    }
```

`imageComplete()` does the actual filtering after the pixels have been delivered and saved. If the producer reports that an error occurred, this method passes the error flags to the consumer and returns. If not, it builds a new array, `pixels[]`, which contains the filtered pixels, and delivers these to the consumer.

Previously, we gave an overview of how the filtering process works. Here are some details. (`xx`, `yy`) represents the current point's `x` and `y` coordinates. The point (`xx`, `yy`) must always fall within the image; otherwise, our loops are constructed incorrectly. Therefore, we can copy (`xx`, `yy`) into the `sumArray[]` for averaging without any tests. For the point's eight neighbors, we check whether the neighbor falls in the image; if so, we add it to `sumArray[]`. For example, the point just below (`xx`, `yy`) is at the bottom center of the 33 rectangle of points we are averaging. We know that `xx` falls within the image; `yy` falls within the image if it doesn't equal `savedHeight-1`. We do similar tests for the other points.

Even though we're working with a rectangular image, our arrays are all one-dimensional so we have to convert a coordinate pair (`xx`, `yy`) into a single array index. To help us do the bookkeeping, we use the local variable `start` to keep track of the start of the current scan line. Then `start` + `xx` is the current point; `start` + `xx` + `savedWidth` is the point immediately below; `start` + `xx` + `savedWidth-1` is the point below and to the left; and so on.

`avgPixels()` is our helper method for computing the average value that we assign to the new pixel. For each pixel in the `pixels[]` array, it extracts the red, blue, green, and alpha components; averages them separately, and returns a new ARGB value.

```
        private int avgPixels (int pixels[], int size) {
            float redSum=0, greenSum=0, blueSum=0, alphaSum=0;
            for (int i=0;i<size;i++)
                try {
                    int pixel = pixels[i];
                    redSum   += defaultCM.getRed   (pixel);
                    greenSum += defaultCM.getGreen (pixel);
                    blueSum  += defaultCM.getBlue  (pixel);
                    alphaSum += defaultCM.getAlpha (pixel);
                } catch (ArrayIndexOutOfBoundsException e) {
                    System.out.println ("Ooops");
                }
            int redAvg   = (int)(redSum   / size);
            int greenAvg = (int)(greenSum / size);
            int blueAvg  = (int)(blueSum  / size);
            int alphaAvg = (int)(alphaSum / size);
            return ((0xff << 24) | (redAvg << 16) |
                    (greenAvg << 8)  | (blueAvg << 0));
        }
    }
```

Producing many images from one: dynamic ImageFilter

The `ImageFilter` framework is flexible enough to allow you to return a sequence of images based on an original. You can send back one frame at a time, calling the following when you are finished with each frame:

```
consumer.imageComplete(ImageConsumer.SINGLEFRAMEDONE);
```

After you have generated all the frames, you can tell the consumer that the sequence is finished with the `STATICIMAGEDONE` constant. In fact, this is exactly what the new animation capabilities of `MemoryImageSource` use.

In Example 12-8, the `DynamicFilter` lets the consumer display an image. After the image has been displayed, the filter gradually overwrites the image with a specified color by sending additional image frames. The end result is a solid colored rectangle. Not too exciting, but it's easy to imagine interesting extensions: you could use this technique to implement a fade from one image into another. The key points to understand are:

- This filter does not override `setPixels()`, so it is extremely fast. In this case, we want the original image to reach the consumer, and there is no reason to save the image in a buffer.
- Filtering takes place in the image-fetching thread, so it is safe to put the filter-processing thread to sleep if the image is coming from disk. If the image is in memory, filtering should not sleep because there will be a noticeable performance lag in your program if it does. The `DynamicFilter` class has a delay parameter to its constructor that lets you control this behavior.
- This subclass overrides `setDimensions()` to save the image's dimensions for its own use. It needs to override `setHints()` because it sends pixels to the consumer in a nonstandard order: it sends the original image, then goes back and starts sending overlays. Likewise, this subclass overrides `resendTopDownLeftRight()` to do nothing because there is no way the original `ImageProducer` can replace all the changes with the original `Image`.
- `imageComplete()` is where all the fun happens. Take a special look at the status flags that are returned.

Example 12–8: DynamicFilter Source

```
import java.awt.*;
import java.awt.image.*;
public class DynamicFilter extends ImageFilter {
    Color overlapColor;
    int   delay;
    int   imageWidth;
    int   imageHeight;
    int   iterations;
    DynamicFilter (int delay, int iterations, Color color) {
        this.delay      = delay;
        this.iterations = iterations;
        overlapColor    = color;
    }
    public void setDimensions (int width, int height) {
        imageWidth  = width;
```

Example 12–8: DynamicFilter Source (continued)

```
            imageHeight = height;
            consumer.setDimensions (width, height);
        }
        public void setHints (int hints) {
            consumer.setHints (ImageConsumer.RANDOMPIXELORDER);
        }
        public void resendTopDownLeftRight (ImageProducer ip) {
        }
        public void imageComplete (int status) {
            if ((status == IMAGEERROR) || (status == IMAGEABORTED)) {
                consumer.imageComplete (status);
                return;
            } else {
                int xWidth = imageWidth / iterations;
                if (xWidth <= 0)
                    xWidth = 1;
                int newPixels[] = new int [xWidth*imageHeight];
                int iColor = overlapColor.getRGB();
                for (int x=0;x<(xWidth*imageHeight);x++)
                    newPixels[x] = iColor;
                int t=0;
                for (;t<(imageWidth-xWidth);t+=xWidth) {
                    consumer.setPixels(t, 0, xWidth, imageHeight,
                            ColorModel.getRGBdefault(), newPixels, 0, xWidth);
                    consumer.imageComplete (ImageConsumer.SINGLEFRAMEDONE);
                    try {
                        Thread.sleep (delay);
                    } catch (InterruptedException e) {
                        e.printStackTrace();
                    }
                }
                int left = imageWidth-t;
                if (left > 0) {
                    consumer.setPixels(imageWidth-left, 0, left, imageHeight,
                            ColorModel.getRGBdefault(), newPixels, 0, xWidth);
                    consumer.imageComplete (ImageConsumer.SINGLEFRAMEDONE);
                }
                consumer.imageComplete (STATICIMAGEDONE);
            }
        }
    }
```

The `DynamicFilter` relies on the default `setPixels()` method to send the original image to the consumer. When the original image has been transferred, the image producer calls this filter's `imageComplete()` method, which does the real work. Instead of relaying the completion status to the consumer, `imageComplete()` starts generating its own data: solid rectangles that are all in the `overlapColor` specified in the constructor. It sends these rectangles to the consumer by calling consumer.setPixels(). After each rectangle, it calls consumer.imageComplete() with the SINGLEFRAMEDONE flag, meaning that it has just finished one frame of a multi-frame sequence. When the rectangles have completely covered the image, the method imageComplete() finally notifies the consumer that the entire image sequence has been transferred by sending the STATICIMAGEDONE flag.

The following code is a simple applet that uses this image filter to produce a new image:

```
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
public class DynamicImages extends Applet {
    Image i, j;
    public void init () {
        i = getImage (getDocumentBase(), "rosey.jpg");
        j = createImage (new FilteredImageSource (i.getSource(),
                        new DynamicFilter(250, 10, Color.red)));
    }
    public void paint (Graphics g) {
        g.drawImage (j, 10, 10, this);
    }
}
```

One final curiosity: the DynamicFilter doesn't make any assumptions about the color model used for the original image. It sends its overlays with the default RGB color model. Therefore, this is one case in which an ImageConsumer may see calls to setPixels() that use different color models.

12.5.2 RGBImageFilter

RGBImageFilter is an abstract subclass of ImageFilter that provides a shortcut for building the most common kind of image filters: filters that independently modify the pixels of an existing image, based only on the pixel's position and color. Because RGBImageFilter is an abstract class, you must subclass it before you can do anything. The only method your subclass must provide is filterRGB(), which produces a new pixel value based on the original pixel and its location. A handful of additional methods are in this class; most of them provide the behind-the-scenes framework for funneling each pixel through the filterRGB() method.

If the filtering algorithm you are using does not rely on pixel position (i.e., the new pixel is based only on the old pixel's color), AWT can apply an optimization for images that use an IndexColorModel: rather than filtering individual pixels, it can filter the image's color map. In order to tell AWT that this optimization is okay, add a constructor to the class definition that sets the canFilterIndexColorModel variable to true. If canFilterIndexColorModel is false (the default) and an IndexColorModel image is sent through the filter, nothing happens to the image.

Variables

protected boolean canFilterIndexColorModel

Setting the `canFilterIndexColorModel` variable permits the `ImageFilter` to filter `IndexColorModel` images. The default value is `false`. When this variable is `false`, `IndexColorModel` images are not filtered. When this variable is `true`, the `ImageFilter` filters the colormap instead of the individual pixel values.

protected ColorModel newmodel

The `newmodel` variable is used to store the new `ColorModel` when `canFilterIndexColorModel` is `true` and the `ColorModel` actually is of type `IndexColorModel`. Normally, you do not need to access this variable, even in subclasses.

protected ColorModel origmodel

The `origmodel` variable stores the original color model when filtering an `IndexColorModel`. Normally, you do not need to access this variable, even in subclasses.

Constructors

public RGBImageFilter ()—called by subclass

The only constructor for `RGBImageFilter` is the implied constructor with no parameters. In most subclasses of `RGBImageFilter`, the constructor has to initialize only the `canFilterIndexColorModel` variable.

ImageConsumer interface methods

public void setColorModel (ColorModel model)

The `setColorModel()` method changes the `ColorModel` of the filter to `model`. If `canFilterIndexColorModel` is `true` and `model` is of type `IndexColorModel`, a filtered version of `model` is used instead.

public void setPixels (int x, int y, int w, int h, ColorModel model, byte pixels[], int off, int scansize)
public void setPixels (int x, int y, int w, int h, ColorModel model, int pixels[], int off, int scansize)

If necessary, the `setPixels()` method converts the `pixels` buffer to the default RGB `ColorModel` and then filters them with `filterRGBPixels()`. If `model` has already been converted, this method just passes the pixels along to the consumer's `setPixels()`.

Other methods

The only method you care about here is `filterRGB()`. All subclasses of RGBImageFilter *must* override this method. It is very difficult to imagine situations in which you would override (or even call) the other methods in this group. They are helper methods that funnel pixels through `filterRGB()`.

public void substituteColorModel (ColorModel oldModel, ColorModel newModel)

`substituteColorModel()` is a helper method for `setColorModel()`. It initializes the protected variables of `RGBImageFilter`. The `origmodel` variable is set to `oldModel` and the `newmodel` variable is set to `newModel`.

public IndexColorModel filterIndexColorModel (IndexColorModel icm)

`filterIndexColorModel()` is another helper method for `setColorModel()`. It runs the entire color table of `icm` through `filterRGB()` and returns the filtered `ColorModel` for use by `setColorModel()`.

public void filterRGBPixels (int x, int y, int width, int height, int pixels[], int off, int scansize)

`filterRGBPixels()` is a helper method for `setPixels()`. It filters each element of the `pixels` buffer through `filterRGB()`, converting pixels to the default RGB `ColorModel` first. This method changes the values in the `pixels` array.

public abstract int filterRGB (int x, int y, int rgb)

`filterRGB()` is the one method that `RGBImageFilter` subclasses must implement. The method takes the `rgb` pixel value at position (`x`, `y`) and returns the converted pixel value in the default RGB `ColorModel`. Coordinates of (-1, -1) signify that a color table entry is being filtered instead of a pixel.

A transparent image filter that extends RGBImageFilter

Creating your own `RGBImageFilter` is fairly easy. One of the more common applications for an `RGBImageFilter` is to make images transparent by setting the alpha component of each pixel. To do so, we extend the abstract `RGBImageFilter` class. The filter in Example 12-9 makes the entire image translucent, based on a percentage passed to the class constructor. Filtering is independent of position, so the constructor can set the `canFilterIndexColorModel` variable. A constructor with no arguments uses a default alpha value of 0.75.

Example 12–9: TransparentImageFilter Source

```
import java.awt.image.*;
class TransparentImageFilter extends RGBImageFilter {
    float alphaPercent;
    public TransparentImageFilter () {
        this (0.75f);
    }
    public TransparentImageFilter (float aPercent)
            throws IllegalArgumentException {
        if ((aPercent < 0.0) || (aPercent > 1.0))
            throw new IllegalArgumentException();
        alphaPercent = aPercent;
        canFilterIndexColorModel = true;
    }
```

Example 12–9: TransparentImageFilter Source (continued)

```
        public int filterRGB (int x, int y, int rgb) {
            int a = (rgb >> 24) & 0xff;
            a *= alphaPercent;
            return ((rgb & 0x00ffffff) | (a << 24));
        }
    }
```

12.5.3 CropImageFilter

The `CropImageFilter` is an `ImageFilter` that crops an image to a rectangular region. When used with `FilteredImageSource`, it produces a new image that consists of a portion of the original image. The cropped region must be completely within the original image. It is never necessary to subclass this class. Also, using the 10 or 11 argument version of `Graphics.drawImage()` introduced in Java 1.1 precludes the need to use this filter, unless you need to save the resulting cropped image.

If you crop an image and then send the result through a second `ImageFilter`, the pixel array received by the filter will be the size of the original `Image`, with the `offset` and `scansize` set accordingly. The `width` and `height` are set to the cropped values; the result is a smaller `Image` with the same amount of data. `CropImageFilter` keeps the full pixel array around, partially empty.

Constructors

public CropImageFilter (int x, int y, int width, int height) ★

The constructor for `CropImageFilter` specifies the rectangular area of the old image that makes up the new image. The (`x`, `y`) coordinates specify the top left corner for the cropped image; `width` and `height` must be positive or the resulting image will be empty. If the (`x`, `y`) coordinates are outside the original image area, the resulting image is empty. If (`x`, `y`) starts within the image but the rectangular area of size `width` `height` goes beyond the original image, the part that extends outside will be black. (Remember the color black has pixel values of 0 for red, green, and blue.)

ImageConsumer interface methods

public void setProperties (Hashtable properties) ★

The `setProperties()` method adds the `croprect` image property to the properties list. The bounding `Rectangle`, specified by the (`x`, `y`) coordinates and `width` `height` size, is associated with this property. After updating `properties`, this method sets the properties list of the consumer.

public void setDimensions (int width, int height) ★

The `setDimensions()` method of `CropImageFilter` ignores the `width` and `height` parameters to the function call. Instead, it relies on the size parameters in the constructor.

public void setPixels (int x, int y, int w, int h, ColorModel model, byte pixels[], int offset, int scansize) ★

public void setPixels (int x, int y, int w, int h, ColorModel model, int pixels[], int offset, int scansize) ★

These `setPixels()` methods check to see what portion of the `pixels` array falls within the cropped area and pass those pixels along.

Cropping an image with CropImageFilter

Example 12-10 uses a `CropImageFilter` to extract the center third of a larger image. No subclassing is needed; the `CropImageFilter` is complete in itself. The output is displayed in Figure 12-7.

Example 12–10: Crop Applet Source

```
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
public class Crop extends Applet {
    Image i, j;
    public void init () {
        MediaTracker mt = new MediaTracker (this);
        i = getImage (getDocumentBase(), "rosey.jpg");
        mt.addImage (i, 0);
        try {
            mt.waitForAll();
            int width       = i.getWidth(this);
            int height      = i. getHeight(this);
            j = createImage (new FilteredImageSource (i.getSource(),
                                new CropImageFilter (width/3, height/3,
                                                     width/3, height/3)));
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
    }
    public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this);                  // regular
        if (j != null) {
            g.drawImage (j, 10, 90, this);             // cropped
        }
    }
}
```

Figure 12–7: Image cropping example output.

TIP You can use `CropImageFilter` to help improve your animation performance or just the general download time of images. Without `CropImageFilter`, you can use `Graphics.clipRect()` to clip each image of an image strip when drawing. Instead of clipping each `Image` (each time), you can use `CropImageFilter` to create a new `Image` for each cell of the strip. Or for times when an image strip is inappropriate, you can put all your images within one image file (in any order whatsoever), and use `CropImageFilter` to get each out as an `Image` .

12.5.4 ReplicateScaleFilter

Back in Chapter 2 we introduced you to the `getScaledInstance()` method. This method uses a new image filter that is provided with Java 1.1. The `ReplicateScaleFilter` and its subclass, `AreaAveragingScaleFilter`, allow you to scale images before calling `drawImage()`. This can greatly speed your programs because you don't have to wait for the call to `drawImage()` before performing scaling.

The `ReplicateScaleFilter` is an `ImageFilter` that scales by duplicating or removing rows and columns. When used with `FilteredImageSource`, it produces a new image that is a scaled version of the original. As you can guess, `ReplicateScaleFilter` is very fast, but the results aren't particularly pleasing aesthetically. It is great if you want to magnify a checkerboard but not that useful if you want to scale an image of your Aunt Polly. Its subclass, `AreaAveragingScaleFilter`, implements a more time-consuming algorithm that is more suitable when image quality is a concern.

Constructor

public ReplicateScaleFilter (int width, int height)

The constructor for ReplicateScaleFilter specifies the size of the resulting image. If either parameter is -1, the resulting image maintains the same aspect ratio as the original image.

ImageConsumer interface methods

public void setProperties (Hashtable properties)

The setProperties() method adds the rescale image property to the properties list. The value of the rescale property is a quoted string showing the image's new width and height, in the form "<width>x<height>", where the width and height are taken from the constructor. After updating properties, this method sets the properties list of the consumer.

public void setDimensions (int width, int height)

The setDimensions() method of ReplicateScaleFilter passes the new width and height from the constructor along to the consumer. If either of the constructor's parameters are negative, the size is recalculated proportionally. If both are negative, the size becomes width height.

public void setPixels (int x, int y, int w, int h, ColorModel model, int pixels[], int offset, int scansize)
public void setPixels (int x, int y, int w, int h, ColorModel model, byte pixels[], int offset, int scansize)

The setPixels() method of ReplicateScaleFilter checks to see which rows and columns of pixels to pass along.

12.5.5 AreaAveragingScaleFilter

The AreaAveragingScaleFilter subclasses ReplicateScaleFilter to provide a better scaling algorithm. Instead of just dropping or adding rows and columns, AreaAveragingScaleFilter tries to blend pixel values when creating new rows and columns. The filter works by replicating rows and columns to generate an image that is a multiple of the original size. Then the image is resized back down by an algorithm that blends the pixels around each destination pixel.

AreaAveragingScaleFilter methods

Because this filter subclasses ReplicateScaleFilter, the only methods it includes are those that override methods of ReplicateScaleFilter.

Constructors

public AreaAveragingScaleFilter (int width, int height) ★

The constructor for `AreaAveragingScaleFilter` specifies the size of the resulting image. If either parameter is -1, the resulting image maintains the same aspect ratio as the original image.

ImageConsumer interface methods

public void setHints (int hints) ★

The `setHints()` method of `AreaAveragingScaleFilter` checks to see if some optimizations can be performed based upon the value of the `hints` parameter. If they can't, the image filter has to cache the pixel data until it receives the entire image.

public void setPixels (int x, int y, int w, int h, ColorModel model, byte pixels[], int offset, int scansize) ★
public void setPixels (int x, int y, int w, int h, ColorModel model, int pixels[], int offset, int scansize) ★

The `setPixels()` method of `AreaAveragingScaleFilter` accumulates the pixels or passes them along based upon the available hints. If `setPixels()` accumulates the pixels, this filter passes them along to the consumer when appropriate.

12.5.6 Cascading Filters

It is often a good idea to perform complex filtering operations by using several filters in a chain. This technique requires the system to perform several passes through the image array, so it may be slower than using a single complex filter; however, cascading filters yield code that is easier to understand and quicker to write—particularly if you already have a collection of image filters from other projects.

For example, assume you want to make a color image transparent and then render the image in black and white. The easy way to do this task is to apply a filter that converts color to a gray value and then apply the `TransparentImageFilter` we developed in Example 12-9. Using this strategy, we have to develop only one very simple filter. Example 12-11 shows the source for the `GrayImageFilter`; Example 12-12 shows the applet that applies the two filters in a daisy chain.

Example 12–11: GrayImageFilter Source

```
import java.awt.image.*;
public class GrayImageFilter extends RGBImageFilter {
    public GrayImageFilter () {
        canFilterIndexColorModel = true;
    }
```

Example 12–11: GrayImageFilter Source (continued)

```
    public int filterRGB (int x, int y, int rgb) {
        int gray  = (((rgb & 0xff0000) >> 16) +
                    ((rgb & 0x00ff00) >> 8) +
                    (rgb & 0x0000ff)) / 3;
        return (0xff000000 | (gray << 16) | (gray <<  8) |  gray);
    }
}
```

Example 12–12: DrawingImages Source

```
import java.applet.*;
import java.awt.*;
import java.awt.image.*;
public class DrawingImages extends Applet {
    Image i, j, k, l;
    public void init () {
        i = getImage (getDocumentBase(), "rosey.jpg");
        GrayImageFilter gif = new GrayImageFilter ();
        j = createImage (new FilteredImageSource (i.getSource(), gif));
        TransparentImageFilter tf = new TransparentImageFilter (.5f);
        k = createImage (new FilteredImageSource (j.getSource(), tf));
        l = createImage (new FilteredImageSource (i.getSource(), tf));
    }
    public void paint (Graphics g) {
        g.drawImage (i, 10, 10, this);                   // regular
        g.drawImage (j, 270, 10, this);                  // gray
        g.drawImage (k, 10, 110, Color.red, this);       // gray - transparent
        g.drawImage (l, 270, 110, Color.red, this);      // transparent
    }
}
```

Granted, neither the `GrayImageFilter` or the `TransparentImageFilter` are very complex, but consider the savings you would get if you wanted to blur an image, crop it, and then render the result in grayscale. Writing a filter that does all three is not a task for the faint of heart; remember, you can't subclass `RGBImageFilter` or `CropImageFilter` because the result does not depend purely on each pixel's color and position. However, you can solve the problem easily by cascading the filters developed in this chapter.

13

In this chapter:
- *AWTException*
- *IllegalComponentStateException*
- *AWTError*

AWT Exceptions and Errors

This chapter describes `AWTException`, `IllegalComponentStateException`, and `AWTError`. `AWTException` is a subclass of `Exception`. It is not used by any of the public classes in `java.awt`; you may, however, find it convenient to throw `AWTException` within your own code. `IllegalComponentStateException` is another `Exception` subclass, which is new to Java 1.1. This exception is used when you try to do something with a `Component` that is not yet appropriate. `AWTError` is a subclass of `Error` that is thrown when a serious problem occurs in AWT—for example, the environment is unable to get the platform's `Toolkit`.

13.1 AWTException

`AWTException` is a generic exception that can be thrown when an exceptional condition has occurred within AWT. None of the AWT classes throw this. If you subclass any of the AWT classes, you can throw an `AWTException` to indicate a problem. Using `AWTException` is slightly preferable to creating your own `Exception` subclass because you do not have to generate another class file. Since it is a part of Java, `AWTException` is guaranteed to exist on the run-time platform.

If you throw an instance of `AWTException`, like any other `Exception`, it must be caught in a `catch` clause or declared in the `throws` clause of the method.

13.1.1 AWTException Method

Constructor

public AWTException (String message)

The sole constructor creates an `AWTException` with a detailed message of `message`. This message can be retrieved using `getMessage()`, which it inherits from `Exception` (and which is required by the `Throwable` interface). If you do not want a detailed message, message may be null.

13.1.2 Throwing an AWTException

An AWTException is used the same way as any other Throwable object. Here's an example:

```
if (someProblem) {
    throw new AWTException ("Problem Encountered While Initializing");
}
```

13.2 IllegalComponentStateException

IllegalComponentStateException is a subclass of IllegalStateException; both are new to Java 1.1. This exception is used when you try to do something with a Component that is not yet appropriate. With the standard AWT components, this can happen only in three instances:

- If you call setCaretPosition() to set the cursor position of a text component before the component's peer exists.
- If you call getLocale() to get the locale of a component that does not have one and is not in a container that has one.
- If you call getLocationOnScreen() for a component that is not showing.

In these cases, the operation isn't fundamentally illegal; you are just trying to perform it before the component is ready. When you create your own components, you should consider using this exception for similar cases.

Since IllegalComponentStateException is a subclass of Run-TimeException, you do not have to enclose method calls that might throw this exception within try/catch blocks. However, catching this exception isn't a bad idea, since it should be fairly easy to correct the problem and retry the operation.

13.2.1 IllegalComponentStateException Method

Constructor

public IllegalComponentStateException () ★

The first constructor creates an IllegalComponentStateException instance with no detail message.

public IllegalComponentStateException (String message) ★

This constructor creates an `IllegalComponentStateException` with a detail message of `message`. This message can be retrieved using `getMessage()`, which it inherits from `Exception` (and is required by the `Throwable` interface).

13.2.2 IllegalComponentStateException Example

The following code throws an `IllegalComponentStateException`. The `Exception` occurs because the `TextField` peer does not exist when `setCaretPosition()` is called. `setCaretPosition()` throws an `IllegalComponentStateException`, and the next statement never executes.

```
import java.awt.TextField;
public class illegal {
    public static void main (String[] args) {
        new TextField().setCaretPosition (24);
        System.out.println ("Never gets here");
    }
}
```

13.3 AWTError

`AWTError` is a subclass of `Error` that is used when a serious run-time error has occurred within AWT. For example, an `AWTError` is thrown if the default `Toolkit` cannot be initialized or if you try to create a `FileDialog` within Netscape Navigator (since that program does not permit local file system access). When an `AWTError` is thrown and not caught, the virtual machine stops your program. You may throw this `Error` to indicate a serious run-time problem in any subclass of the AWT classes. Using `AWTError` is slightly preferable to creating your own `Error` because you don't have to provide another class file. Since it is part of Java, `AWTError` is guaranteed to exist on the run-time platform.

Methods are not required to declare that they throw `AWTError`. If you throw an error that is not caught, it will eventually propagate to the top level of the system.

13.3.1 AWTError Method

Constructor

public AWTError (String message)

The sole constructor creates an `AWTError` with a detail message of `message`. This message can be retrieved using `getMessage()`, which it inherits from `Error` (and is required by the `Throwable` interface). If you do not want a detailed message, `message` may be `null`.

13.3.2 Throwing an AWTError

The code in Example 13-1 throws an `AWTError` if it is executed with this command:

```
java -Dawt.toolkit=foo throwme
```

The error occurs because the Java interpreter tries to use the `toolkit foo`, which does not exist (assuming that class `foo` does not exist in your `CLASSPATH`). Therefore, `getDefaultToolkit()` throws an `AWTError`, and the next statement never executes.

Example 13–1: The throwme class

```
import java.awt.Toolkit;
public class throwme {
    public static void main (String[] args) {
        System.out.println (Toolkit.getDefaultToolkit());
        System.out.println ("Never Gets Here");
    }
}
```

14

In this chapter:
- *What's a Java Applet?*
- *AudioClip Interface*
- *AppletContext Interface*
- *AppletStub Interface*
- *Audio in Applications*

And Then There Were Applets

Although it is not part of the `java.awt` package, the `java.applet` package is closely related. The `java.applet` package provides support for running an applet in the context of a World Wide Web browser. It consists of one class (`Applet`) and three interfaces (`AppletContext`, `AudioClip`, and `AppletStub`). The `Applet` class supports the "applet life cycle" methods (`init()`, `start()`, `stop()`, `destroy()`) that you override to write an applet. `AudioClip` provides support for audio within applets. (Applications use the `sun.audio` package for audio support; `sun.audio` is also covered in this chapter.) The `AppletStub` and `AppletContext` interfaces provide a way for the applet to interact with its run-time environment. Many of the methods of `AppletStub` and `AppletContext` are duplicated in the `Applet` class.

14.1 What's a Java Applet?

Much of the initial excitement about Java centered around applets. Applets are small Java programs that can be embedded within HTML pages and downloaded and executed by a web browser. Because executing code from random Internet sites presents a security risk, Java goes to great lengths to ensure the integrity of the program executing and to prevent it from performing any unauthorized tasks.

An applet is a specific type of Java `Container`. The class hierarchy of an applet is shown in Figure 14-1.

When you are writing an applet, remember that you can use the features of its ancestors. In particular, remember to check the methods of the `Component`, `Container`, and `Panel` classes, which are inherited by the `Applet` class.

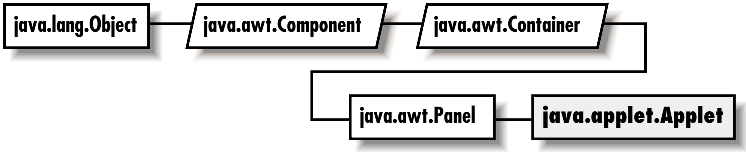


Figure 14–1: Applet class hierarchy

14.1.1 Applet Methods

All the methods of `Applet`, except `setStub()`, either need to be overridden or are methods based on one of the `java.applet` interfaces. The system calls `setStub()` to set up the context of the interfaces. The browser implements the `AppletContext` and `AppletStub` interfaces.

Constructor

public Applet ()

The system calls the `Applet` constructor when the applet is loaded and before it calls `setStub()`, which sets up the applet's stub and context. When you subclass `Applet`, you usually do not provide a constructor. If you do provide a constructor, you do not have access to the `AppletStub` or `AppletContext` and, therefore, may not call any of their methods.

AppletStub setup

public final void setStub (AppletStub stub)

The `setStub()` method of `Applet` is called by the browser when the applet is loaded into the system. It sets the `AppletStub` of the applet to `stub`. In turn, the `AppletStub` contains the applet's `AppletContext`.

Applet information methods

Several methods of `Applet` provide information that can be used while the applet is running.

public AppletContext getAppletContext ()

The `getAppletContext()` method returns the current `AppletContext`. This is part of the applet's stub, which is set by the system when `setStub()` is called.

public URL getCodeBase ()

The `getCodeBase()` method returns the complete URL of the *.class* file that contains the applet. This method can be used with the `getImage()` or the `getAudioClip()` methods, described later in this chapter, to load an image or audio file relative to the *.class* file location.

public URL getDocumentBase ()

The `getDocumentBase()` method returns the complete URL of the *.html* file that loaded the applet. This can be used with the `getImage()` or `getAudioClip()` methods, described later in this chapter, to load an image or audio file relative to the *.html* file.

public String getParameter (String name)

The `getParameter()` method allows you to get run-time parameters from within the <APPLET> tag of the *.html* file that loaded the applet. Parameters are defined by HTML <PARAM> tags, which have the form:

```
<PARAM name="parameter" value="value>
```

If the `name` parameter of `getParameter()` matches the `name` string of a <PARAM> tag, `getParameter()` returns the tag's `value` as a string. If `name` is not found within the <PARAM> tags of the <APPLET>, `getParameter()` returns `null`. The argument `name` is not case sensitive; that is, it matches parameter names regardless of case. Remember that `getParameter()` always returns a string, even though the parameter values might appear as integers or floating point numbers in the HTML file. In some situations, it makes sense to pass multiple values in a single parameter; if you do this, you have to parse the parameter string manually. Using a `StringTokenizer` will make the job easier.

Enabling your applets to accept parameters allows them to be customized at run-time by the HTML author, without providing the source code. This provides greater flexibility on the Web without requiring any recoding. Example 14-1 shows how an applet reads parameters from an HTML file. It contains three parts: the HTML file that loads the applet, the applet source code, and the output from the applet.

Example 14–1: Getting Parameters from an HTML File

```
<APPLET CODE=ParamApplet WIDTH=100 HEIGHT=100>
<PARAM NAME=one VALUE=1.0>
<PARAM name=TWO value=TOO>
</APPLET>

public class ParamApplet extends java.applet.Applet {
    public void init () {
        String param;
        float one;
        String two;
```

Example 14–1: Getting Parameters from an HTML File (continued)

```
        if ((param = getParameter ("ONE")) == null) {
            one = -1.0f;  // Not present
        } else {
            one = Float.valueOf (param).longValue();
        }
        if ((param = getParameter ("two")) == null) {
            two = "two";
        } else {
            two = param.toUpperCase();
        }
        System.out.println ("One: " + one);
        System.out.println ("Two: " + two);
    }
}

One: 1
Two: TOO
```

public String getAppletInfo ()

The `getAppletInfo()` method lets an applet provide a short descriptive string to the browser. This method is frequently overridden to return a string showing the applet's author and copyright information. How (or whether) to display this information is up to the browser. With *appletviewer*, this information is displayed when the user selects the Info choice under the Applet menu. Neither Netscape Navigator nor Internet Explorer currently display this information.

public String[][] getParameterInfo ()

The `getParameterInfo()` method lets an applet provide a two-dimensional array of strings describing the parameters it reads from `<PARAM>` tags. It returns an array of three strings for each parameter. In each array, the first `String` represents the parameter name, the second describes the data type, and the third is a brief description or range of values. Like `getAppletInfo()`, how (or whether) to display this information is up to the browser. With appletviewer, this information is displayed when the user selects the Info choice under the Applet menu. Neither Netscape Navigator nor Internet Explorer currently display this information. The following code shows how an applet might use `getParameterInfo()` and `getAppletInfo()`:

```
public String getAppletInfo() {
    String whoami = "By John Zukowski (c) 1997";
    return whoami;
}
public String[][] getParameterInfo() {
    String[][] strings = {
        {"parameter1",     "String",      "Background Color name"},
        {"parameter2",     "URL",         "Image File"},
        {"parameter3",     "1-10",        "Number in Series"}
```

```
        };
        return strings;
    }
```

public void showStatus (String message)

The `showStatus()` method displays `message` on the browser's status line, if it has one. Again, how to display this string is up to the browser, and the browser can overwrite it whenever it wants. You should only use `showStatus()` for messages that the user can afford to miss.

public boolean isActive ()

The `isActive()` method returns the current state of the applet. While an applet is initializing, it is not active, and calls to `isActive()` return `false`. The system marks the applet active just prior to calling `start()`; after this point, calls to `isActive()` return `true`.

public Locale getLocale () ★

The `getLocale()` method retrieves the current `Locale` of the applet, if it has one. Using a `Locale` allows you to write programs that can adapt themselves to different languages and different regional variants. If no `Locale` has been set, `getLocale()` returns the default `Locale`. The default `Locale` has a user language of English and no region. To change the default `Locale`, set the system properties `user.language` and `user.region`, or call `Locale.setDefault()` (`setDefault()` verifies access rights with the security manager).*

Applet life cycle

The browser calls four methods of the `Applet` class to execute the applet. These methods constitute the applet's life cycle. The default versions don't do anything; you must override at least one of them to create a useful applet.

public void init ()

The `init()` method is called once when the applet is first loaded. It should be used for tasks that need to be done only once. `init()` is often used to load images or sound files, set up the screen, get parameters out of the HTML file, and create objects the applet will need later. You should not do anything that might "hang" or wait indefinitely. In a sense, `init()` does things that might otherwise be done in an applet's constructor.

public void start ()

The `start()` method is called every time the browser displays the web page containing the applet. `start()` usually does the "work" of the applet. It often starts threads, plays sound files, or does computation. `start()` may also be called when the browser is de-iconified.

---

* For more on the `Locale` class, see *Java Fundamental Classes Reference*, by Mark Grand, from O'Reilly & Associates.

public void stop ()

The `stop()` method is called whenever the browser leaves the web page containing the applet. It should stop or suspend anything that the applet is doing. For example, it should suspend any threads that have been created and stop playing any sound files. `stop()` may also be called when the browser is iconified.

public void destroy ()

The `destroy()` method is called when the browser determines that it no longer needs to keep the applet around—in practice, when the browser decides to remove the applet from its cache or the browser exits. After this point, if the browser needs to display the applet again, it will reload the applet and call the applet's `init()` method. `destroy()` gives the applet a final opportunity to release any resources it is using (for example, close any open sockets). Most applets don't need to implement `destroy()`. It is always a good idea to release resources as soon as they aren't needed, rather than waiting for `destroy()`. There are no guarantees about when `destroy()` will be called; if your browser has a sufficiently large cache, the applet may stay around for a very long time.

Applet-sizing methods

public void resize(int width, int height)

The `resize()` method changes the size of the applet space to `width height`. The browser must support changing the applet space or else the sizing does not change. Netscape Navigator does not allow an applet to change its size; the applet is sized to the region allocated by the `<APPLET>` tag, period.

Because `Applet` is a subclass of `Component`, it inherits the Java 1.1 method `setSize()`, which has the same function.

public void resize (Dimension dim)

This `resize()` method calls the previous version of `resize()` with a width of `dim.width` and a height of `dim.height`.

Images

We have discussed `Image` objects extensively in Chapter 2, *Simple Graphics*, and Chapter 12, *Image Processing*, and used them in many of our examples. When writing an applet, you can use the `getImage()` method directly. In applications, you must go through `Toolkit` (which the following methods call) to get images.

public Image getImage (URL url)

The `getImage()` method loads the image file located at `url`. `url` must be a complete and valid URL. The method returns a system-specific object that subclasses `Image` and returns immediately. The `Image` is not loaded until needed, either by `prepareImage()`, `MediaTracker`, or `drawImage()`.

public Image getImage (URL url, String filename)

The `getImage()` method loads the image file located at `url` in `filename`. The applet locates the file relative to the specified URL; that is, if the URL ends with a filename, the applet removes the filename and appends the `filename` argument to produce a new URL. `getImage()` returns a system-specific object that subclasses `Image` and returns immediately. The `Image` is not loaded until needed, either by `prepareImage()`, `MediaTracker`, or `drawImage()`.

In most cases, the `url` argument is a call to `getDocumentBase()` or `getCodeBase()`; most often, image files are located in the same directory as the HTML file, the applet's Java class file, or their own subdirectory.

Audio

Every Java platform is guaranteed to understand Sun's AU file format, which contains a single channel of 8000 Hz µLaw encoded audio data.* Java applets do not require any helper applications to play audio; they use the browser's audio capabilities. You can use an independent application, like Sun's *audiotool*, to control the volume. Of course, the user's workstation or PC needs audio hardware, but these days, it's hard to buy a computer that isn't equipped for audio.

The Java Media Framework API is rumored to provide support for additional audio formats, like Microsoft's *.wav* files or Macintosh/SGI *.aiff* audio files. At present, if you want your Java program to play audio files in other formats, you must first convert the audio file to the *.au* format, using a utility like SOX (Sound Exchange).† Once converted, your Java program can play the resulting *.au* file normally. (If you are interested in more information about audio, look in the *alt.binaries.sounds.d* newsgroup.)

The `Applet` class provides two ways to play audio clips. The first mechanism provides a method to load and play an audio file once:

public void play (URL url)

The `play()` method downloads and plays the audio file located at `url`. `url` must be a complete and valid URL. If `url` is invalid, no sound is played. Some environments throw an exception if the URL is invalid, but not all. Calling `play()` within an applet's `destroy()` method usually has no effect; the applet

* The AU format is explained in the Audio File Format FAQ (version 3.10) located at *ftp://ftp.cwi.nl/pub/audio/index.html* in files *AudioFormats.part1* and *AudioFormats.part2*.

† SOX is available at http://www.spies.com/Sox. The current version of SOX is 10; version 11 is in gamma release. The UNIX source is located in *sox10.tar.gz*, while the DOS executable is *sox10dos.zip*.

and its resources will probably be deallocated before `play()` has time to download the audio file.

public void play (URL url, String filename)

This version of `play()` downloads and plays the audio file located at `url` in the file `filename`. The applet locates the file relative to the specified URL; that is, if the URL ends with a filename, the applet removes the filename and appends the `filename` argument to produce a new URL. If the resulting URL is invalid, no sound is played. Some environments throw an exception if the URL is invalid, but not all.

In most cases, the `url` argument is a call to `getDocumentBase()` or `getCodeBase()`; most often, sound files are located in the same directory as the HTML file or the applet's Java class file. For some reason, you cannot have a double dot (`..`) in the URL of an audio file; you can in the URL of an image file. Putting a double dot in the URL of an audio file raises a security exception in an applet causing `play()` to fail.

The following applet plays an audio file located relative to the HTML file from which the applet was loaded:

```
import java.net.*;
import java.applet.*;
public class audioTest extends Applet {
    public void init () {
        System.out.println ("Before");
        play (getDocumentBase(), "audio/flintstones.au");
        System.out.println ("After");
    }
}
```

The second way to play audio files splits the process into two steps: you get an `AudioClip` object and then play it as necessary. This procedure eliminates a significant drawback to `play()`: if you call `play()` repeatedly, it reloads the audio file each time, making the applet much slower.

public AudioClip getAudioClip (URL url)

The `getAudioClip()` method loads the audio file located at `url`. `url` must be a complete and valid URL. Upon success, `getAudioClip()` returns an instance of a class that implements the `AudioClip` interface. You can then call methods in the `AudioClip` interface (see Section 14.2) to play the clip. If an error occurs during loading (e.g., because the file was not found or the URL was invalid), `getAudioClip()` returns `null`.

`getAudioClip()` sounds similar to `getImage()`, and it is. However, Java currently loads audio clips synchronously; it does not start a separate thread as it does for images. You may want to create a helper class that loads audio clips in a separate thread.

The actual class of the AudioClip object depends on the platform you are using; you shouldn't need to know it. If you are curious, the *appletviewer* uses the class sun.applet.AppletAudioClip; Netscape Navigator uses the class netscape.applet.AppletAudioClip.

public AudioClip getAudioClip (URL url , String filename)

This version of the getAudioClip() method loads the audio file located at url in the file filename. The applet locates the file relative to the specified URL; that is, if the URL ends with a filename, the applet removes the filename and appends the filename argument to produce a new URL. If the resulting URL is invalid, the file is not loaded. Upon success, getAudioClip() returns an instance of a class that implements the AudioClip interface. You can then call methods in the AudioClip interface (see Section 14.2) to play the clip. If an error occurs during loading (e.g., because the file was not found or the URL was invalid), getAudioClip() returns null.

In most cases, the url argument is a call to getDocumentBase() or getCodeBase(); most often, sound files are located in the same directory as the HTML file or the applet's Java class file.

14.2 AudioClip Interface

Once an audio file is loaded into memory with getAudioClip(), you use the AudioClip interface to work with it.

Methods

Three methods define the AudioClip interface. The class that implements these methods depends on the run-time environment; the class is probably sun.applet.AppletAudioClip or netscape.applet.AppletAudioClip.

If you play an audio clip anywhere within your Applet, you should call the AudioClip stop() method within the stop() method of the applet. This ensures that the audio file will stop playing when the user leaves your web page. Stopping audio clips is a must if you call loop() to play the sound continuously; if you don't stop an audio clip, the user will have to exit the browser to get the sound to stop playing.

Applets can play audio clips simultaneously. Based upon the user's actions, you may want to play a sound file in the background continuously, while playing other files.

void play ()

The play() method plays the audio clip once from the beginning.

void loop ()

The `loop()` method plays the audio clip continuously. When it gets to the end-of-file marker, it resets itself to the beginning.

void stop ()

The `stop()` method stops the applet from playing the audio clip.

14.2.1 Using an AudioClip

The applet in Example 14-2 loads three audio files in the `init()` method. The `start()` method plays Dino barking in the background as a continuous loop. Whenever the browser calls `paint()`, Fred yells "Wilma," and when you click the mouse anywhere, the call to `mouseDown()` plays Fred yelling, "Yabba-Dabba-Doo." If you try real hard, all three can play at once. Before playing any audio clip, the applet makes sure that the clip is not null—that is, that the clip loaded correctly. `stop()` stops all clips from playing; you should make sure that applets stop all audio clips before the viewer leaves the web page.

Example 14–2: AudioClip Usage

```
import java.net.*;
import java.awt.*;
import java.applet.*;
public class AudioTestExample extends Applet{
    AudioClip audio1, audio2, audio3;
    public void init () {
        audio1 = getAudioClip (getCodeBase(), "audio/flintstones.au");
        audio2 = getAudioClip (getCodeBase(), "audio/dino.au");
        audio3 = getAudioClip (getCodeBase(), "audio/wilma.au");
    }
    public boolean mouseDown (Event e, int x, int y) {
        if (audio1 != null)
            audio1.play();
        return true;
    }
    public void start () {
        if (audio2 != null)
            audio2.loop();
    }
    public void paint (Graphics g) {
        if (audio3 != null)
            audio3.play();
    }
    public void stop () {
        if (audio1 != null)
            audio1.stop();
        if (audio2 != null)
            audio2.stop();
```

Example 14–2: AudioClip Usage (continued)

```
            if (audio3 != null)
                audio3.stop();
        }
    }
```

14.3 AppletContext Interface

The `AppletContext` interface provides the means to control the browser environment where the applet is running.

Methods

Some of these methods are so frequently used that they are also provided within the `Applet` class.

public abstract AudioClip getAudioClip (URL url)

The `getAudioClip()` method loads the audio file located at `url`. `url` must be a complete and valid URL. Upon success, `getAudioClip()` returns an instance of a class that implements the `AudioClip` interface. You can then call methods in the `AudioClip` interface (see Section 14.2) to play the clip. If an error occurs during loading (e.g., because the file was not found or the URL was invalid), `getAudioClip()` returns `null`.

public abstract Image getImage (URL url)

The `getImage()` method loads the image file located at `url`. `url` must be a complete and valid URL. The method returns a system-specific object that subclasses `Image` and returns immediately. The `Image` is not loaded until needed. A call to `prepareImage()`, `MediaTracker`, or `drawImage()` forces loading to start.

public abstract Applet getApplet (String name)

The `getApplet()` method fetches the `Applet` from the current HTML page named `name`, which can be the applet's class name or the name provided in the `NAME` parameter of the <APPLET> tag. `getApplet()` returns `null` if the applet does not exist in the current context. This method allows you to call methods of other applets within the same context, loaded by the same `ClassLoader`. For example:

```
MyApplet who = (MyApplet)getAppletContext().getApplet("hey");
who.method();
```

TIP Netscape Navigator 3.0 restricts which applets can communicate with each other. Internet Explorer seems to have a similar restriction. For applets to communicate, they must:

- Have the same `CODEBASE`.
- Have the same or no `ARCHIVES` tag.
- Have `MAYSCRIPT` tags and appear in the same frame; alternatively, neither applet may have a `MAYSCRIPT` tag.

If these conditions are not met and you try to cast the return value of `getApplet()` or `getApplets()` to the appropriate class, either the cast will throw a `ClassCastException`; or nothing will happen, and the method will not continue beyond the point of the failure.

public abstract Enumeration getApplets ()

The `getApplets()` method gathers all the `Applets` in the current context, loaded by the same `ClassLoader`, into a collection and returns the `Enumeration`. You can then cycle through them to perform some operation collectively. For example:

```
Enumeration e = getAppletContext().getApplets();
while (e.hasMoreElements()) {
    Object o = e.nextElement();
    if (o instance of MyApplet) {
        MyApplet a = (Object)o;
        a.MyAppletMethod();
    }
}
```

TIP If you want communication between applets on one page, be aware that there is no guarantee which applet will start first. Communications must be synchronized by using a controlling class or continual polling.

public abstract void showDocument (URL url)

The `showDocument()` method shows `url` in the current browser window. The browser may ignore the request if it so desires.

public abstract void showDocument (URL url, String frame)

The `showDocument()` method shows `url` in a browser window specified by `frame`. Different `frame` values and the results are shown in Table 14-1. The browser may ignore the request, as *appletviewer* does.

```
try {
    URL u = new URL (getDocumentBase(), (String) file);
    getAppletContext().showDocument (u, "_blank");
} catch (Exception e) {
}
```

Table 14–1: Target Values

Target String	Results
`_blank`	Show `url` new browser window with no name.
`_parent`	Show `url` in the parent frame of the current window.
`_self`	Replace current `url` with `url` (i.e., display in the current window).
`_top`	Show `url` in top-most frame.
`name`	Show `url` in new browser window named `name`.

public abstract void showStatus (String message)

The `showStatus()` method displays `message` on the browser's status line, if it has one. How to display this string is up to the browser, and the browser can overwrite it whenever it wants. You should use `showStatus()` only for messages that the user can afford to miss.

14.4 AppletStub Interface

The `AppletStub` interface provides a way to get information from the run-time browser environment. The `Applet` class provides methods with similar names that call these methods.

Methods

public abstract boolean isActive ()

The `isActive()` method returns the current state of the applet. While an applet is initializing, it is not active, and calls to `isActive()` return `false`. The system marks the applet active just prior to calling `start()`; after this point, calls to `isActive()` return `true`.

public abstract URL getDocumentBase ()

The `getDocumentBase()` method returns the complete URL of the HTML file that loaded the applet. This method can be used with the `getImage()` or `getAudioClip()` methods to load an image or audio file relative to the HTML file.

public abstract URL getCodeBase ()

The `getCodeBase()` method returns the complete URL of the *.class* file that contains the applet. This method can be used with the `getImage()` method or the `getAudioClip()` method to load an image or audio file relative to the *.class* file.

public abstract String getParameter (String name)

The `getParameter()` method allows you to get parameters from `<PARAM>` tags within the `<APPLET>` tag of the HTML file that loaded the applet. The `name` parameter of `getParameter()` must match the name string of the `<PARAM>` tag; `name` is case insensitive. The return value of `getParameter()` is the value associated with `name`; it is always a `String` regardless of the type of data in the tag. If `name` is not found within the `<PARAM>` tags of the `<APPLET>`, `getParameter()` returns `null`.

public abstract AppletContext getAppletContext ()

The `getAppletContext()` method returns the current `AppletContext` of the applet. This is part of the stub that is set by the system when `setStub()` is called.

public abstract void appletResize (int width, int height)

The `appletResize()` method is called by the resize method of the `Applet` class. The method changes the size of the applet space to `width height`. The browser must support changing the applet space; if it doesn't, the size remains unchanged.

14.5 Audio in Applications

The rest of this chapter describes how to use audio in your applications. Because the audio support discussed so far has been provided by the browser, applications that don't run in the context of a browser must use a different set of classes to work with audio. These classes are within the `sun.audio` package. Although the `sun.*` package hierarchy is not necessarily included by other vendors, the `sun.audio` classes discussed here are provided with Netscape Navigator 2.0/3.0 and Internet Explorer 3.0. Therefore, you can use these classes within applets, too. This section ends by developing a `SunAudioClip` class that has an interface similar to the applet's audio interface; you can use it to minimize coding differences between applets and applications.

14.5.1 AudioData

The `AudioData` class holds a clip of 8000 Hz μLaw audio data. This data can be used to construct an `AudioDataStream` or `ContinuousAudioDataStream`, which can then be played with the `AudioPlayer`.

Constructor

public AudioData (byte buffer[])

The `AudioData` constructor accepts a byte array `buffer` and creates an instance of `AudioData`. The buffer should contain 8000 Hz μLaw audio data.

Methods

There are no methods for `AudioData`.

14.5.2 AudioStream

`AudioStream` subclasses `FilterInputStream`, which extends `InputStream`. Using an `InputStream` lets you move back and forth (rewind and fast forward) within an audio file, in addition to playing the audio data from start to finish.

Constructors

public AudioStream (InputStream in) throws IOException

The `AudioStream` constructor has `InputStream in` as its parameter and can throw `IOException` on error. In the following code, we get an input stream by opening a *.au* file. Another common way to construct an `AudioStream` is to use the stream associated with a URL through the URL's `openStream()` method.

```
FileInputStream fis = new FileInputStream ("/usr/openwin/demo/sounds/1.au");
AudioStream audiostream = new AudioStream (fis);
```

or:

```
AudioStream audiostream = new AudioStream (savedUrl.openStream());
```

If you are constructing the audio data yourself, you would use a `ByteArrayInputStream`. Whatever the source of the data, the input stream should provide data in Sun's *.au* format.

Methods

public int read (byte buffer[], int offset, int length) throws IOException

The `read()` method for `AudioStream` reads an array of bytes into `buffer`. `offset` is the first element of `buffer` that is used. `length` is the maximum number of bytes to read. This method blocks until some input is available. `read()` returns the actual number of bytes read. If the end of stream is encountered and no bytes were read, `read()` returns -1. Ordinarily, you `read()` an `AudioStream` only if you want to modify the audio data in some way.

public int getLength()

The `getLength()` method returns the length of the audio data contained within the `AudioStream`, excluding any header information in the file.

public AudioData getData () throws IOException

The `getData()` method of `AudioStream` is the most important and most frequently used. It reads the data from the input stream and creates an `AudioData` instance. As the following code shows, you can create an `AudioStream` and get the `AudioData` with one statement.

```
AudioData audiodata = new AudioStream (aUrl.openStream()).getData();
```

14.5.3 AudioDataStream

Constructors

public AudioDataStream (AudioData data)

This constructor creates an `AudioDataStream` from an `AudioData` object `data`. The resulting `AudioDataStream` is a subclass of `ByteArrayInputStream` and can be played by the `AudioPlayer.start()` method.

Methods

There are no methods for `AudioDataStream`.

14.5.4 ContinuousAudioDataStream

Constructors

public ContinuousAudioDataStream (AudioData data)

This constructor creates a continuous stream of audio from `data`. The resulting `ContinuousAudioDataStream` is a subclass of `AudioDataStream` and, therefore, of `ByteArrayInputStream`. It can be played by `AudioPlayer.start()`; whenever the player reaches the end of the continuous audio data stream, it restarts from the beginning.

Methods

public int read ()

This `read()` method of `ContinuousAudioDataStream` overrides the `read()` method in `ByteArrayInputStream` to rewind back to the beginning of the stream when end-of-file is reached. This method is used by the system when it reads the `InputStream`; it is rarely called directly. `read()` never returns -1 since it loops back to the beginning on end-of-file.

public int read (byte buffer[], int offset, int length)

This `read()` method of `ContinuousAudioDataStream` overrides the `read()` method in `ByteArrayInputStream` to rewind back to the beginning of the stream when end-of-file is reached. This method is used by the system when it reads the `InputStream`; it is rarely called directly. `read()` returns the actual number of bytes read. `read()` never returns -1 since it loops back to the beginning on end-of-file.

14.5.5 AudioStreamSequence

Constructors

public AudioStreamSequence (Enumeration e)

The constructor for `AudioStreamSequence` accepts an `Enumeration e`(normally the elements of a `Vector` of `AudioStreams`) as its sole parameter. The constructor converts the sequence of audio streams into a single stream to be played in order. An example follows:

```
Vector v = new Vector ();
v.addElement (new AudioStream (url1.openStream ());
v.addElement (new AudioStream (url2.openStream ());
AudioStreamSequence audiostream = new AudioStreamSequence (v.elements ());
```

Methods

public int read ()

This `read()` method of `AudioStreamSequence` overrides the `read()` method in `InputStream` to start the next stream when end-of-file is reached. This method is used by the system when it reads the `InputStream` and is rarely called directly. If the end of all streams is encountered and no bytes were read, `read()` returns -1. Otherwise, `read()` returns the character read.

public int read (byte buffer[], int offset, int length)

This `read()` method of `AudioStreamSequence` overrides the `read()` method in `InputStream` to start the next stream when end-of-file is reached. This method is used by the system when it reads the `InputStream` and is rarely called directly. `read()` returns the actual number of bytes read. If the end of all streams is encountered and no bytes were read, `read()` returns -1.

14.5.6 AudioPlayer

The `AudioPlayer` class is the workhorse of the `sun.audio` package. It is used to play all the streams that were created with the other classes. There is no constructor for `AudioPlayer`; it just extends `Thread` and provides `start()` and `stop()` methods.

Variable

public final static AudioPlayer player

`player` is the default audio player. This audio player is initialized automatically when the class is loaded; you do not have to initialize it (in fact, you can't because it is final) or call the constructor yourself.

Methods

public synchronized void start (InputStream in)

The `start()` method starts a thread that plays the `InputStream in`. Stream `in` continues to play until there is no more data or it is stopped. If `in` is a `ContinuousAudioDataStream`, the playing continues until `stop()` (described next) is called.

public synchronized void stop (InputStream in)

The `stop()` method stops the player from playing `InputStream in`. Nothing happens if the stream `in` is no longer playing or was never started.

14.5.7 SunAudioClip Class Definition

The class in Example 14-3 is all you need to play audio files in applications. It implements the `java.applet.AudioClip` interface, so the methods and functionality will be familiar. The test program in `main()` demonstrates how to use the class. Although the class itself can be used in applets, provided your users have the `sun.audio` package available, it is geared towards application users.

Example 14–3: The SunAudioClip Class

```
import java.net.URL;
import java.io.FileInputStream;
import sun.audio.*;
public class SunAudioClip implements java.applet.AudioClip {
    private AudioData audiodata;
    private AudioDataStream audiostream;
    private ContinuousAudioDataStream continuousaudiostream;
    static int length;
    public SunAudioClip (URL url) throws java.io.IOException {
        audiodata = new AudioStream (url.openStream()).getData();
        audiostream = null;
        continuousaudiostream = null;
    }
    public SunAudioClip (String filename) throws java.io.IOException {
        FileInputStream fis = new FileInputStream (filename);
        AudioStream audioStream = new AudioStream (fis);
        audiodata = audioStream.getData();
        audiostream = null;
        continuousaudiostream = null;
    }
    public void play () {
```

Example 14–3: The SunAudioClip Class (continued)

```
            audiostream = new AudioDataStream (audiodata);
            AudioPlayer.player.start (audiostream);
        }
        public void loop () {
            continuousaudiostream = new ContinuousAudioDataStream (audiodata);
            AudioPlayer.player.start (continuousaudiostream);
        }
        public void stop () {
            if (audiostream != null)
                AudioPlayer.player.stop (audiostream);
            if (continuousaudiostream != null)
                AudioPlayer.player.stop (continuousaudiostream);
        }
        public static void main (String args[]) throws Exception {
            URL url1 = new URL ("http://localhost:8080/audio/1.au");
            URL url2 = new URL ("http://localhost:8080/audio/2.au");
            SunAudioClip sac1 = new SunAudioClip (url1);
            SunAudioClip sac2 = new SunAudioClip (url2);
            SunAudioClip sac3 = new SunAudioClip ("1.au");
            sac1.play ();
            sac2.loop ();
            sac3.play ();
            try {// Delay for loop
                Thread.sleep (2000);
            } catch (InterruptedException ie) {}
            sac2.stop();
        }
    }
```

In this chapter:

- *Toolkit*
- *The Peer Interfaces*

15

Toolkit and Peers

This chapter describes the `Toolkit` class and the purposes it serves. It also describes the `java.awt.peer` package of interfaces, along with how they fit in with the general scheme of things. The most important advice I can give you about the peer interfaces is not to worry about them. Unless you are porting Java to another platform, creating your own `Toolkit`, or adding any native component, you can ignore the peer interfaces.

15.1 Toolkit

The `Toolkit` object is an abstract class that provides an interface to platform-specific details like window size, available fonts, and printing. Every platform that supports Java must provide a concrete class that extends the `Toolkit` class. The Sun JDK provides a `Toolkit` for Windows NT/95 (`sun.awt.win32.MToolkit` [Java1.0] or `sun.awt.windows.MToolkit` [Java1.1]), Solaris/Motif (`sun.awt.motif.MToolkit`), and Macintosh (`sun.awt.macos.MToolkit`). Although the `Toolkit` is used frequently, both directly and behind the scenes, you would never create any of these objects directly. When you need a `Toolkit`, you ask for it with the static method `getDefaultToolkit()` or the `Component.getToolkit()` method.

You might use the `Toolkit` object if you need to fetch an image in an application (`getImage()`), get the font information provided with the `Toolkit` (`getFontList()` or `getFontMetrics()`), get the color model (`getColorModel()`), get the screen metrics (`getScreenResolution()` or `getScreenSize()`), get the system clipboard (`getSystemClipboard()`), get a print job (`getPrintJob()`), or ring the bell (`beep()`). The other methods of `Toolkit` are called for you by the system.

15.1.1 Toolkit Methods

Constructors

public Toolkit()—cannot be called by user

Because `Toolkit` is an abstract class, it has no usable constructor. To get a `Toolkit` object, ask for your environment's default toolkit by calling the static method `getDefaultToolkit()` or call `Component.getToolkit()` to get the toolkit of a component. When the actual `Toolkit` is created for the native environment, the `awt` package is loaded, the `AWT-Win32` and `AWT-Callback-Win32` or `AWT-Motif` and `AWT-Input` threads (or the appropriate threads for your environment) are created, and the threads go into infinite loops for screen maintenance and event handling.

Pseudo-Constructors

public static synchronized Toolkit getDefaultToolkit ()

The `getDefaultToolkit()` method returns the system's default `Toolkit` object. The default `Toolkit` is identified by the `System` property `awt.toolkit`, which defaults to an instance of the `sun.awt.motif.MToolkit` class. On the Windows NT/95 platforms, this is overridden by the Java environment to be `sun.awt.win32.MToolkit` (Java1.0) or `sun.awt.windows.MToolkit` (Java1.1). On the Macintosh platform, this is overridden by the environment to be `sun.awt.macos.MToolkit`. Most browsers don't let you change the system property `awt.toolkit`. Since this is a static method, you don't need to have a `Toolkit` object to call it; just call `Toolkit.getDefaultToolkit()`.

Currently, only one `Toolkit` can be associated with an environment. You are more than welcome to try to replace the one provided with the JDK. This permits you to create a whole new widget set, outside of Java, while maintaining the standard AWT API.

System information

public abstract ColorModel getColorModel ()

The `getColorModel()` method returns the current `ColorModel` used by the system. The default `ColorModel` is the standard RGB model, with 8 bits for each of red, green, and blue. There are an additional 8 bits for the alpha component, for pixel-level transparency.

public abstract String[] getFontList ()

The `getFontList()` method returns a `String` array of the set Java fonts available with this `Toolkit`. Normally, these fonts will be understood on all the Java platforms. The set provided with Sun's JDK 1.0 (with Netscape Navigator and Internet Explorer, on platforms other than the Macintosh) contains TimesRoman, Dialog, Helvetica, Courier (the only fixed-width font), DialogInput, and ZapfDingbat.

In Java 1.1, `getFont()` reports all the 1.0 font names. It also reports Serif, which is equivalent to TimesRoman; San Serif, which is equivalent to Helvetica; and Monospaced, which is equivalent to Courier. The names TimesRoman, Helvetica, and Courier are still supported but should be avoided. They have been deprecated and may disappear in a future release. Although the JDK 1.1 reports the existence of the ZapfDingbat font, you can't use it. The characters in this font have been remapped to Unicode characters in the range `\u2700` to `\u27ff`.

public abstract FontMetrics getFontMetrics (Font font)

The `getFontMetrics()` method returns the `FontMetrics` for the given `Font` object. You can use this value to compute how much space would be required to display some text using this `font`. You can use this version of `getFontMetrics()` (unlike the similar method in the `Graphics` class) prior to drawing anything on the screen.

public int getMenuShortcutKeyMask() ★

The `getMenuShortcutKeyMask()` method identifies the accelerator key for menu shortcuts for the user's platform. The return value is one of the modifier masks in the `Event` class, like `Event.CTRL_MASK`. This method is used internally by the `MenuBar` class to help in handling menu selection events. See Chapter 10, *Would You Like to Choose from the Menu?* for more information about dealing with menu accelerators.

public abstract PrintJob getPrintJob (Frame frame, String jobtitle, Properties props) ★

The `getPrintJob()` method initiates a print operation, `PrintJob`, on the user's platform. After getting a `PrintJob` object, you can use it to print the current graphics context as follows:

```
// Java 1.1 only
PrintJob p = getToolkit().getPrintJob (aFrame, "hi", aProps);
Graphics pg = p.getGraphics();
printAll (pg);
pg.dispose();
p.end();
```

With somewhat more work, you can print arbitrary content. See Chapter 17, *Printing*, for more information about printing. The `frame` parameter serves as the parent to any print dialog window, `jobtitle` serves as the identification string in the print queue, and `props` serves as a means to provide platform-specific properties (default printer, page order, orientation, etc.). If `props` is `(Properties)null`, no properties will be used. `props` is particularly interesting in that it is used both for input and for output. When the environment creates a print dialog, it can read default values for printing options from the properties sheet and use that to initialize the dialog. After `getPrintJob()` returns, the properties sheet is filled in with the actual printing options that the user requested. You can then use these option settings as the defaults for subsequent print jobs.

The actual property names are `Toolkit` specific and may be defined by the environment outside of Java. Furthermore, the environment is free to ignore the `props` parameter altogether; this appears to be the case with Windows NT/95 platforms. (It is difficult to see how Windows NT/95 would use the properties sheet, since these platforms don't even raise the print dialog until you call the method `getGraphics()`.) Table 15-1 shows some of the properties recognized on UNIX platforms; valid property values are shown in a fixed-width font.

Table 15–1: UNIX Printing Properties

Property Name	**Meaning and Possible Values**
`awt.print.printer`	The name of the printer on your system to send the job to.
`awt.print.fileName`	The name of the file to save the print job to.
`awt.print.numCopies`	The number of copies to be printed.
`awt.print.options`	Other options to be used for the run-time system's print command.
`awt.print.destination`	Whether the print job should be sent to a `printer` or saved in a `file`.
`awt.print.paperSize`	The size of the paper on which you want to print—usually, `letter`.
`awt.print.orientation`	Whether the job should be printed in `portrait` or `landscape` orientation.

public static String getProperty (String key, String defaultValue) ★

The `getProperty()` method retrieves the `key` property from the system's *awt.properties* file (located in the *lib* directory under the *java.home* directory). If `key` is not a valid property, `defaultValue` is returned. This file is used to provide localized names for various system resources.

public abstract int getScreenResolution ()

The `getScreenResolution()` method retrieves the resolution of the screen in dots per inch. The sharper the resolution of the screen, the greater number of dots per inch. Values vary depending on the system and graphics mode. The `PrintJob.getPageResolution()` method returns similar information for a printed page.

public abstract Dimension getScreenSize ()

The `getScreenSize()` method retrieves the dimensions of the user's screen in pixels for the current mode. For instance, a VGA system in standard mode will return 640 for the width and 480 for the height. This information is extremely helpful if you wish to manually size or position objects based upon the physical size of the user's screen. The `PrintJob.getPageDimension()` method returns similar information for a printed page.

public abstract Clipboard getSystemClipboard() ★

The `getSystemClipboard()` method returns a reference to the system's clipboard. The clipboard allows your Java programs to use cut and paste operations, either internally or as an interface between your program and objects outside of Java. For instance, the following code copies a `String` from a Java program to the system's clipboard:

```
// Java 1.1 only
Clipboard clipboard = getToolkit().getSystemClipboard();
StringSelection ss = new StringSelection("Hello");
clipboard.setContents(ss, this);
```

Once you have placed the string `"Hello"` on the clipboard, you can paste it anywhere. The details of `Clipboard`, `StringSelection`, and the rest of the `java.awt.datatransfer` package are described in Chapter 16, *Data Transfer*.

public final EventQueue getSystemEventQueue() ★

After checking whether the security manager allows access, this method returns a reference to the system's event queue.

protected abstract EventQueue getSystemEventQueueImpl() ★

`getSystemEventQueueImpl()` does the actual work of fetching the event queue. The toolkit provider implements this method; only subclasses of `Toolkit` can call it.

Images

The `Toolkit` provides a set of basic methods for working with images. These methods are similar to methods in the `Applet` class; `Toolkit` provides its own implementation for use by programs that don't have access to an `AppletContext` (i.e., applications or applets that are run as applications). Remember that you need an instance of `Toolkit` before you can call these methods; for example, to get an image, you might call `Toolkit.getDefaultToolkit().getImage("myImage.gif")`.

public abstract Image getImage (String filename)

The `getImage()` method with a `String` parameter allows applications to get an image from the local filesystem. Its argument is either a relative or absolute `filename` for an image in a recognized image file format. The method returns immediately; the `Image` object that it returns is initially empty. When the image is needed, the system attempts to get `filename` and convert it to an image. To force the file to load immediately or to check for errors while loading, use the `MediaTracker` class.

NOTE This version of `getImage()` is not usable within browsers since it will throw a security exception because the applet is trying to access the local filesystem.

---

public abstract Image getImage (URL url)

The `getImage()` method with the `URL` parameter can be used in either applets or applications. It allows you to provide a URL for an image in a recognized image file format. Like the other `getImage()` methods, this method returns immediately; the `Image` object that it returns is initially empty. When the image is needed, the system attempts to load the file specified by `url` and convert it to an image. You can use the `MediaTracker` class to monitor loading and check whether any errors occurred.

public abstract boolean prepareImage (Image image, int width, int height, ImageObserver observer)

The `prepareImage()` method is called by the system or a program to force `image` to start loading. This method can be used to force an image to begin loading before it is actually needed. The `Image image` will be scaled to be `width` `height`. A `width` and `height` of -1 means `image` will be rendered unscaled (i.e., at the size specified by the image itself). The `observer` is the `Component` on which `image` will be rendered. As the `image` is loaded across the network, the `observer`'s `imageUpdate()` method is called to inform the observer of the image's status.

public abstract int checkImage (Image image, int width, int height, ImageObserver observer)

The `checkImage()` method returns the status of the `image` that is being rendered on `observer`. Calling `checkImage()` only provides information about the image; it does not force the image to start loading. The `image` is being scaled to be `width` `height`. Passing a `width` and `height` of −1 means the image will be displayed without scaling. The return value of `checkImage()` is some combination of ImageObserver flags describing the data that is now available. The ImageObserver flags are: WIDTH, HEIGHT, PROPERTIES, SOMEBITS, FRAMEBITS, ALLBITS, ERROR, and ABORT. Once ALLBITS is set, the image is completely loaded, and the return value of checkImage() will not change. For more information about these flags, see Chapter 12, *Image Processing*.

The following program loads an image; whenever paint() is called, it displays what information about that image is available. When the ALLBITS flag is set, checkingImages knows that the image is fully loaded, and that a call to drawImage() will display the entire image.

```
import java.awt.*;
import java.awt.image.*;
import java.applet.*;
public class checkingImages extends Applet {
    Image i;
    public void init () {
        i = getImage (getDocumentBase(), "ora-icon.gif");
    }
    public void displayChecks (int i) {
        if ((i & ImageObserver.WIDTH) != 0)
            System.out.print ("Width ");
        if ((i & ImageObserver.HEIGHT) != 0)
            System.out.print ("Height ");
        if ((i & ImageObserver.PROPERTIES) != 0)
            System.out.print ("Properties ");
        if ((i & ImageObserver.SOMEBITS) != 0)
            System.out.print ("Some-bits ");
        if ((i & ImageObserver.FRAMEBITS) != 0)
            System.out.print ("Frame-bits ");
        if ((i & ImageObserver.ALLBITS) != 0)
            System.out.print ("All-bits ");
        if ((i & ImageObserver.ERROR) != 0)
            System.out.print ("Error-loading ");
        if ((i & ImageObserver.ABORT) != 0)
            System.out.print ("Loading-Aborted ");
        System.out.println ();
    }
    public void paint (Graphics g) {
        displayChecks (Toolkit.getDefaultToolkit().checkImage(i, -1, -1, this));
        g.drawImage (i, 0, 0, this);
    }
}
```

Here's the output from running checkingImages under Java 1.0; it shows that the width and height of the image are loaded first, followed by the image properties and the image itself. Java 1.1 also displays Frame-bits once the image is loaded.

```
Width Height
Width Height Properties Some-bits
Width Height Properties Some-bits All-bits
```

```
Width Height Properties Some-bits All-bits
Width Height Properties Some-bits All-bits
... (Repeated Forever More)
```

public abstract Image createImage (ImageProducer producer)

This `createImage()` method creates an `Image` object from an `ImageProducer`. The `producer` parameter must be some class that implements the `ImageProducer` interface. Image producers in the `java.awt.graphics` package are `FilteredImageSource` (which, together with an `ImageFilter`, lets you modify an existing image) and `MemoryImageSource` (which lets you turn an array of pixel information into an image). The image filters provided with `java.awt.image` are `CropImageFilter`, `RGBImageFilter`, `AreaAveragingScaleFilter`, and `ReplicateScaleFilter`. You can also implement your own image producers and image filters. These classes are all covered in detail in Chapter 12.

The following code uses this version of `createImage()` to create a modified version of an original image:

```
Image i = Toolkit.getDefaultToolkit().getImage (u);
      TransparentImageFilter tf = new TransparentImageFilter (.5f);
Image j = Toolkit.getDefaultToolkit().createImage (
              new FilteredImageSource (i.getSource(), tf));
```

public Image createImage (byte[] imageData) ★

This `createImage()` method converts the entire byte array in `imageData` into an `Image`. This data must be in one of the formats understood by this AWT `Toolkit` (GIF, JPEG, or XBM) and relies on the "magic number" of the data to determine the image type.

public Image createImage (byte[] imageData, int offset, int length) ★

This `createImage()` method converts a subset of the byte data in `imageData` into an `Image`. Instead of starting at the beginning, this method starts at `offset` and goes to `offset+length-1`, for a total of `length` bytes. If `offset` is 0 and `length` is `imageData.length`, this method is equivalent to the previous method and converts the entire array.

The data in `imageData` must be in one of the formats understood by this AWT `Toolkit` (GIF, JPEG, or XBM) and relies on the "magic number" of the data to determine the image type.

NOTE For those unfamiliar with magic numbers, most data files are uniquely identified by the first handful or so of bytes. For instance, the first three bytes of a GIF file are "`GIF`". This is what `createImage()` relies upon to do its magic.

Miscellaneous methods

public abstract void beep () ★

The `beep()` method attempts to play an audio beep. You have no control over pitch, duration, or volume; it is like putting `echo ^G` in a UNIX shell script.

public abstract void sync ()

The `sync()` method flushes the display of the underlying graphics context. Normally, this is done automatically, but there are times (particularly when doing animation) when you need to `sync()` the display yourself.

15.2 The Peer Interfaces

Each GUI component that AWT provides has a *peer*. The peer is the implementation of that component in the native environment. For example, the `Choice` component in AWT corresponds to some native object that lets the user select one or more items from a list. As a Java developer, you need to worry only about the interface of the `Choice` object; when someone runs your program, the `Choice` object is mapped to an appropriate native object, which is the `Choice` peer, that "does the right thing." You don't really care what the peer is or how it's implemented; in fact, the peer may look (and to some extent, behave) differently on each platform.

The glue that allows an AWT component and its peer to work together is called a *peer interface*. A peer interface is simply an interface that defines the methods that the peer is required to support. These interfaces are collected in the package `java.awt.peer`. For example, this package contains the `ButtonPeer` interface, which contains the single method `setLabel()`. This means that the native object used to implement a `Button` must contain a method called `setLabel()` in order for AWT to use it as a button peer. (It's not quite that simple; since a button is also a `Component`, the button's peer must also implement the `ComponentPeer` interface, which is much more complicated.)

With one exception, there is a one-to-one correspondence between `Component` classes and peer interfaces: a `Window` has a `WindowPeer`, a `Checkbox` has a `CheckboxPeer`, and so on. The one exception is a new peer interface that appears in Java 1.1: the `LightweightPeer`, which doesn't have a corresponding component. The `LightweightPeer` is used by components that exist purely in Java, don't have a native peer, and are displayed and managed by another container. `LightweightPeer` makes it easier to create new components or containers that can behave like other components, but don't subclass `Canvas` or `Panel` and don't correspond to anything in the native environment. The best usage I can think of is to subclass `Container` to create a lightweight `Panel`. If you are only using a `Panel` to manage layout, there is no need for a peer to be created to process events. This should result in substantial resource savings where multiple panels need to be created just to help with layout. The following code is all you need to create a LightWeight-Panel:

```
import java.awt.*;
public class LightWeightPanel extends Container {
}
```

There also tends to be a one-to-one relationship between the peer methods and the methods of the Java component. That is, each method in the peer interface corresponds to a method of the component. However, although a peer must implement each method in its peer interface, it doesn't necessarily have to do anything in that method. It's entirely possible for a platform to have a native button object that doesn't let you set the label. In this case, the button peer would implement the setLabel() method required by the ButtonPeer interface, but it wouldn't do anything. Of course, the component may also have many methods that don't correspond to the peer methods. Methods that don't correspond to anything in the peer are handled entirely within Java.

The ComponentPeer interface is the parent of all non-menu objects in the peer package. The MenuComponentPeer is the parent of all menu objects. The trees mirror the regular object hierarchies. Figure 15-1 shows the object hierarchy diagram.

Creating a Java component (e.g., Button b = new Button ("Foo")) does not create the peer. An object's peer is created when the object's addNotify() method is called. This is usually when the component's container is added to the screen. The call to a component's addNotify() method in turn calls the appropriate createxxxx() method of the Toolkit (for a Button, createButton()). Figure 15-2 shows the process.

When you remove a component from a container by calling remove(), the container calls the component's removeNotify() method. This usually results in a call to the peer's dispose() method. Depending on the particular component, removeNotify() may be overridden to perform additional work. Removing a Component from a Container does not destroy the Component. The next time the method addNotify() is called, the component must be recreated by the peer, with its previous characteristics. For instance, when a TextField is removed, the current text, plus the start and stop points for the current selection, are saved. These will be restored if you add the text field to its container again. For some components, like a Label, there is no need to retain any additional information.

A component's peer needs to exist only when the user is interacting with it. If you are developing resource-intensive programs, you might want to consider drawing the components manually when they do not have the focus and using the peer only when they actually have input focus. This technique can save a considerable

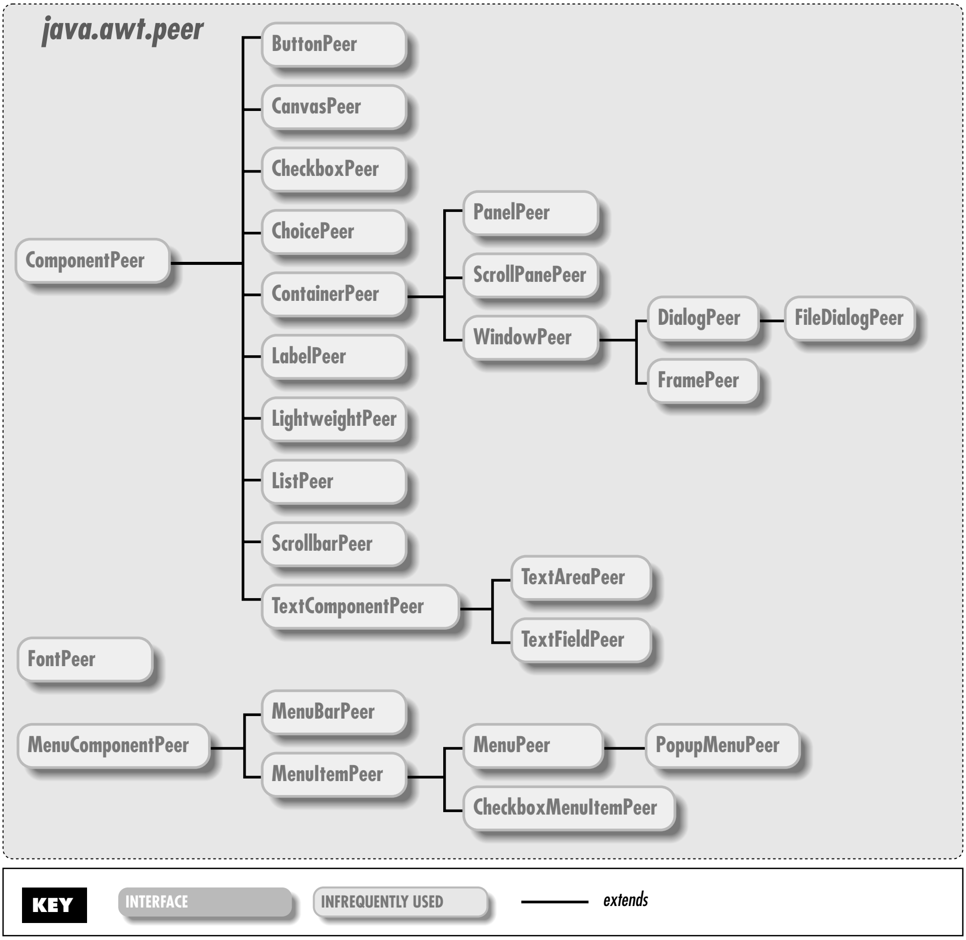


Figure 15–1: java.awt.peer object hierarchy

amount of memory resources but requires extra work on your part as a developer and goes beyond the scope of this book. The `LightweightPeer` interface appears to be designed to make this process easier: you could create a dummy button that doesn't do anything and uses the `LightweightPeer`. Whenever the mouse enters the button's space, you could quickly remove the dummy button and add a real button.

The peer interfaces are listed in their entirety in the reference section. We won't list them here, primarily because you don't need to worry about them unless you're porting Java to a new platform. Each method in a peer interface corresponds exactly to the similarly named method in the matching component. `LightweightPeer` is the only exception, because it doesn't have a matching component, but that's easy to take care of: as you'd expect, `LightweightPeer` doesn't

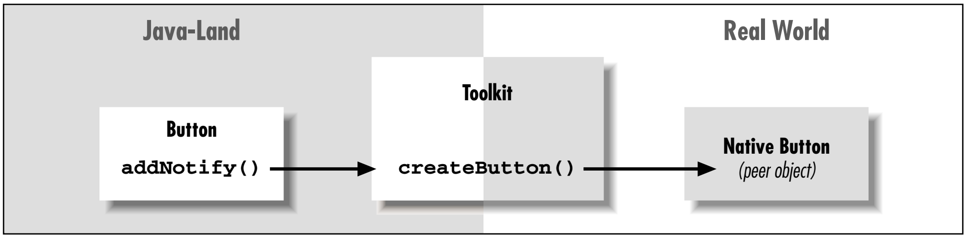


Figure 15–2: Creating a Button peer

define any methods. (Of course, a peer that implements `LightweightPeer` would still need to implement the methods inherited from `ComponentPeer`, but those are inherited when you subclass `Component`.)

In this chapter:

- *DataFlavor*
- *Transferable Interface*
- *ClipboardOwner Interface*
- *Clipboard*
- *StringSelection*
- *UnsupportedFlavorException*
- *Reading and Writing the Clipboard*

16
Data Transfer

One feature that was missing from Java 1.0 was the ability to access the system clipboard. It was impossible to cut and paste data from one program into another. Java 1.1 includes a package called `java.awt.datatransfer` that supports clipboard operations. Using this package, you can cut an arbitrary object from one program and paste it into another. In theory, you can cut and paste almost anything; in practice, you usually want to cut and paste text strings, so the package provides special support for string operations. The current version allows only one object to be on the clipboard at a time.

`java.awt.datatransfer` consists of three classes, two interfaces, and one exception. Objects that can be transferred implement the `Transferable` interface. The `Transferable` interface defines methods for working with different *flavors* of an object. The concept of flavors is basic to Java's clipboard model. Essentially, a flavor is a MIME content type. Any object can be represented in several different ways, each corresponding to a different MIME type. For example, a text string could be represented by a Java `String` object, an array of Unicode character data, or some kind of rich text that contains font information. The object putting the string on the clipboard provides whatever flavors it is capable of; an object pasting the string from the clipboard takes whatever flavor it can handle. Flavors are represented by the `DataFlavor` class, and the `UnsupportedFlavorException` is used when an object asks for a `DataFlavor` that is not available.

The `Clipboard` class represents the clipboard itself. There is a single system clipboard, but you can create as many private clipboards as you want. The system clipboard lets you cut and paste between arbitrary applications (for example, Microsoft Word and some Java programs). Private clipboards are useful within a single application, though you could probably figure out some way to export a clipboard to another application using RMI.

To put data on the clipboard, you must implement the `ClipboardOwner` interface, which provides a means for you to be notified when the data you write is removed from the clipboard. (There isn't any `ClipboardReader` interface; any object can read from the clipboard.) The final component of the `datatransfer` package is a special class called `StringSelection` that facilitates cutting and pasting text strings.

Cutting and pasting isn't the whole story; JavaSoft has also promised drag-and-drop capabilities, but this won't be in the initial release of Java 1.1.

16.1 DataFlavor

A `DataFlavor` represents a format in which data can be transferred. The `DataFlavor` class includes two common data flavors; you can create other flavors by extending this class. Flavors are essentially MIME content types and are represented by the standard MIME type strings. An additional content subtype has been added to represent Java classes; the content type of a Java object is:*

```
application/x-java-serialized-object
<classname>
```

For example, the content type of a `Vector` object would be:

```
application/x-java-serialized-object java.util.Vector
```

In addition to the content type, a `DataFlavor` also contains a *presentable name*. The presentable name is intended to be more comprehensible to humans than the MIME type. For example, the presentable name of a `VectorFlavor` object might just be "Vector", rather than the complex and lengthy MIME type given previously. Presentable names are useful when a program needs to ask the user which data flavor to use.

16.1.1 DataFlavor Methods

Variables

The `DataFlavor` class includes two public variables that hold "prebuilt" flavors representing different kinds of text objects. These flavors are used in conjunction with the `StringSelection` class. Although these flavors are variables for all practical purposes, they are used as constants.

* The type name changed to `x-java-serialized-object` in the 1.1.1 release.

public static DataFlavor stringFlavor ★

The `stringFlavor` variable is the data flavor for textual data represented as a Java `String` object. Its MIME type is `application/x-javaserializedobject String`.

public static DataFlavor plainTextFlavor ★

The `plainTextFlavor` variable is the data flavor for standard, Unicode-encoded text. Its MIME type is `text/plain; charset=unicode`.

Constructors

The `DataFlavor` class has two constructors. One creates a `DataFlavor` given a MIME content type; the other creates a `DataFlavor` given a Java class and builds the MIME type from the class name.

public DataFlavor(String mimeType, String humanPresentableName) ★

The first constructor creates an instance of `DataFlavor` for the `mimeType` flavor of data. The `humanPresentableName` parameter should be a more user-friendly name. It might be used in a menu to let the user select a flavor from several possibilities. It might also be used to generate an error message when the `UnsupportedFlavorException` occurs. The `plainTextFlavor` uses "Plain Text" as its presentable name.

To read data from the clipboard, a program calls the `Transferable.getTransferData()` method. If the data is represented by a `DataFlavor` that doesn't correspond to a Java class (for example, `plainTextFlavor`), `getTransferData()` returns an `InputStream` for you to read the data from.

public DataFlavor(Class representationClass, String humanPresentableName) ★

The other constructor creates an instance of `DataFlavor` for the specific Java class `representationClass`. Again, the `humanPresentableName` provides a more user-friendly name for use in menus, error messages, or other interactions with users. The `stringFlavor` uses "Unicode String" as its presentable name.

A program calls `Transferable.getTransferData()` to read data from the clipboard. If the data is represented by a Java class, `getTransferData()` returns an instance of the representation class itself. It does not return a `Class` object. For example, if the data flavor is `stringFlavor`, `getTransferData()` returns a `String`.

Presentations

public String getHumanPresentableName() ★

The `getHumanPresentableName()` method returns the data flavor's presentable name; for example, `stringFlavor.getHumanPresentableName()` returns the string "Unicode String".

public void setHumanPresentableName(String humanPresentableName) ★

The `setHumanPresentableName()` method changes the data flavor's presentable name to a new `humanPresentableName`. It is hard to imagine why you would want to change a flavor's name.

public String getMimeType() ★

The `getMimeType()` method gets the MIME content type for the `DataFlavor` as a `String`.

public Class getRepresentationClass() ★

The `getRepresentationClass()` method returns the Java type that is used to represent data of this flavor (i.e., the type that would be returned by the `getTransferData()` method). It returns the type as a `Class` object, not an instance of the class itself. Note that all data flavors have a representation class, not just those for which the class is specified explicitly in the constructor. For example, the `plainTextFlavor.getRepresentationClass()` method returns the class `java.io.StringReader`.

public boolean isMimeTypeEqual(String mimeType) ★

The `isMimeTypeEqual()` method checks for string equality between `mimeType` and the data flavor's MIME type string. For some MIME types, this comparison may be too simplistic because character sets may not be present on types like `text/plain`. Therefore, this method would tell you that the MIME type `text/plain; charset=unicode` is different from `text/plain`.

public final boolean isMimeTypeEqual(DataFlavor dataFlavor) ★

The `isMimeTypeEqual()` method checks whether the MIME type of the `dataFlavor` parameter equals the current data flavor's MIME type. It calls the previous method, and therefore has the same weaknesses.

Protected methods

protected String normalizeMimeType(String mimeType) ★

The `normalizeMimeType()` method is used to convert a MIME type string into a standard form. Its argument is a MIME type, as a `String`; it returns the new normalized MIME type. You would never call `normalizeMimeType()` directly, but you might want to override this method if you are creating a subclass of `DataFlavor` and want to change the default normalization process. For example, one thing you might do with this is add the string `charset=US-ASCII` to the `text/plain` MIME type if it appears without a character set.

protected String normalizeMimeTypeParameter(String parameterName, String parameterValue) ★

The `normalizeMimeTypeParameter()` method is used to convert any parameters associated with MIME types into a standard form. Its arguments are a parameter name (for example, `charset`) and the parameter's value (for example, `unicode`). It returns `parameterValue` normalized. You would never call `normalizeMimeTypeParameter()` directly, but you might want to override this method if you are creating a subclass of `DataFlavor` and want to change the default normalization process. For example, parameter values may be case sensitive. You could write a method that would convert the value `Unicode` to the more appropriate form `unicode`.

While it may be more trouble than it's worth, carefully overriding these normalization methods might help you to get more predictable results from methods like `isMimeTypeEqual()`.

Miscellaneous methods

public boolean equals(DataFlavor dataFlavor) ★

The `equals()` method defines equality for flavors. Two `DataFlavor` objects are equal if their MIME type and representation class are equal.

16.2 Transferable Interface

Objects that can be placed on a clipboard must implement the `Transferable` interface. This interface defines a number of methods that let an object describe how it presents itself to clipboard readers. That sounds complex, but it isn't really; these methods let a clipboard reader find out what data flavors are available and what Java types they represent.

The significance of the `Transferable` interface is that it provides a way to get information about the object on the clipboard without knowing what the object actually is. When you read the clipboard, you don't necessarily know what kind of object is there. It might be some kind of text string, but it could just as likely be something bizarre. However, you shouldn't have to care. If you're looking for a `String`, you care only that the object exists in a `stringFlavor` representation. These methods let you ask the object what flavors it supports.

For text strings, the data transfer package provides a `StringSelection` class that implements `Transferable`. At this point, if you want to transfer other kinds of objects, you'll have to create a class that implements `Transferable` yourself. It wouldn't be unreasonable for JavaSoft to provide other "selection" classes (for example, `ImageSelection`) in the future.

Methods

public abstract DataFlavor[] getTransferDataFlavors() ★

The `getTransferDataFlavors()` method should return a sorted array of `DataFlavors` that you support. The most descriptive flavor should be the first element in the array and the least descriptive, last. For example, a textual object would place `DataFlavor.plainTextFlavor` last, because it has less information than `DataFlavor.stringFlavor` (which includes information like the length of the string) and much less information than a hypothetical flavor like `DataFlavor.richTextFlavor`.

public abstract boolean isDataFlavorSupported(DataFlavor flavor) ★

The `isDataFlavorSupported()` method should return `true` if the object supports the given `flavor` and `false` otherwise.

public abstract Object getTransferData(DataFlavor flavor)
throws UnsupportedFlavorException, IOException ★

The `getTransferData()` method is the most complicated to implement. It should return an instance of the class representing the data in the given `flavor`. If `flavor` is not supported by this object, `getTransferData()` must throw the `UnsupportedFlavorException`. However, this method must be able to return a class for each flavor the object supports (i.e., each data flavor listed by `getTransferDataFlavors()`). The method could throw an `IOException` when returning with a `Reader` as the representation class. For example, if some data flavor required you to return a `FileReader` and the file doesn't exist, this method might throw an `IOException`.

16.3 ClipboardOwner Interface

Classes that need to place objects on a clipboard must implement the `ClipboardOwner` interface. An object becomes the clipboard owner by placing something on a `Clipboard` and remains owner as long as that object stays on the clipboard; it loses ownership when someone else writes to the clipboard. The `ClipboardOwner` interface provides a way to receive notification when you lose ownership—that is, when the object you placed on the clipboard is replaced by something else.

Methods

public abstract void lostOwnership(Clipboard clipboard, Transferable contents) ★

The `lostOwnership()` method tells the owner of `contents` that it is no longer on the given `clipboard`. It is usually implemented as an empty stub but is available for situations in which you have to know.

16.4 Clipboard

The `Clipboard` class is a repository for a `Transferable` object and can be used for cut, copy, and paste operations. You can work with a private clipboard by creating your own instance of `Clipboard`, or you can work with the system clipboard by asking the `Toolkit` for it:

```
Toolkit.getDefaultToolkit().getSystemClipboard()
```

When working with the system clipboard, native applications have access to information created within Java programs and vice versa. Access to the system clipboard is controlled by the `SecurityManager` and is restricted within applets.

16.4.1 Clipboard Methods

Variables

protected ClipboardOwner owner ★

The `owner` instance variable represents the current owner of `contents`. When something new is placed on the clipboard, the previous owner is notified by a call to the `lostOwnership()` method. The owner usually ignores this notification. However, the clipboard's `contents` are passed back to `owner` in case some special processing or comparison needs to be done.

protected Transferable contents ★

The `contents` instance variable is the object currently on the clipboard; it was placed on the clipboard by `owner`. To retrieve the current contents, use the `getContents()` method.

Constructors

public Clipboard(String name) ★

The constructor for `Clipboard` allows you to create a private clipboard named `name`. This clipboard is not accessible outside of your program and has no security constraints placed upon it.

Miscellaneous methods

public String getName() ★

The `getName()` method fetches the clipboard's name. For private clipboards, this is the name given in the constructor. The name of the system clipboard is "System".

public synchronized Transferable getContents(Object requester) ★

The `getContents()` method allows you to retrieve the current contents of the clipboard. This is the method you would call when the user selects Paste from a menu.

Once you have the `Transferable` data, you try to get the data in whatever flavor you want by calling the `Transferable.getTransferData()` method, possibly after calling `Transferable.isDataFlavorSupported()`. The `requester` represents the object that is requesting the clipboard's contents; it is usually just `this`, since the current object is making the request.

public synchronized void setContents(Transferable contents, ClipboardOwner owner) ★

The `setContents()` method changes the contents of the clipboard to `contents` and changes the clipboard's owner to `owner`. You would call this method when the user selects Cut or Copy from a menu. The `owner` parameter represents the object that owns `contents`. This object must implement the `ClipboardOwner` interface; it will be notified by a call to `lostOwnership()` when something else is placed on the clipboard.

16.5 StringSelection

`StringSelection` is a convenience class that can be used for copy and paste operations on Unicode text strings (`String`). It implements both the `ClipboardOwner` and `Transferable` interfaces, so it can be used both as the contents of the clipboard and as its owner. For example, if `s` is a `StringSelection`, you can call `Clipboard.setContents(s,s)`. `StringSelection` supports both `stringFlavor` and `plainTextFlavor` and doesn't do anything when it loses clipboard ownership.

16.5.1 StringSelection Methods

Constructors

public StringSelection(String data) ★

The constructor creates an instance of `StringSelection` containing `data`. You can use this object to place the data on a clipboard.

Miscellaneous methods

public DataFlavor[] getTransferDataFlavors() ★

The `getTransferDataFlavors()` method returns a two-element `DataFlavor` array consisting of `DataFlavor.stringFlavor` and `DataFlavor.plainTextFlavor`. This means that you can paste a `StringSelection` as either a Java `String` or as plain text (i.e., the MIME type `plain/text`).

public boolean isDataFlavorSupported(DataFlavor flavor) ★

The `isDataFlavorSupported()` method is returns `true` if `flavor` is either `DataFlavor.stringFlavor` or `DataFlavor.plainTextFlavor`; it returns `false` for any other flavor.

public Object getTransferData(DataFlavor flavor)
throws UnsupportedFlavorException, IOException ★

The `getTransferData()` method returns an object from which you can get the data on the clipboard; the object's type is determined by the `flavor` parameter. This method returns a `String` containing the data on the clipboard if `flavor` is `DataFlavor.stringFlavor`; it returns a `StringBufferInputStream` from which you can read the data on the clipboard if you ask for `DataFlavor.plainTextFlavor`. Otherwise, `getTransferData()` throws an `UnsupportedFlavorException`.

public void lostOwnership(Clipboard clipboard, Transferable contents) ★

The `lostOwnership()` method of `StringSelection` is an empty stub; it does nothing when you lose ownership. If you want to know when you've lost ownership of string data placed on the clipboard, write a subclass of `StringSelection` and override this method.

16.6 UnsupportedFlavorException

The `UnsupportedFlavorException` exception is thrown when you ask `Transferable.getTransferData()` to give you data in a flavor that isn't supported by the object on the clipboard. For example, if the clipboard currently holds an image and you ask for the data in the `stringFlavor`, you will almost certainly get an `UnsupportedFlavorException` because it is unlikely that an image object will be able to give you its data as a `String`. You can either ignore the exception or display an appropriate message to the user.

16.6.1 UnsupportedFlavorException Method

Constructor

public UnsupportedFlavorException (DataFlavor flavor)

The sole constructor creates an `UnsupportedFlavorException` with a detail message containing the human presentable name of `flavor`. To retrieve this message, call `getMessage()`, which this exception inherits from the `Exception` superclass (and which is required by the `Throwable` interface).

16.7 Reading and Writing the Clipboard

Now that you know about the different `java.awt.datatransfer` classes required to use the clipboard, let's put them all together in an example. Example 16-1 creates a `TextField` for input (copying), a read-only `TextArea` for output (pasting), and a couple of buttons to control its operation. Figure 16-1 shows the program's user interface. When the user clicks on the Copy button or presses Return in the `TextField`, the text in the `TextField` is copied to the `Clipboard`. When the user clicks on the Paste button, the contents of the clipboard are drawn in the `TextArea`. Since the clipboard is not private, you can copy or paste from anywhere on your desktop, not just this program.

Example 16–1: Using the System Clipboard

```
// Java 1.1 only
import java.io.*;
import java.awt.*;
import java.awt.datatransfer.*;

public class ClipMe extends Frame {
    TextField tf;
    TextArea ta;
    Button copy, paste;
    Clipboard clipboard = null;
    ClipMe() {
        super ("Clipping Example");
        add (tf = new TextField("Welcome"), "North");
        add (ta = new TextArea(), "Center");
        ta.setEditable(false);
        Panel p = new Panel();
        p.add (copy = new Button ("Copy"));
        p.add (paste = new Button ("Paste"));
        add (p, "South");
        setSize (250, 250);
    }
    public static void main (String args[]) {
        new ClipMe().show();
    }
    public boolean handleEvent (Event e) {
        if (e.id == Event.WINDOW_DESTROY) {
            System.exit(0);
            return true;  // never gets here
        }
        return super.handleEvent (e);
    }
    public boolean action (Event e, Object o) {
        if (clipboard == null)
            clipboard = getToolkit().getSystemClipboard();
        if ((e.target == tf) || (e.target == copy)) {
            StringSelection data;
            data = new StringSelection (tf.getText());
```

Example 16–1: Using the System Clipboard (continued)

```
                clipboard.setContents (data, data);
            } else if (e.target == paste) {
                Transferable clipData = clipboard.getContents(this);
                String s;
                try {
                    s = (String)(clipData.getTransferData(
                            DataFlavor.stringFlavor));
                } catch (Exception ee) {
                    s = ee.toString();
                }
                ta.setText(s);
            }
            return true;
        }
    }
```

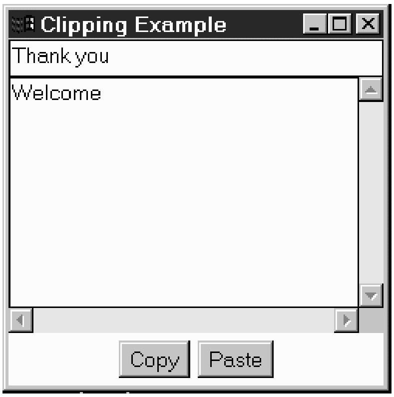


Figure 16–1: Using the system clipboard

We won't say anything about how the display is set up; that should be familiar. All the interesting stuff happens in the `action` method, which is called in response to a button click. We check which button the user clicked; if the user clicked the Copy button, we read the text field `tf` and use it to create a new `StringSelection` named `data`. If the user clicked the Paste button, we retrieve the data from the clipboard by calling `getContents()`. This gives us an object about which (strictly speaking) we know nothing, except that it implements `Transferable`. In this case, we're pretty sure that we're getting text from the clipboard, so we call `getTransferData()` and ask for the data in the `stringFlavor` form. We catch the exception that might occur if we're wrong about the data flavor. This program has no way of placing anything but text on the clipboard, but there's no guarantee that the user didn't cut some other kind of object from a native application.

Once we have our `String`, we call the `setText()` method of the `TextArea` to tell it about the new string, and we are finished.

In this chapter:

- *PrintGraphics Interface*
- *PrintJob Class*
- *Component Methods*
- *Printing Example*
- *Printing Arbitrary Content*

17

Printing

Java 1.1 introduces the ability to print, a capability that was sadly missing in Java 1.0, even though the `Component` class had `print()` and `printAll()` methods. However, it is possible to print arbitrary content, including multipage documents. The printing facility in Java 1.1 is designed primarily to let a program print its display area or any of the components within its display.

Printing is implemented with the help of one public interface, `PrintGraphics`, and one public class, `PrintJob`, of AWT. The real work is hidden behind classes provided with the toolkit for your platform. On Windows NT/95 platforms, these classes are `sun.awt.windows.WPrintGraphics` and `sun.awt.windows.WPrintJob`. Other platforms have similarly named classes.

Printing from an applet has security implications and is restricted by the `SecurityManager`. It is reasonable to suppose that a browser will make it possible to print a page containing an applet; in fact, Netscape has done so ever since Navigator 3.0. However, this ability might not take advantage of Java's printing facility. It isn't reasonable to suppose that an applet will be able to initiate a print job on its own. You might allow a signed applet coming from a trusted source to do so, but you wouldn't want to give any random applet access to your printer. (If you don't understand why, imagine the potential for abuse.)

17.1 PrintGraphics Interface

Printing is similar to drawing an object on the screen. Just as you draw onto a graphics context to display something on the screen, you draw onto a "printing context" to create an image for printing. Furthermore, the printing context and graphics context are very closely related. The graphics context is an instance of the class Graphics. The printing context is also an instance of Graphics, with the additional requirement that it implement the PrintGraphics interface. Therefore, any methods that you use to draw graphics can also be used for printing. Furthermore, the paint() method (which a component uses to draw itself on the screen) is also called when a component must draw itself for printing.

In short, to print, you get a special Graphics object that implements the PrintGraphics interface by calling the getGraphics() method of PrintJob (discussed later in this chapter) through Toolkit. You then call a component's print() or printAll() method or a container's printComponents() method, with this object as the argument. These methods arrange for a call to paint(), which can draw on the printing context to its heart's content. In the simple case where you're just rendering the component on paper, you shouldn't have to change paint() at all. Of course, if you are doing something more complex (that is, printing something that doesn't look exactly like your component), you'll have to modify paint() to determine whether it's painting on screen or on paper, and act accordingly. The code would look something like this:

```
public void paint(Graphics g) {
    if (g instanceof PrintGraphics) {
        // Printing
    }else {
        // Painting
    }
}
```

If the graphics object you receive is an instance of PrintGraphics, you know that paint() has been called for a print request and can do anything specific to printing. As I said earlier, you can use all the methods of Graphics to draw on g. If you're printing, though, you might do anything from making sure that you print in black and white to drawing something completely different. (This might be the trick you use to print the contents of a component rather than the component itself. However, as of Java 1.1, it's impossible to prevent the component from drawing itself. Remember that your paint() method was never responsible for drawing the component; it only drew additions to the basic component. For the time being, it's the same with printing.)

When you call printComponents() on a Container, all the components within the container will be printed. Early beta versions of 1.1 only painted the outline of components within the container. The component should print as it appears on the screen.

17.1.1 Methods

public abstract PrintJob getPrintJob () ★

The `getPrintJob()` method returns the `PrintJob` instance that created this `PrintGraphics` instance.

This seems like circular logic: you need a `PrintJob` to create a `PrintGraphics` object, but you can get a `PrintJob` only from a `PrintGraphics` object. To break the circle, you can get an initial `PrintJob` by calling the `getPrintJob()` method of `Toolkit`. `getPrintJob()` looks like it will be useful primarily within `paint()`, where you don't have access to the original `PrintJob` object and need to get it from the graphics context.

System-provided `PrintGraphics` objects inherit their other methods from the `Graphics` class, which is discussed in Chapter 2, *Simple Graphics*.* The one method that's worth noting here is `dispose()`. In a regular `Graphics` object, calling `dispose()` frees any system resources the object requires. For a `PrintGraphics` object, `dispose()` sends the current object to the printer prior to deallocating its resources. Calling `dispose()` is therefore equivalent to sending a form feed to eject the current page.

17.2 PrintJob Class

The abstract `PrintJob` class provides the basis for the platform-specific printing subclasses. Through `PrintJob`, you have access to properties like page size and resolution.

17.2.1 Constructor and Pseudo-Constructor

public PrintJob () ★

The `PrintJob()` constructor is public; however, the class is abstract, so you would never create a `PrintJob` instance directly.

Since you can't call the `PrintJob` constructor directly, you need some other way of getting a print job to work with. The proper way to get an instance of `PrintJob` is to ask the `Toolkit`, which is described in Chapter 15, *Toolkit and Peers*. The `getPrintJob()` method requires a `Frame` as the first parameter, a `String` as the second parameter, and a `Properties` set as the third parameter. Here's how you might call it:

* Anything can implement the `PrintGraphics` interface, not just subclasses of `Graphics`. However, in order for `paint()` and `print()` to work, it must be a subclass of `Graphics`.

```
PrintJob pjob = getToolkit().getPrintJob(aFrame, "Job Title",
                                          (Properties)null);
```

The `Frame` is used to hold a print dialog box, asking the user to confirm or cancel the print job. (Whether or not you get the print dialog may be platform specific, but your programs should always assume that the dialog may appear.) The `String` is the job's title; it will be used to identify the job in the print queue and on the job's header page, if there is one.

The `Properties` parameter is used to request printing options, like page reversal. The property names, and whether the requested properties are honored at all, are platform specific. UNIX systems use the following properties:

```
awt.print.printer
awt.print.paperSize
awt.print.destination
awt.print.orientation
awt.print.options
awt.print.fileName
awt.print.numCopies
```

Windows NT/95 ignores the properties sheet. If the properties sheet is `null`, as in the previous example, you get the system's default printing options. If the properties sheet is non-`null`, `getPrintJob()` modifies it to show the actual options used to print the job. You can use the modified properties sheet to find out what properties are recognized on your system and to save a set of printing options for use on a later print job.

If you are printing multiple pages, each page should originate from the same print job.

According to Sun's documentation, `getPrintJob()` ought to return `null` if the user cancels the print job. However, this is a problem. On some platforms (notably Windows NT/95), the print dialog box doesn't even appear until you call the `getGraphics()` method. In this case, `getPrintJob()` still returns a print job and never returns `null`. If the user cancels the job, `getGraphics()` returns `null`.

17.2.2 Methods

public abstract Graphics getGraphics () ★

The `getGraphics()` method returns an instance of `Graphics` that also implements `PrintGraphics`. This graphics context can then be used as the parameter to methods like `paint()`, `print()`, `update()`, or `printAll()` to print a single page. (All of these methods result in calls to `paint()`; in `paint()`, you draw whatever you want to print on the `Graphics` object.)

On Windows NT/95 platforms, `getGraphics()` returns `null` if the user cancels the print job.

public abstract Dimension getPageDimension () ★

The `getPageDimension()` method returns the dimensions of the page in pixels, as a `Dimension` object. Since `getGraphics()` returns a graphics context only for a single page, it is the programmer's responsibility to decide when the current page is full, print the current page, and start a new page with a new `Graphics` object. The page size is chosen to roughly represent a screen but has no relationship to the page size or orientation.

public abstract int getPageResolution () ★

The `getPageResolution()` method returns the number of pixels per inch for drawing on the page. It is completely unclear what this means, since the number returned has no relationship to the printer resolution. It appears to be similar to the screen resolution.

public abstract boolean lastPageFirst () ★

The `lastPageFirst()` method lets you know if the user configured the printer to print pages in reverse order. If this returns `true`, you need to generate the last page first. If `false`, you should print the first page first. This is relevant only if you are trying to print a multipage document.

public abstract void end () ★

The `end()` method terminates the print job. This is the last method you should call when printing; it does any cleaning up that's necessary.

public void finalize () ★

The `finalize()` method is called by the garbage collector. In the event you forget to call `end()`, `finalize()` calls it for you. However, it is best to call `end()` as soon as you know you have finished printing; don't rely on `finalize()`.

17.3 Component Methods

The methods that start the printing process come from either the `Component` or `Container` class and are inherited by all their children. All components inherit the `printAll()` and `print()` methods. Containers also inherit the `printComponents()` method, in addition to `printAll()` and `print()`. A container should call `printComponents()` to print itself if it contains any components. Otherwise, it is sufficient to call `printAll()`.

These methods end up calling `paint()`, which does the actual drawing.

17.4 Printing Example

Now that you know about the different classes necessary to print, let's put it all together. Printing takes four steps:

1. Get the `PrintJob`:

```
PrintJob pjob = getToolkit().getPrintJob(this, "Job Title", (Properties)null);
```

2. Get the graphics context from the `PrintJob`:

```
Graphics pg = pjob.getGraphics();
```

3. Print by calling `printAll()` or `print()`. When this method returns, you can call `dispose()` to send the page to the printer:

```
printAll(pg);
pg.dispose(); // This is like sending a form feed
```

4. Clean up after yourself:

```
pjob.end();
```

The following code summarizes how to print:

```
// Java 1.1 only
PrintJob pjob = getToolkit().getPrintJob(this, "Print?", (Properties)null);
if (pjob != null) {
        Graphics pg = pjob.getGraphics();
        if (pg != null) {
            printAll(pg);
            pg.dispose();
        }
    pjob.end();
}
```

This code prints the current component: what you get from the printer should be a reasonable rendition of what you see on the screen. Note that we didn't need to modify `paint()` at all. That should always be the case if you want your printer output to look like your onscreen component.

17.5 Printing Arbitrary Content

Of course, in many situations, you want to do more than print the appearance of a component. You often want to print the contents of some component, rather than the component itself. For example, you may want to print the text the user has typed into a text area, rather than the text area itself. Or you may want to print the contents of a spreadsheet, rather than the collection of components that compose the spreadsheet.

Java 1.1 lets you print arbitrary content, which may include multipage documents. You aren't restricted to printing your components' appearance. In many ways, the steps required to print arbitrary content are similar to those we outlined previously. However, a few tricks are involved:

1. Get the `PrintJob`:

   ```
   PrintJob pjob = getToolkit().getPrintJob(this, "Job Title", (Properties)null);
   ```

2. Get the graphics context from the `PrintJob`:

   ```
   Graphics pg = pjob.getGraphics();
   ```

3. Don't call `printAll()` or `print()`. These methods will try to draw your component on the page, which you don't want. Instead, get the dimensions of the page by calling `getPageDimension()`:

   ```
   pjob.getPageDimension();
   ```

4. Set the font for your graphics context; then get the font metrics from your graphics context.

   ```
   Font times = new Font ("SansSerif", Font.PLAIN, 12);
   pg.setFont(times);
   FontMetrics tm = pg.getFontMetrics(times);
   ```

5. Draw whatever you want into the graphics context, using the methods of the `Graphics` class. If you are drawing text, it's your responsibility to do all the positioning, making sure that your text falls within the page boundaries. By the time you're through with this, you'll have the `FontMetrics` class memorized.

6. When you've finished drawing the current page, call `dispose()`; this sends the page to the printer and releases the resources tied up by the `PrintGraphics` object.

   ```
   pg.dispose(); // This is like sending a form feed
   ```

7. If you want to print more pages, return to step 2.

8. Clean up after yourself:

   ```
   pjob.end();
   ```

Remember to set a font for the `PrintGraphics` object explicitly! It doesn't have a default font.

An example that loads and prints a text file is available from this book's Web page.

In this chapter:

- *Introduction to the Reference Chapters*
- *Package diagrams*

java.applet Reference

Introduction to the Reference Chapters

The preceding seventeen chapters cover just about all there is to know about AWT. We have tried to organize them logically, and provide all the information that you would expect in a reference manual—plus much more in the way of examples and practical information about how to do things effectively. However, there are many times when you just need a reference book, pure and simple: one that's organized alphabetically, and where you can find any method if you know the class and package that it belongs to, without having to second guess the author's organizational approach. That's what the rest of this book provides. It's designed to help you if you need to look something up quickly, and find a brief but accurate summary of what it does. In these sections, the emphasis is on *brief*; if you want a longer description, look in the body of the book.

The reference sections describe the following packages:

- `java.applet` (Chapter 18, *java.applet Reference*)
- `java.awt` (Chapter 1, *java.awt Reference*)
- `java.awt.datatransfer` (Chapter 20, *java.awt.datatransfer Reference*)
- `java.awt.event` (Chapter 21, *java.awt.event Reference*)
- `java.awt.image` (Chapter 22, *java.awt.image Reference*)
- `java.awt.peer` (Chapter 23, *java.awt.peer Reference*)

Within each package, classes and interfaces are listed alphabetically. There is a description and a pseudo-code definition for each class or interface. Each variable and method is listed and described. New Java 1.1 classes are marked with a black star (★), as are new methods and new variables. Of course, if a class is new, all its methods are new. We didn't mark individual methods in new classes. Methods that are deprecated in Java 1.1 are marked with a white star (☆).

Inheritance presents a significant problem with documenting object-oriented libraries, because the bulk of a class's methods tend to be hiding in the superclasses. Even if you're very familiar with object-oriented software development, when you're trying to look up a method under the pressure of some deadline, it's easy to forget that you need to look at the superclasses in addition to the class you're interested in itself. Nowhere is this problem worse than in AWT, where some classes (in particular, components and containers) inherit well over 100 methods, and provide few methods of their own. For example, the `Button` class contains seven public methods, none of which happens to be `setFont()`. The font used to display a button's label is certainly settable—but to find it, you have to look in the superclass `Component`.

So far, we haven't found a way around this problem. The description of each class has an abbreviated class hierarchy diagram, showing superclasses (all the way back to Object), immediate subclasses, and the interfaces that the class implements. Ideally, it would be nice to have a list of all the inherited methods—and in other parts of Java, that's possible. For AWT, the lists would be longer than the rest of this book, much too long to be practical, or even genuinely useful. Someday, electronic documentation may be able to solve this problem, but we're not there yet.

Package diagrams

The following figures provide a visual representation of the relationships between the classes in the AWT packages.

`java.awt`, as the mother of all AWT packages, is better represented by two diagrams, one for the graphics classes and one for the component and layout classes.

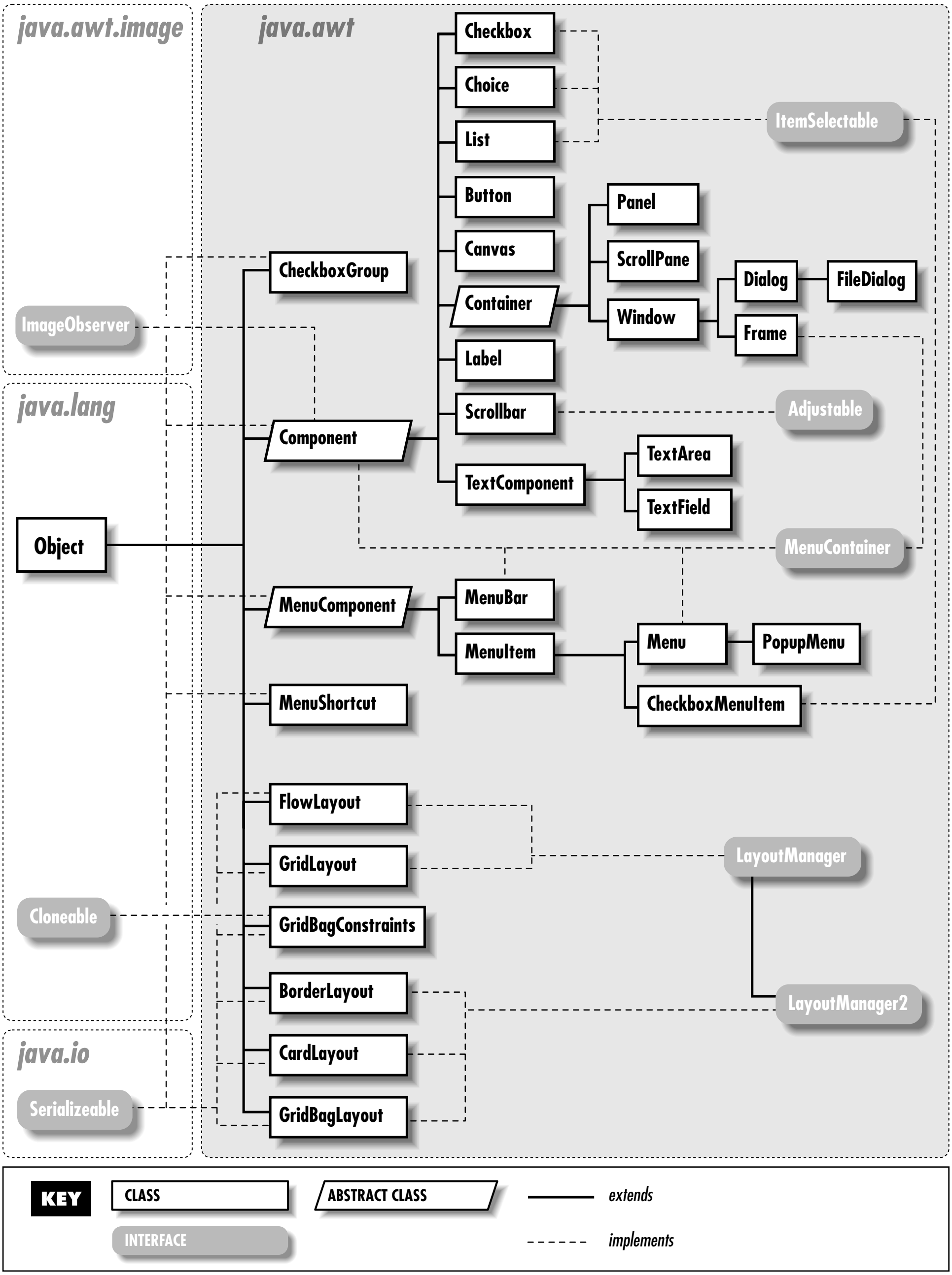


Figure 18–1: Component and Layout classes of the java.awt package.

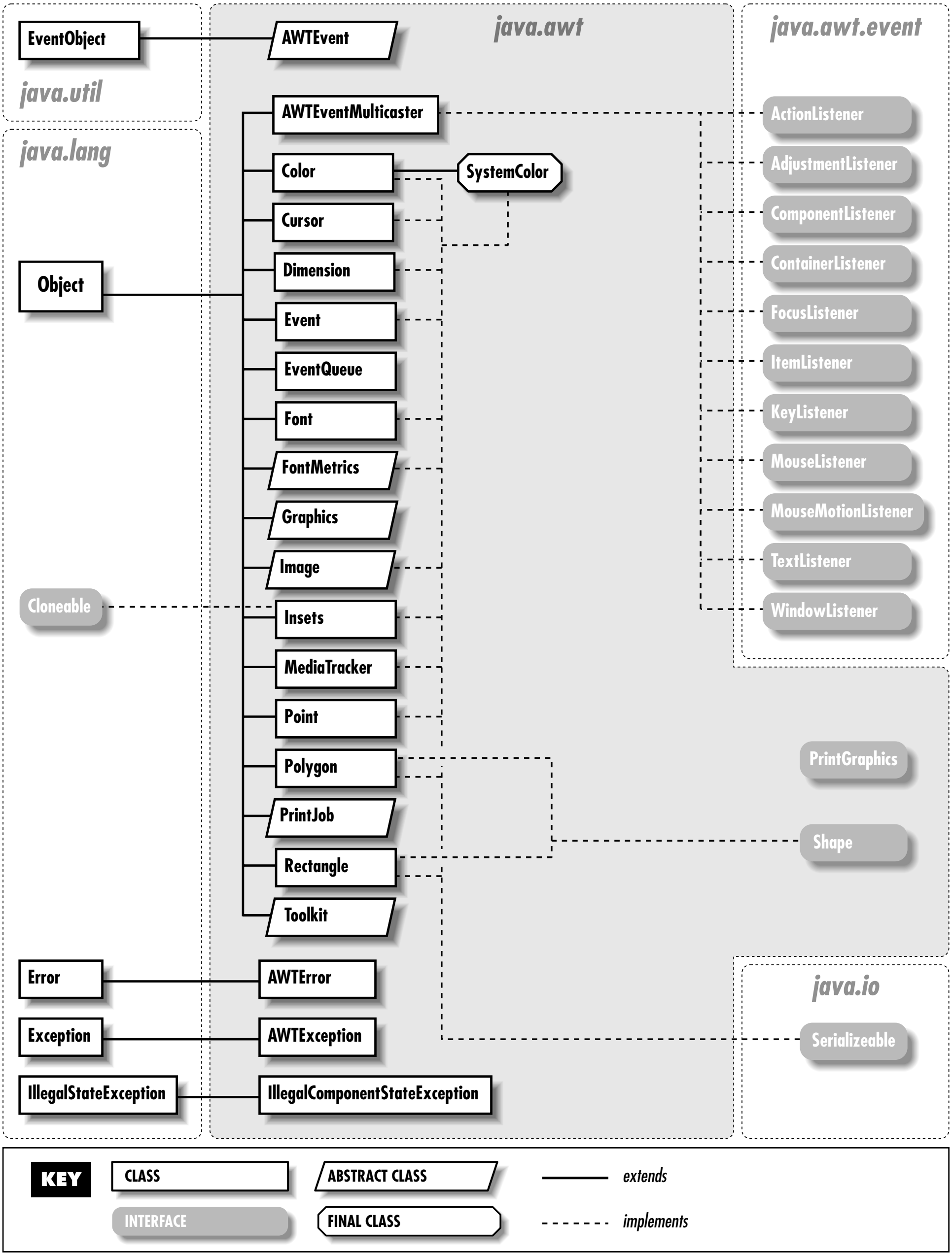


Figure 18–2: Graphics classes of java.awt package

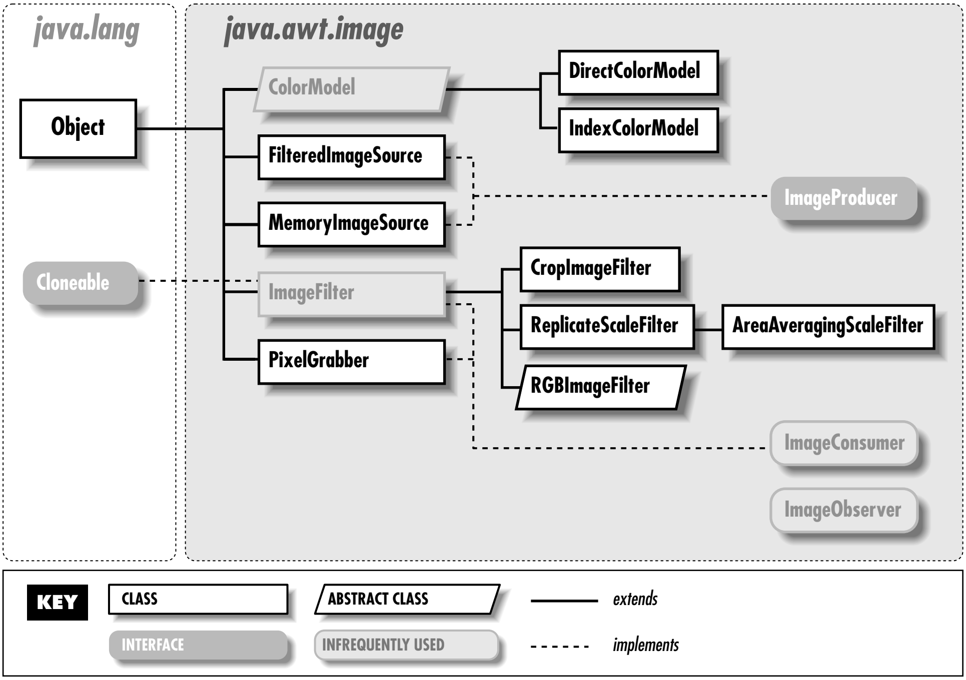


Figure 18–3: The java.awt.image package

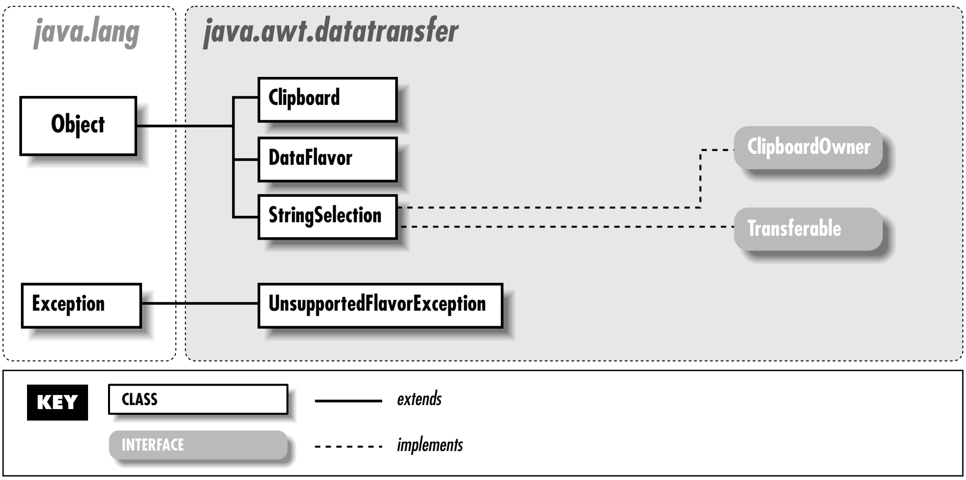


Figure 18–4: The java.awt.datatransfer package

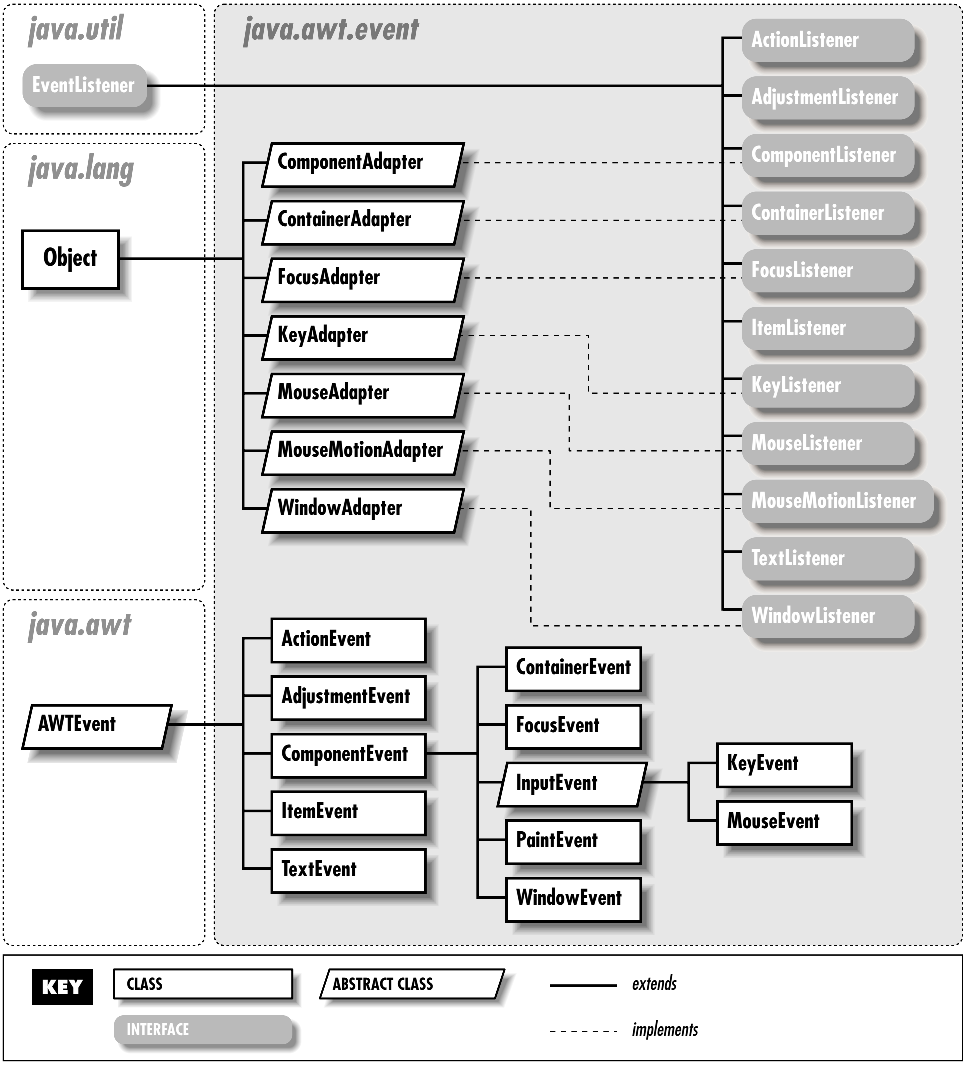


Figure 18–5: The java.awt.event package

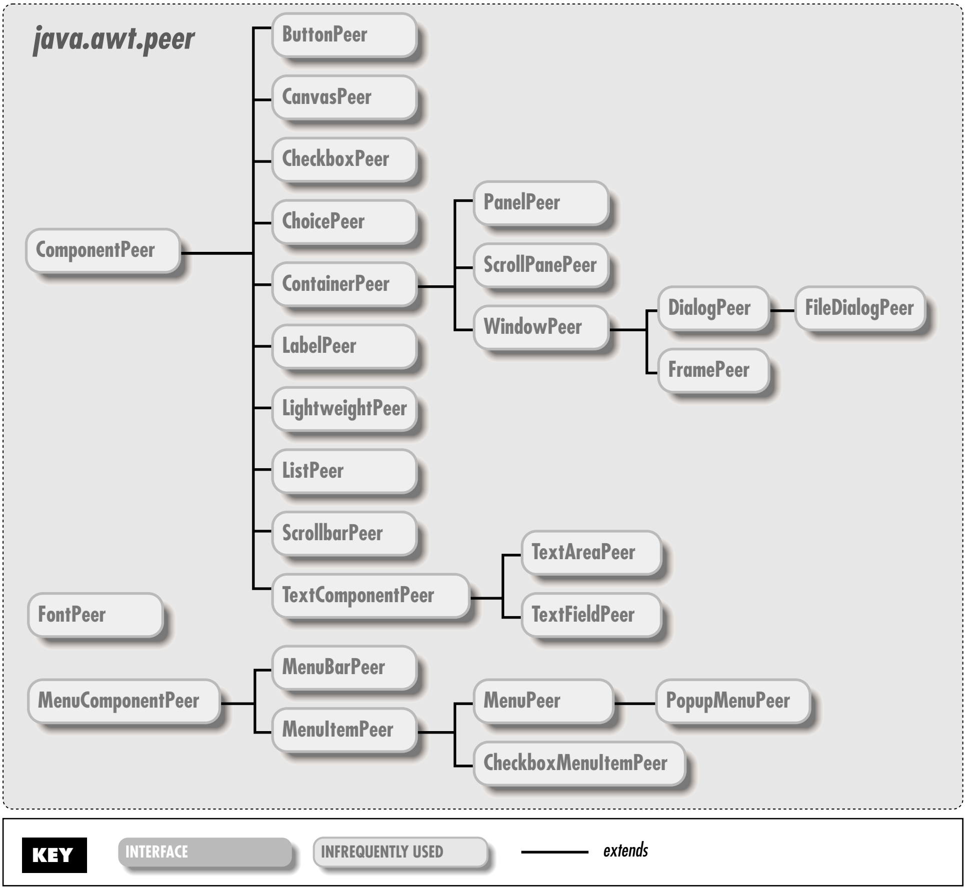


Figure 18–6: The java.awt.peer package

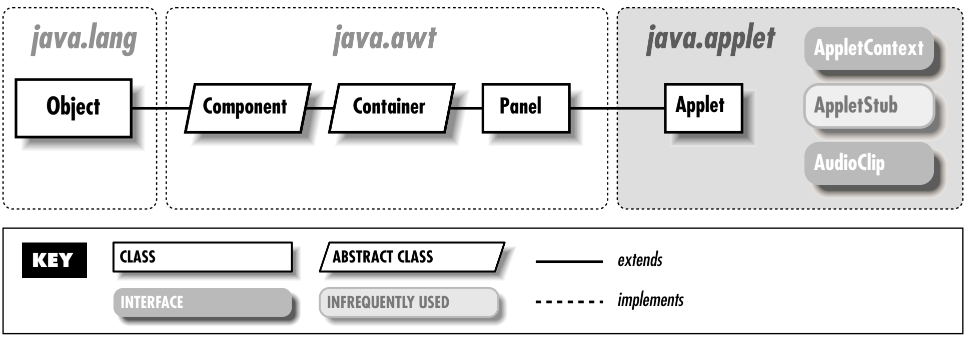
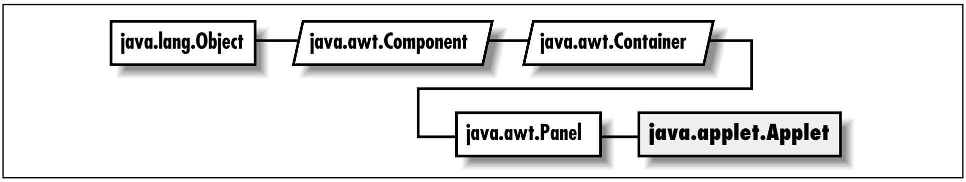


Figure 18–7: The java.applet package

18.1 Applet



Description

The `Applet` class provides the framework for delivering Java programs within web pages.

Class Definition

```
public class java.applet.Applet
    extends java.awt.Panel {
  // Constructors
  public Applet();

  // Instance Methods
  public void destroy();
  public AppletContext getAppletContext();
  public String getAppletInfo();
  public AudioClip getAudioClip (URL url);
  public AudioClip getAudioClip (URL url, String filename);
  public URL getCodeBase();
  public URL getDocumentBase();
  public Image getImage (URL url);
  public Image getImage (URL url, String filename);
  public Locale getLocale(); ★
  public String getParameter (String name);
  public String[][] getParameterInfo();
  public void init();
  public boolean isActive();
  public void play (URL url);
  public void play (URL url, String filename);
  public void resize (int width, int height);
  public void resize (Dimension dim);
  public final void setStub (AppletStub stub);
  public void showStatus (String message);
```

```
  public void start();
  public void stop();
}
```

Constructors

Applet

`public Applet()`

Description Constructs an `Applet` object.

Instance Methods

destroy

`public void destroy()`

Description Called when the browser determines that it doesn't need to keep the applet around anymore.

getAppletContext

`public AppletContext getAppletContext()`

Returns The current `AppletContext` of the applet.

getAppletInfo

`public String getAppletInfo()`

Returns A short information string about the applet to be shown to the user.

getAudioClip

`public AudioClip getAudioClip (URL url)`

Parameters *url* `URL` of an audio file.
Returns Object that implements the `AudioClip` interface for playing audio files.
Description Fetches an audio file to play with the `AudioClip` interface.

`public AudioClip getAudioClip (URL url , String filename)`

Parameters *url* Base `URL` of an audio file.
filename Specific file, relative to `url`, that contains an audio file.
Returns Object that implements `AudioClip` interface for playing audio file.

Description	Fetches an audio file to play with the `AudioClip` interface.

getCodeBase

`public URL getCodeBase()`

Returns	The complete `URL` of the *.class* file that contains the applet.

getDocumentBase

`public URL getDocumentBase()`

Returns	The complete `URL` of the *.html* file that loaded the applet.

getImage

`public Image getImage (URL url)`

Parameters	*url*	`URL` of an image file.
Returns	`Image` to be displayed.	
Description	Initiates the image loading process for the file located at the specified location.	

`public Image getImage (URL url, String filename)`

Parameters	*url*	Base `URL` of an image file.
	filename	Specific file, relative to `url`, that contains an image file.
Returns	Image to be displayed.	
Description	Initiates the image loading process for the file located at the specified location.	

getLocale

`public Locale getLocale()` ★

Returns	`Applet`'s locale.
Overrides	`Component.getLocale()`
Description	Used for internationalization support.

getParameter

`public String getParameter (String name)`

Parameters	*name*	Name of parameter to get.
Returns	The value associated with the given parameter in the HTML file, or `null`.	
Description	Allows you to get parameters from within the `<APPLET>` tag of the *.html* file that loaded the applet.	

getParameterInfo

```
public String[][] getParameterInfo()
```

Returns — Overridden to provide a series of three-string arrays that describes the parameters this applet reads.

init

```
public void init()
```

Description — Called by the system when the applet is first loaded.

isActive

```
public boolean isActive()
```

Returns — `true` if the applet is active, `false` otherwise.

play

```
public void play (URL url)
```

Parameters — *url* — `URL` of an audio file .
Description — Plays an audio file once.

```
public void play (URL url, String filename)
```

Parameters — *url* — Base `URL` of an audio file .
filename — Specific file, relative to `url`, that contains an audio file.
Description — Plays an audio file once.

resize

```
public void resize(int width, int height)
```

Parameters — *width* — New width for the `Applet`.
height — New height for the `Applet`.
Description — Changes the size of the applet.

```
public void resize (Dimension dim)
```

Parameters — *dim* — New dimensions for the applet.
Description — Changes the size of the applet.

setStub

```
public final void setStub (AppletStub stub)
```

Parameters	*stub*	Platform specific stubfor environment.
Description	Called by the system to setup `AppletStub`.	

showStatus

```
public void showStatus (String message)
```

Parameters	*message*	Message to display to user.
Description	Displays a message on the status line of the browser.	

start

```
public void start()
```

Description	Called by the system every time the applet is displayed.

stop

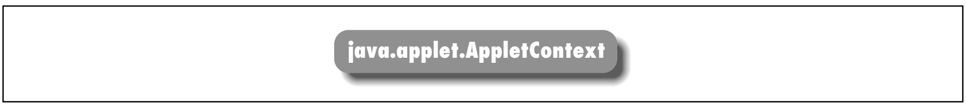
```
public void stop()
```

Description	Called by the system when it wants the applet to stop execution; typically, every time the user leaves the page that includes the applet.

See Also

`AppletContext`, `AppletStub`, `AudioClip`, `Container`, `Dimension`, `Image`, `Locale`, `Panel`, `String`, `URL`

18.2 AppletContext



Description

`AppletContext` is an interface that provides the means to control the browser environment in which the applet is running.

Interface Definition

```
public abstract interface java.applet.AppletContext {

  // Interface Methods
  public abstract Applet getApplet (String name);
```

```
  public abstract Enumeration getApplets();
  public abstract AudioClip getAudioClip (URL url);
  public abstract Image getImage (URL url);
  public abstract void showDocument (URL url);
  public abstract void showDocument (URL url, String frame);
  public abstract void showStatus (String message);
}
```

Interface Methods

getApplet

`public abstract Applet getApplet (String name)`

Parameters	*name*	Name of applet to locate.
Returns	`Applet` fetched.	
Description	Gets a reference to another executing applet.	

getApplets

`public abstract Enumeration getApplets()`

Returns	List of applets executing.
Description	Gets references to all executing applets.

getAudioClip

`public abstract AudioClip getAudioClip (URL url)`

Parameters	*url*	Location of an audio file.
Returns	`AudioClip` fetched.	
Description	Loads an audio file.	

getImage

`public abstract Image getImage (URL url)`

Parameters	*url*	Location of an image file.
Returns	Image fetched.	
Description	Loads an image file.	

showDocument

`public abstract void showDocument (URL url)`

Parameters	*url*	New web page to display.
Description	Changes the displayed web page.	

```
public abstract void showDocument (URL url, String frame)
```

Parameters	*url*	New web page to display.
	frame	Name of the frame in which to display the new page.
Description	Displays a web page in another frame.	

`showStatus`

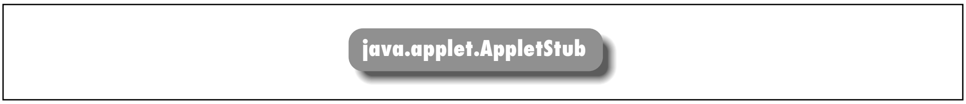
```
public abstract void showStatus (String message)
```

Parameters	*message*	Message to display.
Description	Displays a message on the status line of the browser.	

See Also

`Applet`, `AudioClip`, `Enumeration`, `Image`, `Object`, `String`, `URL`

18.3 AppletStub



Description

`AppletStub` is an interface that provides the means to get information from the run-time browser environment.

Interface Definition

```
public abstract interface java.applet.AppletStub {

  // Interface Methods
  public abstract void appletResize (int width, int height);
  public abstract AppletContext getAppletContext();
  public abstract URL getCodeBase();
  public abstract URL getDocumentBase();
  public abstract String getParameter (String name);
  public abstract boolean isActive();
}
```

Interface Methods

appletResize

```
public abstract void appletResize (int width, int height)
```

Parameters	*width*	Requested new width for applet.
	height	Requested new height for applet.
Description	Changes the size of the applet.	

getAppletContext

```
public abstract AppletContext getAppletContext()
```

Returns Current `AppletContext` of the applet.

getCodeBase

```
public abstract URL getCodeBase()
```

Returns Complete `URL` for the applet's *.class* file.

getDocumentBase

```
public abstract URL getDocumentBase()
```

Returns Complete `URL` for the applet's *.html* file.

getParameter

```
public abstract String getParameter (String name)
```

Parameters	*name*	Name of a `<PARAM>` tag.
Returns	Value associated with the parameter.	
Description	Gets a parameter value from the `<PARAM>` tag(s) of the applet.	

isActive

```
public abstract boolean isActive()
```

Returns	`true` if the applet is active, `false` otherwise
Description	Returns current state of the applet.

See Also

`AppletContext`, `Object`, `String`, `URL`

18.4 AudioClip

java.applet.AudioClip

Description

`AudioClip` is an interface for playing audio files.

Interface Definition

```
public abstract interface java.applet.AudioClip {

  // Interface Methods
  public abstract void loop();
  public abstract void play();
  public abstract void stop();
}
```

Interface Methods

loop

`public abstract void loop()`

Description	Plays an audio clip continuously.

play

`public abstract void play()`

Description	Plays an audio clip once from the beginning.

stop

`public abstract void stop()`

Description	Stops playing an audio clip.

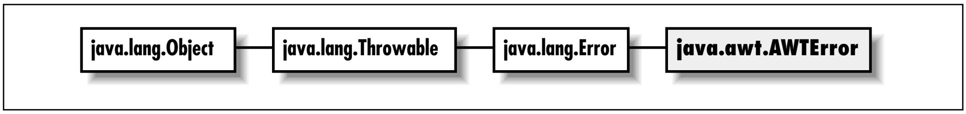
See Also

`Object`

19

java.awt Reference

19.1 AWTError



Description

An `AWTError`; thrown to indicate a serious runtime error.

Class Definition

```
public class java.awt.AWTError
    extends java.lang.Error {

  // Constructors
  public AWTError (String message);
}
```

Constructors

AWTError

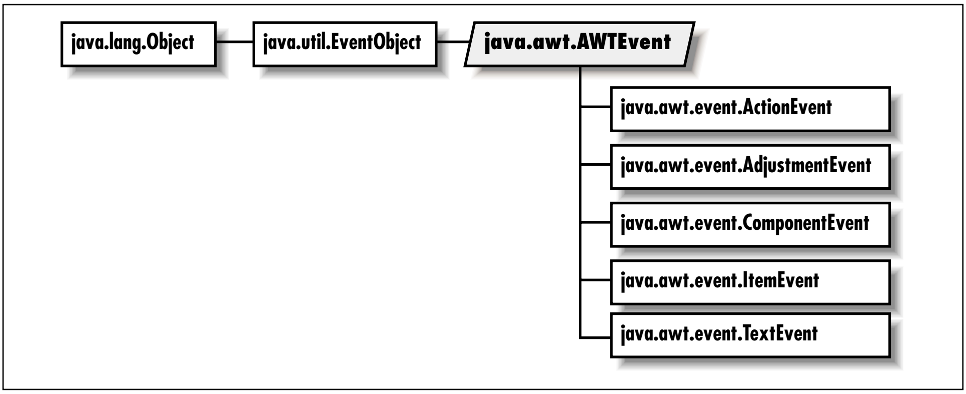
```
public AWTError (String message)
```

Parameters *message* Detail message

See Also

`Error`, `String`

19.2 AWTEvent ★



Description

The root class of all AWT events. Subclasses of this class are the replacement for `java.awt.Event`, which is only used for the Java 1.0.2 event model. In Java 1.1, event objects are passed from event source components to objects implementing a corresponding listener interface. Some event sources have a corresponding interface, too. For example, `AdjustmentEvents` are passed from `Adjustable` objects to `AdjustmentListeners`. Some event types do not have corresponding interfaces; for example, `ActionEvents` are passed from `Buttons` to `ActionListeners`, but there is no "Actionable" interface that `Button` implements.

Class Definition

```
public abstract class java.awt.AWTEvent
    extends java.util.EventObject {

  // Constants
  public final static long ACTION_EVENT_MASK;
  public final static long ADJUSTMENT_EVENT_MASK;
  public final static long COMPONENT_EVENT_MASK;
```

```
  public final static long CONTAINER_EVENT_MASK;
  public final static long FOCUS_EVENT_MASK;
  public final static long ITEM_EVENT_MASK;
  public final static long KEY_EVENT_MASK;
  public final static long MOUSE_EVENT_MASK;
  public final static long MOUSE_MOTION_EVENT_MASK;
  public final static long RESERVED_ID_MAX;
  public final static long TEXT_EVENT_MASK;
  public final static long WINDOW_EVENT_MASK;

  // Variables
  protected boolean consumed;
  protected int id;

  // Constructors
  public AWTEvent (Event event);
  public AWTEvent (Object source, int id);

  // Instance Methods
  public int getID();
  public String paramString();
  public String toString();

  // Protected Instance Methods
  protected void consume();
  protected boolean isConsumed();
}
```

Constants

ACTION_EVENT_MASK

`public static final long ACTION_EVENT_MASK`

The mask for action events.

ADJUSTMENT_EVENT_MASK

`public static final long ADJUSTMENT_EVENT_MASK`

The mask for adjustment events.

COMPONENT_EVENT_MASK

`public static final long COMPONENT_EVENT_MASK`

The mask for component events.

CONTAINER_EVENT_MASK

`public static final long CONTAINER_EVENT_MASK`

The mask for container events.

FOCUS_EVENT_MASK

`public static final long FOCUS_EVENT_MASK`

The mask for focus events.

ITEM_EVENT_MASK

`public static final long ITEM_EVENT_MASK`

The mask for item events.

KEY_EVENT_MASK

`public static final long KEY_EVENT_MASK`

The mask for key events.

MOUSE_EVENT_MASK

`public static final long MOUSE_EVENT_MASK`

The mask for mouse events.

MOUSE_MOTION_EVENT_MASK

`public static final long MOUSE_MOTION_EVENT_MASK`

The mask for mouse motion events.

RESERVED_ID_MAX

`public static final int`

The maximum reserved event id.

TEXT_EVENT_MASK

`public static final long TEXT_EVENT_MASK`

The mask for text events.

WINDOW_EVENT_MASK

`public static final long WINDOW_EVENT_MASK`

The mask for window events.

Variables

consumed

```
protected boolean consumed
```

If `consumed` is `true`, the event will not be sent back to the peer. Semantic events will never be sent back to a peer; thus `consumed` is always `true` for semantic events.

id

```
protected int id
```

The type ID of this event.

Constructors

AWTEvent

```
public AWTEvent (Event event)
```

Parameters	*event*	A version 1.0.2 `java.awt.Event` object.
Description	Constructs a 1.1 `java.awt.AWTEvent` derived from a 1.0.2 `java.awt.Event` object.	

```
public AWTEvent (Object source, int id)
```

Parameters	*source*	The object that the event originated from.
	id	An event type ID.
Description	Constructs an `AWTEvent` object.	

Instance Methods

getID

```
public int getID()
```

Returns	The type ID of the event.

paramString

```
public String paramString()
```

Returns	A string with the current settings of `AWTEvent`.
Description	Helper method for `toString()` that generates a string of current settings.

toString

```
public String toString()
```

Returns A string representation of the `AWTEvent` object.
Overrides `Object.toString()`

Protected Instance Methods

consume

```
protected void consume()
```

Description Consumes the event so it is not sent back to its source.

isConsumed

```
public boolean isConsumed()
```

Returns A flag indicating whether this event has been consumed.

See Also

`ActionEvent`, `AdjustmentEvent`, `ComponentEvent`, `Event`, `EventObject`, `FocusEvent`, `ItemEvent`, `KeyEvent`, `MouseEvent`, `WindowEvent`

19.3 AWTEventMulticaster ★

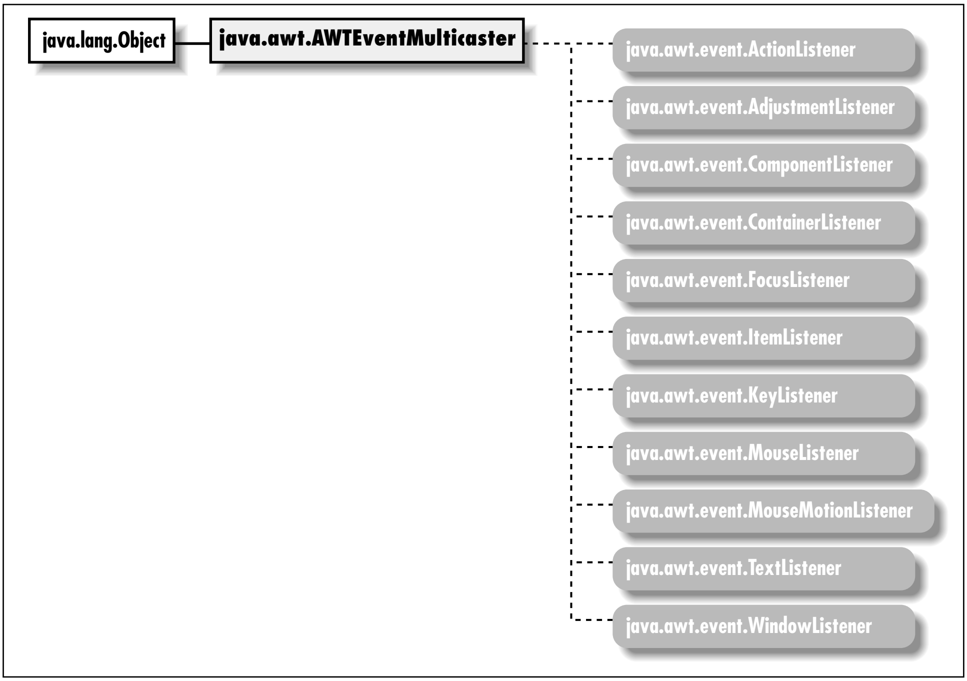
Description

This class multicasts events to event listeners. Each multicaster has two listeners, cunningly named `a` and `b`. When an event source calls one of the listener methods of the multicaster, the multicaster calls the same listener method on both `a` and `b`. Multicasters are built into trees using the static `add()` and `remove()` methods. In this way a single event can be sent to many listeners.

Static methods make it easy to implement event multicasting in component subclasses. Each time an `add<type>Listener()` function is called in the component subclass, call the corresponding `AWTEventMulticaster.add()` method to chain together (or "tree up") listeners. Similarly, when a `remove<type>Listener()` function is called, `AWTEventMulticaster.remove()` can be called to remove a chained listener.

Class Definition

```
public class java.awt.AWTEventMulticaster
  extends java.lang.Object
  implements java.awt.event.ActionListener, java.awt.event.AdjustmentListener,
             java.awt.event.ComponentListener, java.awt.event.ContainerListener,
             java.awt.event.FocusListener, java.awt.event.ItemListener,
             java.awt.event.KeyListener, java.awt.event.MouseListener,
```




```
            java.awt.event.MouseMotionListener, java.awt.event.TextListener,
            java.awt.event.WindowListener {

    // Variables
    protected EventListener a;
    protected EventListener b;

    // Constructors
    protected AWTEventMulticaster(EventListener a, EventListener b);

    // Class Methods
    public static ActionListener add(ActionListener a, ActionListener b);
    public static AdjustmentListener add(AdjustmentListener a,
        AdjustmentListener b);
    public static ComponentListener add(ComponentListener a,
        ComponentListener b);
    public static ContainerListener add(ContainerListener a,
        ContainerListener b);
    public static FocusListener add(FocusListener a, FocusListener b);
    public static ItemListener add(ItemListener a, ItemListener b);
    public static KeyListener add(KeyListener a, KeyListener b);
    public static MouseListener add(MouseListener a, MouseListener b);
    public static MouseMotionListener add(MouseMotionListener a,
        MouseMotionListener b);
```

```
public static TextListener add(TextListener a, TextListener b);
public static WindowListener add(WindowListener a, WindowListener b);
protected static EventListener addInternal(EventListener a, EventListener b);
public static ActionListener remove(ActionListener l, ActionListener oldl);
public static AdjustmentListener remove(AdjustmentListener l,
    AdjustmentListener oldl);
public static ComponentListener remove(ComponentListener l,
    ComponentListener oldl);
public static ContainerListener remove(ContainerListener l,
    ContainerListener oldl);
public static FocusListener remove(FocusListener l, FocusListener oldl);
public static ItemListener remove(ItemListener l, ItemListener oldl);
public static KeyListener remove(KeyListener l, KeyListener oldl);
public static MouseListener remove(MouseListener l, MouseListener oldl);
public static MouseMotionListener remove(MouseMotionListener l,
    MouseMotionListener oldl);
public static TextListener remove(TextListener l, TextListener oldl);
public static WindowListener remove(WindowListener l, WindowListener;
protected static EventListener removeInternal(EventListener l,
    EventListener oldl);

// Instance Methods
public void actionPerformed(ActionEvent e);
public void adjustmentValueChanged(AdjustmentEvent e);
public void componentAdded(ContainerEvent e);
public void componentHidden(ComponentEvent e);
public void componentMoved(ComponentEvent e);
public void componentRemoved(ContainerEvent e);
public void componentResized(ComponentEvent e);
public void componentShown(ComponentEvent e);
public void focusGained(FocusEvent e);
public void focusLost(FocusEvent e);
public void itemStateChanged(ItemEvent e);
public void keyPressed(KeyEvent e);
public void keyReleased(KeyEvent e);
public void keyTyped(KeyEvent e);
public void mouseClicked(MouseEvent e);
public void mouseDragged(MouseEvent e);
public void mouseEntered(MouseEvent e);
public void mouseExited(MouseEvent e);
public void mouseMoved(MouseEvent e);
public void mousePressed(MouseEvent e);
public void mouseReleased(MouseEvent e);
public void textValueChanged(TextEvent e);
public void windowActivated(WindowEvent e);
public void windowClosed(WindowEvent e);
public void windowClosing(WindowEvent e);
public void windowDeactivated(WindowEvent e);
public void windowDeiconified(WindowEvent e);
```

```
    public void windowIconified(WindowEvent e);
    public void windowOpened(WindowEvent e);
    // Protected Instance Methods
    protected EventListener remove(EventListener oldl);
    protected void saveInternal(ObjectOutputStream s, String k) throws IOException;
}
```

Variables

a

`protected EventListener a`

One of the `EventListeners` this `AWTEventMulticaster` sends events to.

b

`protected EventListener b`

One of the `EventListeners` this `AWTEventMulticaster` sends events to.

Constructors

AWTEventMulticaster

`protected AWTEventMulticaster (EventListener a, EventListener b)`

Parameters	*a*	A listener that receives events.
	b	A listener that receives events.
Description	Constructs an `AWTEventMulticaster` that sends events it receives to the supplied listeners. The constructor is protected because it is only the class methods of `AWTEventMulticaster` that ever instantiate this class.	

Class Methods

add

`public static ActionListener add (ActionListener a, ActionListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to `a` and `b`.	

`public static AdjustmentListener add (AdjustmentListener a, AdjustmentListener b)`

Parameters	*a*	An event listener.

	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static ComponentListener add (ComponentListener a, ComponentListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static ContainerListener add (ContainerListener a, ContainerListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static FocusListener add (FocusListener a, FocusListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static ItemListener add (ItemListener a, ItemListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static KeyListener add (KeyListener a, KeyListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static MouseListener add (MouseListener a, MouseListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to a and b.	

`public static MouseMotionListener add (MouseMotionListener a, MouseMotionListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to `a` and `b`.	

`public static TextListener add (TextListener a, TextListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to `a` and `b`.	

`public static WindowListener add (WindowListener a, WindowListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to `a` and `b`.	

addInternal

`public static EventListener addInternal (EventListener a, EventListener b)`

Parameters	*a*	An event listener.
	b	An event listener.
Returns	A listener object that passes events to `a` and `b`.	
Description	This method is a helper for the `add()` methods.	

remove

`public static ActionListener remove (ActionListener l, ActionListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static AdjustmentListener remove (AdjustmentListener l, AdjustmentListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static ComponentListener remove (ComponentListener l, ComponentListener oldl)`

Parameters	*l*	An event listener.

	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static ContainerListener remove (ContainerListener l, ContainerListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static FocusListener remove (FocusListener l, FocusListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static ItemListener remove (ItemListener l, ItemListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static KeyListener remove (KeyListener l, KeyListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static MouseListener remove (MouseListener l, MouseListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static MouseMotionListener remove (MouseMotionListener l, MouseMotionListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

`public static TextListener remove (TextListener l, TextListener oldl)`

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

```
public static WindowListener remove (WindowListener l,
WindowListener oldl)
```

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

```
public static WindowListener remove (WindowListener l,
WindowListener oldl)
```

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	

removeInternal

```
public static EventListener removeInternal (EventListener
l, EventListener oldl)
```

Parameters	*l*	An event listener.
	oldl	An event listener.
Returns	A listener object that multicasts to `l` but not `oldl`.	
Description	This method is a helper for the `remove()` methods.	

Instance Methods

actionPerformed

```
public void actionPerformed (ActionEvent e)
```

Parameters	*e*	The action event that occurred.
Description	Handles the event by passing it on to listeners `a` and `b`.	

adjustmentValueChanged

```
public void adjustmentValueChanged (AdjustmentEvent e)
```

Parameters	*e*	The adjustment event that occurred.
Description	Handles the event by passing it on to listeners `a` and `b`.	

componentAdded

`public void componentAdded (ContainerEvent e)`

Parameters *e* The container event that occurred.
Description Handles the event by passing it on to listeners a and b.

componentHidden

`public void componentHidden (ComponentEvent e)`

Parameters *e* The component event that occurred.
Description Handles the event by passing it on to listeners a and b.

componentMoved

`public void componentMoved (ComponentEvent e)`

Parameters *e* The component event that occurred.
Description Handles the event by passing it on to listeners a and b.

componentRemoved

`public void componentRemoved (ContainerEvent e)`

Parameters *e* The container event that occurred.
Description Handles the event by passing it on to listeners a and b.

componentResized

`public void componentResized (ComponentEvent e)`

Parameters *e* The component event that occurred.
Description Handles the event by passing it on to listeners a and b.

componentShown

`public void componentShown (ComponentEvent e)`

Parameters *e* The component event that occurred.
Description Handles the event by passing it on to listeners a and b.

focusGained

`public void focusGained (FocusEvent e)`

Parameters *e* The focus event that occurred.
Description Handles the event by passing it on to listeners a and b.

focusLost

`public void focusLost (FocusEvent e)`

Parameters *e* The focus event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

itemStateChanged

`public void itemStateChanged (ItemEvent e)`

Parameters *e* The item event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

keyPressed

`public void keyPressed (KeyEvent e)`

Parameters *e* The key event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

keyReleased

`public void keyReleased (KeyEvent e)`

Parameters *e* The key event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

keyTyped

`public void keyTyped (KeyEvent e)`

Parameters *e* The key event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseClicked

`public void mouseClicked (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseDragged

`public void mouseDragged (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseEntered

`public void mouseEntered (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseExited

`public void mouseExited (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseMoved

`public void mouseMoved (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mousePressed

`public void mousePressed (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

mouseReleased

`public void mouseReleased (MouseEvent e)`

Parameters *e* The mouse event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

textValueChanged

`public void textValueChanged (TextEvent e)`

Parameters *e* The text event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowActivated

`public void windowActivated (WindowEvent e)`

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowClosed

```
public void windowClosed (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowClosing

```
public void windowClosing (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowDeactivated

```
public void windowDeactivated (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowDeiconified

```
public void windowDeiconified (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowIconified

```
public void windowIconified (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

windowOpened

```
public void windowOpened (WindowEvent e)
```

Parameters *e* The window event that occurred.
Description Handles the event by passing it on to listeners `a` and `b`.

Protected Instance Methods

remove

```
protected EventListener remove(EventListener oldl)
```

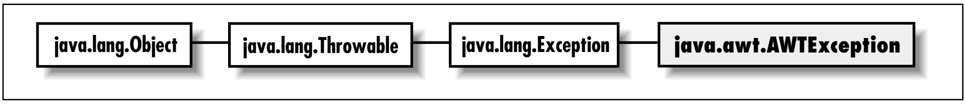
Parameters *oldl* The listener to remove.
Returns The resulting `EventListener`.

Description This method removes `oldl` from the `AWTEventMulticaster` and returns the resulting listener.

See Also

`ActionEvent`, `AdjustmentEvent`, `ComponentEvent`, `Event`, `EventListener`, `EventObject`, `FocusEvent`, `ItemEvent`, `KeyEvent`, `MouseEvent`, `Window-Event`

19.4 AWTException



Description

An `AWTException`; thrown to indicate an exceptional condition; must be caught or declared in a `throws` clause.

Class Definition

```
public class java.awt.AWTException
    extends java.lang.Exception {

  // Constructors
  public AWTException (String message);
}
```

Constructors

AWTException

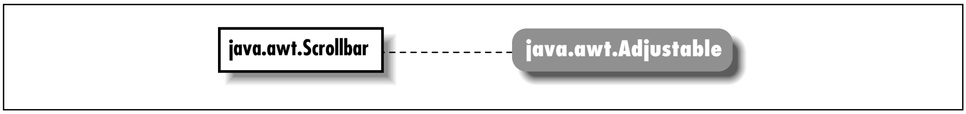
`public AWTException (String message)`

Parameters *message* Detailed message.

See Also

`Exception`, `String`

19.5 Adjustable ★



Description

The `Adjustable` interface is useful for scrollbars, sliders, dials, and other components that have an adjustable numeric value. Classes that implement the `Adjustable` interface should send `AdjustmentEvent` objects to listeners that have registered via `addAdjustmentListener(AdjustmentListener)`.

Interface Definition

```
public abstract interface java.awt.Adjustable {

  // Constants
  public final static int HORIZONTAL = 0;
  public final static int VERTICAL = 1;

  // Interface Methods
  public abstract void addAdjustmentListener (AdjustmentListener l);
  public abstract int getBlockIncrement();
  public abstract int getMaximum();
  public abstract int getMinimum();
  public abstract int getOrientation();
  public abstract int getUnitIncrement();
  public abstract int getValue();
  public abstract int getVisibleAmount();
  public abstract void removeAdjustmentListener (AdjustmentListener l);
  public abstract void setBlockIncrement (int b);
  public abstract void setMaximum (int max);
  public abstract void setMinimum (int min);
  public abstract void setUnitIncrement (int u);
  public abstract void setValue (int v);
  public abstract void setVisibleAmount (int v);
}
```

Constants

HORIZONTAL

```
public static final int HORIZONTAL
```

A constant representing horizontal orientation.

VERTICAL

```
public static final int VERTICAL
```

A constant representing vertical orientation.

Interface Methods

addAdjustmentListener

```
public abstract void addAdjustmentListener (ActionListener
l)
```

Parameters	*l*	An object that implements the `AdjustmentListener` interface.
Description	Add a listener for adjustment event.	

getBlockIncrement

```
public abstract int getBlockIncrement()
```

Returns The amount to scroll when a paging area is selected.

getMaximum

```
public abstract int getMaximum()
```

Returns The maximum value that the `Adjustable` object can take.

getMinimum

```
public abstract int getMinimum()
```

Returns The minimum value that the `Adjustable` object can take.

getOrientation

```
public abstract int getOrientation()
```

Returns A value representing the direction of the `Adjustable` object.

getUnitIncrement

```
public abstract int getUnitIncrement()
```

Returns The unit amount to scroll.

getValue

```
public abstract int getValue()
```

Returns The current setting for the `Adjustable` object.

getVisibleAmount

```
public abstract int getVisibleAmount()
```

Returns The current visible setting (i.e., size) for the `Adjustable` object.

removeAdjustmentListener

```
public abstract void removeAdjustmentListener
(AdjustmentListener l)
```

Parameters *l* One of the object's `AdjustmentListeners`.
Description Remove an adjustment event listener.

setBlockIncrement

```
public abstract void setBlockIncrement (int b)
```

Parameters *b* New block increment amount.
Description Changes the block increment amount for the `Adjustable` object.

setMaximum

```
public abstract void setMaximum (int max)
```

Parameters *max* New maximum value.
Description Changes the maximum value for the `Adjustable` object.

setMinimum

```
public abstract void setMinimum (int min)
```

Parameters *min* New minimum value.
Description Changes the minimum value for the `Adjustable` object.

setUnitIncrement

```
public abstract void setUnitIncrement (int u)
```

Parameters *u* New unit increment amount.
Description Changes the unit increment amount for the `Adjustable` object.

setValue

```
public abstract void setValue (int v)
```

Parameters *v* New value.
Description Changes the current value of the `Adjustable` object.

setVisibleAmount

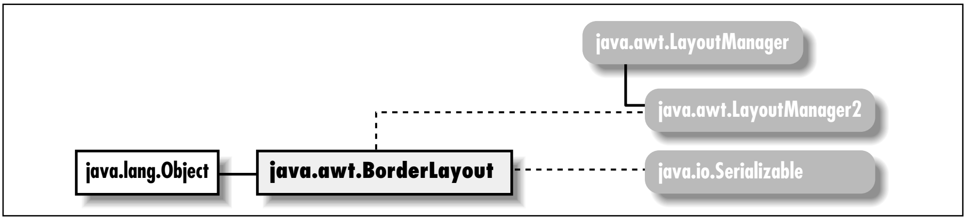
```
public abstract void setVisibleAmount (int v)
```

Parameters *v* New amount visible.
Description Changes the current visible amount of the `Adjustable` object.

See Also

`AdjustmentEvent`, `AdjustmentListener`, `Scrollbar`

19.6 BorderLayout



Description

`BorderLayout` is a `LayoutManager` that provides the means to lay out components along the edges of a container. It divides the container into five regions, named North, East, South, West, and Center. Normally you won't call the `LayoutManager`'s methods yourself. When you `add()` a `Component` to a `Container`, the `Container` calls the `addLayoutComponent()` method of its `LayoutManager`.

Class Definition

```
public class java.awt.BorderLayout
    extends java.lang.Object
    implements java.awt.LayoutManager2, java.io.Serializable {

  // Constants
  public final static String CENTER; ★
  public final static String EAST; ★
  public final static String NORTH; ★
  public final static String SOUTH; ★
  public final static String WEST; ★
```

```
  // Constructors
  public BorderLayout();
  public BorderLayout (int hgap, int vgap);

  // Instance Methods
  public void addLayoutComponent (Component comp, Object constraints); ★
  public void addLayoutComponent (String name, Component component); ☆
  public int getHgap(); ★
  public abstract float getLayoutAlignmentX(Container target); ★
  public abstract float getLayoutAlignmentY(Container target); ★
  public int getVgap(); ★
  public abstract void invalidateLayout(Container target); ★

  public void layoutContainer (Container target);
  public abstract Dimension maximumLayoutSize(Container target); ★
  public Dimension minimumLayoutSize (Container target);
  public Dimension preferredLayoutSize (Container target);
  public void removeLayoutComponent (Component component);
  public void setHgap (int hgap); ★
  public void setVgap (int vgap); ★
  public String toString();
}
```

Constants

CENTER

`public final static String CENTER`

A constant representing center orientation.

EAST

`public final static String EAST`

A constant representing east orientation.

NORTH

`public final static String NORTH`

A constant representing north orientation.

SOUTH

`public final static String SOUTH`

A constant representing south orientation.

WEST

`public final static String WEST`

A constant representing west orientation.

Constructors

BorderLayout

`public BorderLayout()`

Description Constructs a `BorderLayout` object.

`public BorderLayout (int hgap, int vgap)`

Parameters	*hgap*	Horizontal space between each component in the container.
	vgap	Vertical space between each component in the container.
Description	Constructs a `BorderLayout` object with the values specified as the gaps between each component in the container managed by this instance of `BorderLayout`.	

Instance Methods

addLayoutComponent

`public void addLayoutComponent (Component comp, Object constraints)` ★

Parameters	*comp*	The component being added.
	constraints	An object describing the constraints on this component.
Implements	`LayoutManager2.addLayoutComponent()`	
Description	Adds the component `comp` to a container subject to the given `constraints`. This is a more general version of `addLayoutComponent(String, Component)` method. It corresponds to `java.awt.Container`'s `add(Component, Object)` method. In practice, it is used the same in version 1.1 as in Java 1.0.2, except with the parameters swapped:	

```
Panel p = new Panel(new BorderLayout());
p.add(new Button("OK"), BorderLayout.SOUTH);
```

addLayoutComponent

`public void addLayoutComponent (String name, Component component)` ☆

Parameters	*name*	Name of region to add component to.
	component	Actual component being added.
Implements	`LayoutManager.addLayoutComponent()`	
Description	Adds a component to a container in region `name`. This has been replaced in version 1.1 with the more general `addLayoutComponent(Component, Object)`.	

getHgap

`public int getHgap()` ★

Returns The horizontal gap for this `BorderLayout` instance.

getLayoutAlignmentX

`public abstract float getLayoutAlignmentX (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is left aligned, .5 is centered, and 1 is right aligned.	

getLayoutAlignmentY

`public abstract float getLayoutAlignmentY (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is top aligned, .5 is centered, and 1 is bottom aligned.	

getVgap

`public int getVgap()` ★

Returns The vertical gap for this `BorderLayout` instance.

invalidateLayout

`public abstract void invalidateLayout (Container target)` ★

Parameters	*target*	The container to invalidate.
Description	Does nothing.	

layoutContainer

`public void layoutContainer (Container target)`

Parameters	*target*	The container that needs to be redrawn.
Implements	`LayoutManager.layoutContainer()`	
Description	Draws components contained within `target`.	

maximumLayoutSize

`public abstract Dimension maximumLayoutSize (Container target)` ★

Parameters	*target*	The container to inspect.
	Returns	A `Dimension` whose horizontal and vertical components are `Integer.MAX_VALUE`.
Description	For `BorderLayout`, a maximal `Dimension` is always returned.	

minimumLayoutSize

`public Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of the container `target`.	
Implements	`LayoutManager.minimumLayoutSize()`	
Description	Calculates minimum size of `target`. container.	

preferredLayoutSize

`public Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of the container `target`.	
Implements	`LayoutManager.preferredLayoutSize()`	
Description	Calculates preferred size of `target` container.	

removeLayoutComponent

`public void removeLayoutComponent (Component component)`

Parameters	*component*	Component to stop tracking.
Implements	`LayoutManager.removeLayoutComponent()`	
Description	Removes `component` from any internal tracking systems.	

`setHgap`

`public void setHgap (int hgap)` ★

Parameters	*hgap*	The horizontal gap value.
Description	Sets the horizontal gap between components.	

`setVgap`

`public void setVgap (int vgap)` ★

Parameters	*vgap*	The vertical gap value.
Description	Sets the vertical gap between components.	

`toString`

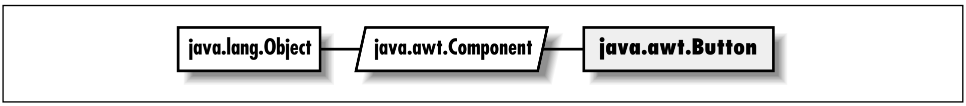
`public String toString()`

Returns	A string representation of the `BorderLayout` object.
Overrides	`Object.toString()`

See Also

`Component`, `Container`, `Dimension`, `LayoutManager`, `LayoutManager2`, `Object`, `String`

19.7 Button



Description

The `Button` is the familiar labeled button object. It inherits most of its functionality from `Component`. For example, to change the font of the `Button`, you would use `Component`'s `setFont()` method. The `Button` sends `java.awt.event.ActionEvent` objects to its listeners when it is pressed.

Class Definition

```
public class java.awt.Button
    extends java.awt.Component {

  // Constructors
  public Button();
  public Button (String label);

  // Instance Methods
  public void addActionListener (ActionListener l); ★
  public void addNotify();
  public String getActionCommand(); ★
  public String getLabel();
  public void removeActionListener (ActionListener l); ★
  public void setActionCommand (String command); ★
  public synchronized void setLabel (String label);

  // Protected Instance Methods
  protected String paramString();
  protected void processActionEvent (ActionEvent e); ★
  protected void processEvent (AWTEvent e); ★
}
```

Constructors

Button

`public Button()`

Description Constructs a `Button` object with no label.

`public Button (String label)`

Parameters *label* The text for the label on the button

Description Constructs a `Button` object with text of `label`.

Instance Methods

addActionListener

`public void addActionListener (ActionListener l)` ★

Parameters *l* An object that implements the `ActionListener` interface.

Description Add a listener for the action event.

addNotify

`public void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `Button`'s peer.

getActionCommand

`public String getActionCommand()` ★

Returns	Current action command string.
Description	Returns the string used for the action command.

getLabel

`public String getLabel()`

Returns	Text of the `Button`'s label.

removeActionListener

`public void removeActionListener (ActionListener l)` ★

Parameters	*l*	One of this `Button`'s `ActionListeners`.
Description	Remove an action event listener.	

setActionCommand

`public void setActionCommand (String command)` ★

Parameters	*command*	New action command string.
Description	Specify the string used for the action command.	

setLabel

`public synchronized void setLabel (String label)`

Parameters	*label*	New text for label of `Button`.
Description	Changes the `Button`'s label to `label`.	

Protected Instance Methods

paramString

`protected String paramString()`

Returns	String with current settings of `Button`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` used to generate a string of current settings.

processActionEvent

`protected void processActionEvent (ActionEvent e) ★`

Parameters	*e*	The action event to process.
Description	Action events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

processEvent

`protected void processEvent (AWTEvent e) ★`

Parameters	*e*	The event to process.
Description	Low level `AWTEvents` are passed to this method for processing.	

See Also

`ActionListener`, `Component`, `String`

19.8 Canvas

Description

`Canvas` is a `Component` that provides a drawing area and is often used as a base class for new components.

Class Definition

```
public class java.awt.Canvas
    extends java.awt.Component {

  // Constructors
  public Canvas();

  // Instance Methods
  public void addNotify();
  public void paint (Graphics g);
}
```

Constructors

Canvas

`public Canvas()`

Description	Constructs a `Canvas` object.

Instance Methods

addNotify

`public void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `Canvas`'s peer.

paint

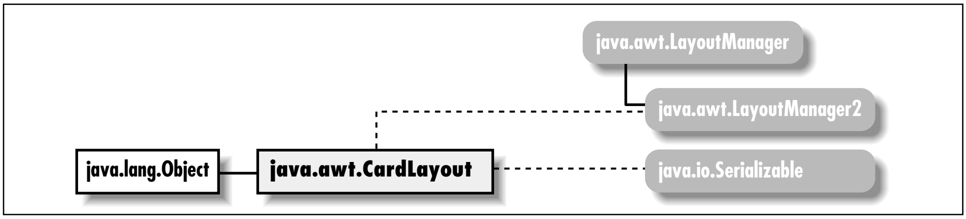
`public void paint (Graphics g)`

Parameters	*g*	Graphics context of component.
Description	Empty method to be overridden in order to draw something in graphics context.	

See Also

`Component`, `Graphics`

19.9 CardLayout



Description

The `CardLayout LayoutManager` provides the means to manage multiple components, displaying one at a time. Components are displayed in the order in which they are added to the layout, or in an arbitrary order by using an assignable name.

Class Definition

```
public class java.awt.CardLayout
    extends java.lang.Object
    implements java.awt.LayoutManager2, java.io.Serializable {

  // Constructors
  public CardLayout();
  public CardLayout (int hgap, int vgap);

  // Instance Methods
  public void addLayoutComponent (Component comp,
      Object constraints); ★
  public void addLayoutComponent (String name, Component component); ☆
  public void first (Container parent);
  public int getHgap(); ★
  public abstract float getLayoutAlignmentX(Container target); ★
  public abstract float getLayoutAlignmentY(Container target); ★
  public int getVgap(); ★
  public abstract void invalidateLayout(Container target); ★
  public void last (Container parent);
  public void layoutContainer (Container target);
  public abstract Dimension maximumLayoutSize(Container target); ★
  public Dimension minimumLayoutSize (Container target);
  public void next (Container parent);
  public Dimension preferredLayoutSize (Container target);
  public void previous (Container parent);
  public void removeLayoutComponent (Component component);
  public void setHgap (int hgap); ★
  public void setVgap (int vgap); ★
```

```
  public void show (Container parent, String name);
  public String toString();
}
```

Constructors

CardLayout

`public CardLayout()`

Description Constructs a `CardLayout` object.

`public CardLayout (int hgap, int vgap)`

Parameters *hgap* Horizontal space around left and right of container

vgap Vertical space around top and bottom of container

Description Constructs a `CardLayout` object with the values specified as the gaps around the container managed by this instance of `CardLayout`.

Instance Methods

addLayoutComponent

`public void addLayoutComponent (Component comp, Object constraints)` ★

Parameters *comp* The component being added.

constraints An object describing the constraints on this component.

Implements `LayoutManager2.addLayoutComponent()`

Description Adds the component `comp` to a container subject to the given `constraints`. This is a more generalized version of `addLayoutComponent(String, Component)`. It corresponds to `java.awt.Container's add(Component, Object)`. In practice, it is used the same in Java 1.1 as in Java 1.0.2, except with the parameters swapped:

```
Panel p = new Panel();
p.setLayoutManager(new CardLayout());
p.add(new Button("OK"), "Don Julio");
```

addLayoutComponent

`public void addLayoutComponent (String name, Component component)` ☆

Parameters	*name*	Name of the component to add.
	component	The actual component being added.
Implements	`LayoutManager.addLayoutComponent()`	
Description	Places `component` under the layout's management, assigning it the given `name`. This has been replaced in version 1.1 with the more general `addLayoutComponent(Component, Object)`.	

first

`public void first (Container parent)`

Parameters	*parent*	The container whose displayed component is changing.
Throws	`IllegalArgumentException`	If the `LayoutManager` of `parent` is not `CardLayout`.
Description	Sets the container to display the first component in parent.	

getHgap

`public int getHgap()` ★

Returns	The horizontal gap for this `CardLayout` instance.

getLayoutAlignmentX

`public abstract float getLayoutAlignmentX (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is left aligned, .5 is centered, and 1 is right aligned.	

getLayoutAlignmentY

`public abstract float getLayoutAlignmentY (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	

Description — This method returns the preferred alignment of the given container `target`. A return value of 0 is top aligned, .5 is centered, and 1 is bottom aligned.

getVgap

`public int getVgap()` ★

Returns — The vertical gap for this `CardLayout` instance.

invalidateLayout

`public abstract void invalidateLayout (Container target)` ★

Parameters	*target*	The container to invalidate.
Description	Does nothing.	

last

`public void last (Container parent)`

Parameters	*parent*	The container whose displayed component is changing.
Throws	`IllegalArgumentException`	If the `LayoutManager` of `parent` is not `CardLayout`.
Description	Sets the container to display the final component in parent.	

layoutContainer

`public void layoutContainer (Container target)`

Parameters	*target*	The container that needs to be redrawn.
Implements	`LayoutManager.layoutContainer()`	
Description	Displays the currently selected component contained within `target`.	

maximumLayoutSize

`public abstract Dimension maximumLayoutSize .hw Container (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	A `Dimension` whose horizontal and vertical components are `Integer.MAX_VALUE`.	
Description	For `CardLayout`, a maximal `Dimension` is always returned.	

minimumLayoutSize

`public Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of the container `target`.	
Implements	`LayoutManager.minimumLayoutSize()`	
Description	Calculates minimum size of the `target` container.	

next

`public void next (Container parent)`

Parameters	*parent*	The container whose displayed component is changing.
Throws	`IllegalArgumentException`	If the `LayoutManager` of `parent` is not `CardLayout`.
Description	Sets the container to display the following component in the parent.	

preferredLayoutSize

`public Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of the container `target`.	
Implements	`LayoutManager.preferredLayoutSize()`	
Description	Calculates preferred size of the `target` container.	

previous

`public void previous (Container parent)`

Parameters	*parent*	The container whose displayed component is changing.
Throws	`IllegalArgumentException`	If the `LayoutManager` of `parent` is not `CardLayout`.
Description	Sets the container to display the prior component in `parent`.	

removeLayoutComponent

`public void removeLayoutComponent (Component component)`

Parameters	*component*	Component to stop tracking.

Implements	`LayoutManager.removeLayoutComponent()`	
Description	Removes `component` from the layout manager's internal tables.	

setHgap

`public void setHgap (int hgap)` ★

Parameters	*hgap*	The horizontal gap value.
Description	Sets the horizontal gap for the left and right of the container.	

setVgap

`public void setVgap (int vgap)` ★

Parameters	*vgap*	The vertical gap value.
Description	Sets the vertical gap for the top and bottom of the container.	

show

`public void show (Container parent, String name)`

Parameters	*parent*	The container whose displayed component is changing.
	name	Name of component to display.
Throws	`IllegalArgumentException`	
		If `LayoutManager` of `parent` is not `CardLayout`.
Description	Sets the container to display the component `name` in `parent`.	

toString

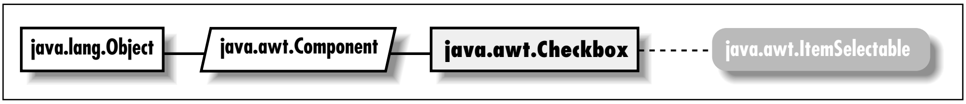
`public String toString()`

Returns	A string representation of the `CardLayout` object.
Overrides	`Object.toString()`

See Also

`Component`, `Container`, `Dimension`, `LayoutManager`, `LayoutManager2`, `Object`, `String`

19.10 Checkbox



Description

The `Checkbox` is a `Component` that provides a true or false toggle switch for user input.

Class Definition

```
public class java.awt.Checkbox
    extends java.awt.Component
    implements java.awt.ItemSelectable {

  // Constructors
  public Checkbox();
  public Checkbox (String label);
  public Checkbox (String label, boolean state); ★
  public Checkbox (String label, boolean state, CheckboxGroup group); ★
  public Checkbox (String label, CheckboxGroup group, boolean state);

  // Instance Methods
  public void addItemListener (ItemListener l); ★
  public void addNotify();
  public CheckboxGroup getCheckboxGroup();
  public String getLabel();
  public Object[] getSelectedObjects(); ★
  public boolean getState();
  public void removeItemListener (ItemListener l); ★
  public void setCheckboxGroup (CheckboxGroup group);
  public synchronized void setLabel (String label);
  public void setState (boolean state);

  // Protected Instance Methods
  protected String paramString();
  protected void processEvent (AWTEvent e); ★
  protected void processItemEvent (ItemEvent e); ★
}
```

Constructors

Checkbox

`public Checkbox()`

Description	Constructs a `Checkbox` object with no label that is initially `false`.	

`public Checkbox (String label)`

Parameters	*label*	Text to display with the `Checkbox`.
Description	Constructs a `Checkbox` object with the given `label` that is initially `false`.	

`public Checkbox (String label, boolean state)` ★

Parameters	*label*	Text to display with the `Checkbox`.
	state	Intial value of the `Checkbox`.
Description	Constructs a `Checkbox` with the given `label`, initialized to the given `state`.	

`public Checkbox (String label, boolean state, CheckboxGroup group)` ★

Parameters	*label*	Text to display with the `Checkbox`.
	state	Intial value of the `Checkbox`.
	group	The `CheckboxGroup` this `Checkbox` should belong to.
Description	Constructs a `Checkbox` with the given `label`, initialized to the given `state` and belonging to `group`.	

`public Checkbox (String label, CheckboxGroup group, boolean state)`

Parameters	*label*	Text to display with the `Checkbox`.
	group	The `CheckboxGroup` this `Checkbox` should belong to.
	state	Intial value of the `Checkbox`.
Description	Constructs a `Checkbox` object with the given settings.	

Instance Methods

addItemListener

`public void addItemListener (ItemListener l)` ★

Parameters	*l*	The listener to be added.
Implements	`ItemSelectable.addItemListener(ItemListener l)`	
Description	Adds a listener for the `ItemEvent` objects this `Checkbox` generates.	

addNotify

`public void addNotify()`

Overrides `Component.addNotify()`
Description Creates `Checkbox` peer.

getCheckboxGroup

`public CheckboxGroup getCheckboxGroup()`

Returns The current `CheckboxGroup` associated with the `Checkbox`, if any.

getLabel

`public String getLabel()`

Returns The text associated with the `Checkbox`.

getSelectedObjects

`public Object[] getSelectedObjects()` ★

Implements `ItemSelectable.getSelectedObjects()`
Description If the `Checkbox` is checked, returns an array with length 1 containing the label of the `Checkbox`; otherwise returns `null`.

getState

`public boolean getState()`

Returns The current state of the `Checkbox`.

removeItemListener

`public void removeItemListener (ItemListener l)` ★

Parameters *l* The listener to be removed.
Implements `ItemSelectable.removeItemListener (ItemListener l)`
Description Removes the specified `ItemListener` so it will not receive `ItemEvent` objects from this `Checkbox`.

setCheckboxGroup

`public void setCheckboxGroup (CheckboxGroup group)`

Parameters *group* New group in which to place the `Checkbox`.
Description Associates the `Checkbox` with a different `CheckboxGroup`.

setLabel

`public synchronized void setLabel (String label)`

Parameters	*label*	New text to associate with `Checkbox`.
Description	Changes the text associated with the `Checkbox`.	

setState

`public void setState (boolean state)`

Parameters	*state*	New state for the `Checkbox`.
Description	Changes the state of the `Checkbox`.	

Protected Instance Methods

paramString

`protected String paramString()`

Returns	String with current settings of `Checkbox`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

processEvent

`protected void processEvent(AWTEvent e)` ★

Parameters	*e*	The event to process.
Description	Low level `AWTEvents` are passed to this method for processing.	

processItemEvent

`protected void processItemEvent(ItemEvent e)` ★

Parameters	*e*	The item event to process.
Description	Item events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

See Also

`CheckboxGroup`, `Component`, `ItemEvent`, `ItemSelectable`, `String`

19.11 CheckboxGroup

Description

The `CheckboxGroup` class provides the means to group multiple `Checkbox` items into a mutual exclusion set, so that only one checkbox in the set has the value `true` at any time. The checkbox with the value `true` is the currently selected checkbox. Mutually exclusive checkboxes usually have a different appearance from regular checkboxes and are also called “radio buttons.”

Class Definition

```
public class java.awt.CheckboxGroup
    extends java.lang.Object
    implements java.io.Serializable {

  // Constructors
  public CheckboxGroup();

  // Instance Methods
  public Checkbox getCurrent(); ☆
  public Checkbox getSelectedCheckbox() ★
  public synchronized void setCurrent (Checkbox checkbox); ☆
  public synchronized void setSelectedCheckbox (Checkbox checkbox); ★
  public String toString();
}
```

Constructors

CheckboxGroup

```
public CheckboxGroup()
```

Description   Constructs a `CheckboxGroup` object.

Instance Methods

getCurrent

```
public Checkbox getCurrent() ☆
```

Returns   The currently selected `Checkbox` within the `CheckboxGroup`.
Description   Replaced by the more aptly named `getSelectedCheckbox()`.

getSelectedCheckbox

`public Checkbox getSelectedCheckbox()` ★

Returns	The currently selected `Checkbox` within the `CheckboxGroup`.

setCurrent

`public synchronized void setCurrent (Checkbox checkbox)` ☆

Parameters	*checkbox*	The `Checkbox` to select.
Description	Changes the currently selected `Checkbox` within the `CheckboxGroup`.	
Description	Replaced by `setSelectedCheckbox(Checkbox)`.	

setSelectedCheckbox

`public synchronized void setSelectedCheckbox (Checkbox checkbox)` ★

Parameters	*checkbox*	The `Checkbox` to select.
Description	Changes the currently selected `Checkbox` within the `CheckboxGroup`.	

toString

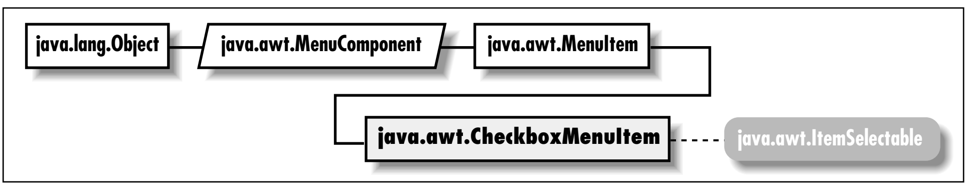
`public String toString()`

Returns	A string representation of the `CheckboxGroup` object.
Overrides	`Object.toString()`

See Also

`Checkbox`, `Object`, `String`

19.12 CheckboxMenuItem



Description

The `CheckboxMenuItem` class represents a menu item with a boolean state.

Class Definition

```
public class java.awt.CheckboxMenuItem
    extends java.awt.MenuItem
    implements java.awt.ItemSelectable {

  // Constructors
  public CheckboxMenuItem(); ★
  public CheckboxMenuItem (String label);
  public CheckboxMenuItem (String label, boolean state); ★

  // Instance Methods
  public void addItemListener (ItemListener l); ★
  public void addNotify();
  public Object[] getSelectedObjects(); ★
  public boolean getState();
  public String paramString();
  public void removeItemListener (ItemListener l); ★
  public synchronized void setState (boolean condition);

  // Protected Instance Methods
  protected void processEvent (AWTEvent e); ★
  protected void processItemEvent (ItemEvent e); ★
}
```

Constructors

CheckboxMenuItem

`public CheckboxMenuItem()` ★

Description — Constructs a `CheckboxMenuItem` object with no label.

`public CheckboxMenuItem (String label)`

Parameters	*label*	Text that appears on `CheckboxMenuItem`.
Description	Constructs a `CheckboxMenuItem` object whose value is initially `false`.	

`public CheckboxMenuItem (String label, boolean state)` ★

Parameters	*label*	Text that appears on `CheckboxMenuItem`.
	state	The initial state of the menu item.
Description	Constructs a `CheckboxMenuItem` object with the specified `label` and `state`.	

Instance Methods

addItemListener

`public void addItemListener (ItemListener l) ★`

Parameters *l* The listener to be added.
Implements `ItemSelectable.addItemListener(ItemListener l)`
Description Adds a listener for the `ItemEvent` objects this `CheckboxMenuItem` fires off.

addNotify

`public void addNotify()`

Overrides `MenuItem.addNotify()`
Description Creates `CheckboxMenuItem`'s peer.

getSelectedObjects

`public Object[] getSelectedObjects() ★`

Implements `ItemSelectable.getSelectedObjects()`
Description If the `CheckboxMenuItem` is checked, returns an array with length `1` containing the label of the `CheckboxMenuItem`; otherwise returns `null`.

getState

`public boolean getState()`

Returns The current state of the `CheckboxMenuItem`.

paramString

`public String paramString()`

Returns A string with current settings of `CheckboxMenuItem`.
Overrides `MenuItem.paramString()`
Description Helper method for `toString()` to generate string of current settings.

removeItemListener

`public void removeItemListener (ItemListener l) ★`

Parameters *l* The listener to be removed.
Implements `ItemSelectable.removeItemListener (ItemListener l)`

Description Removes the specified `ItemListener` so it will not receive `ItemEvent` objects from this `CheckboxMenuItem`.

`setState`

`public synchronized void setState (boolean condition)`

Parameters *condition* New state for the `CheckboxMenuItem`.
Description Changes the state of the `CheckboxMenuItem`.

Protected Instance Methods

`processEvent`

`protected void processEvent(AWTEvent e)` ★

Parameters *e* The event to process.
Overrides `MenuItem.processEvent(AWTEvent)`
Description Low level `AWTEvents` are passed to this method for processing.

`processItemEvent`

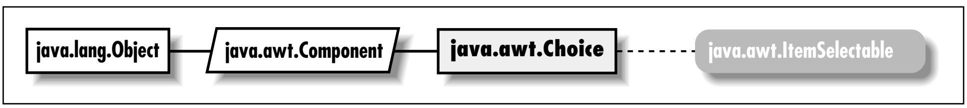
`protected void processItemEvent(ItemEvent e)` ★

Parameters *e* The item event to process.
Description Item events are passed to this method for processing. Normally, this method is called by `processEvent()`.

See Also

`ItemEvent`, `ItemSelectable`, `MenuItem`, `String`

19.13 Choice



Description

The `Choice` is a `Component` that provides a drop-down list of choices to choose from.

Class Definition

```
public class java.awt.Choice
    extends java.awt.Component
    implements java.awt.ItemSelectable {
```

```
    // Constructors
    public Choice();

    // Instance Methods
    public synchronized void add (String item); ★
    public synchronized void addItem (String item); ☆
    public void addItemListener (ItemListener l); ★
    public void addNotify();
    public int countItems();  ☆
    public String getItem (int index);
    public int getItemCount(); ★
    public int getSelectedIndex();
    public synchronized String getSelectedItem();
    public synchronized Object[] getSelectedObjects(); ★
    public synchronized void insert (String item, int index); ★
    public synchronized void remove (int position); ★
    public synchronized void remove (String item); ★
    public synchronized void removeAll(); ★
    public void removeItemListener (ItemListener l); ★
    public synchronized void select (int pos);
    public synchronized void select (String str);

    // Protected Instance Methods
    protected String paramString();
    protected void processEvent (AWTEvent e);  ★
    protected void processItemEvent (ItemEvent e); ★
}
```

Constructors

Choice

`public Choice()`

Description Constructs a `Choice` object.

Instance Methods

add

`public synchronized void add (String item)` ★

Parameters	*item*	Text for new entry.
Throws	`NullPointerException`	
		If `item` is null.
Description	Adds a new entry to the available choices.	

addItem

`public synchronized void addItem (String item) ☆`

Parameters	*item*	Text for new entry.
Throws	`NullPointerException`	
		If `item` is null.
Description	Replaced by `add(String)`.	

addItemListener

`public void addItemListener (ItemListener l) ★`

Parameters	*l*	The listener to be added.
Implements	`ItemSelectable.addItemListener(ItemListener l)`	
Description	Adds a listener for the `ItemEvent` objects this `Choice` generates.	

addNotify

`public void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `Choice`'s peer.

countItems

`public int countItems() ☆`

Returns	Number of items in the `Choice`.
Description	Replaced by `getItemCount()`.

getItem

`public String getItem (int index)`

Parameters	*index*	Position of entry.
Returns	A string for an entry at a given position.	
Throws	`ArrayIndexOutOfBoundsException`	
		If `index` is invalid; indices start at zero.

getItemCount

`public int getItemCount() ★`

Returns	Number of items in the `Choice`.

getSelectedIndex

`public int getSelectedIndex()`

Returns Position of currently selected entry.

getSelectedItem

`public synchronized String getSelectedItem()`

Returns Currently selected entry as a String.

getSelectedObjects

`public synchronized Object[] getSelectedObjects()` ★

Implements `ItemSelectable.getSelectedObjects()`
Description A single-item array containing the current selection.

insert

`public synchronized void insert (String item, int index)`
★

Parameters *item* The string to add.
index The position for the new string.
Throws `IllegalArgumentException`
If `index` is less than zero.
Description Inserts `item` in the given position.

remove

`public synchronized void remove (int position)` ★

Parameters *position* The index of an entry in the `Choice` component.
Description Removes the entry in the given position.

`public synchronized void remove (String string)` ★

Parameters *string* Text of an entry within the `Choice` component.
Throws `IllegalArgumentException`
If `string` is not in the `Choice`.
Description Makes the first entry that matches `string` the selected item.

removeAll

public synchronized void removeAll() ★

Description Removes all the entries from the Choice.

removeItemListener

public void removeItemListener (ItemListener l) ★

Parameters *l* The listener to be removed.
Implements ItemSelectable.removeItemListener (ItemListener l)
Description Removes the specified ItemListener so it will not receive ItemEvent objects from this Choice.

select

public synchronized void select (int pos)

Parameters *pos* The index of an entry in the Choice component.
Throws IllegalArgumentException
If the position is not valid.
Description Makes the entry in the given position.

public synchronized void select (String str)

Parameters *str* Text of an entry within the Choice component.
Description Makes the first entry that matches str the selected item for the Choice.

Protected Instance Methods

paramString

protected String paramString()

Returns A string with current settings of Choice.
Overrides Component.paramString()
Description Helper method for toString() to generate string of current settings.

processEvent

protected void processEvent (AWTEvent e) ★

Parameters *e* The event to process.
Description Low level AWTEvents are passed to this method for processing.

processItemEvent

```
protected void processItemEvent (ItemEvent e) ★
```

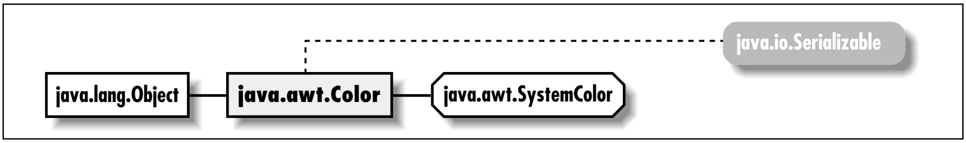
Parameters *e* The item event to process.

Description Item events are passed to this method for processing. Normally, this method is called by `processEvent()`.

See Also

`Component`, `ItemSelectable`, `String`

19.14 Color



Description

The `Color` class represents a specific color to the system.

Class Definition

```
public final class java.awt.Color
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public static final Color black;
  public static final Color blue;
  public static final Color cyan;
  public static final Color darkGray;
  public static final Color gray;
  public static final Color green;
  public static final Color lightGray;
  public static final Color magenta;
  public static final Color orange;
  public static final Color pink;
  public static final Color red;
  public static final Color white;
  public static final Color yellow;

  // Constructors
  public Color (int rgb);
  public Color (int red, int green, int blue);
  public Color (float red, float green, float blue);
```

```
  // Class Methods
  public static Color decode (String name); ★
  public static Color getColor (String name);
  public static Color getColor (String name, Color defaultColor);
  public static Color getColor (String name, int defaultColor);
  public static Color getHSBColor (float hue, float saturation,
      float brightness);
  public static int HSBtoRGB (float hue, float saturation, float brightness);
  public static float[] RGBtoHSB (int red, int green, int blue,
      float hsbvalues[]);

  // Instance Methods
  public Color brighter();
  public Color darker();
  public boolean equals (Object object);
  public int getBlue();
  public int getGreen();
  public int getRed();
  public int getRGB();
  public int hashCode();
  public String toString();
}
```

Constants

black

`public static final Color black`

The color black.

blue

`public static final Color blue`

The color blue.

cyan

`public static final Color cyan`

The color cyan.

darkGray

`public static final Color darkGray`

The color dark gray.

gray

```
public static final Color gray
```

The color gray.

green

```
public static final Color green
```

The color green.

lightGray

```
public static final Color lightGray
```

The color light gray.

magenta

```
public static final Color magenta
```

The color magenta.

orange

```
public static final Color orange
```

The color orange.

pink

```
public static final Color pink
```

The color pink.

red

```
public static final Color red
```

The color red.

white

```
public static final Color white
```

The color white.

yellow

```
public static final Color yellow
```

The color yellow.

Constructors

Color

`public Color (int rgb)`

Parameters *rgb* Composite color value

Description Constructs a `Color` object with the given `rgb` value.

`public Color (int red, int green, int blue)`

Parameters *red* Red component of color in the range[0, 255]
green Green component of color in the range[0, 255]
blue Blue component of color in the range[0, 255]

Description Constructs a `Color` object with the given `red`, `green`, and `blue` values.

`public Color (float red, float green, float blue)`

Parameters *red* Red component of color in the range[0.0, 1.0]
green Green component of color in the range[0.0, 1.0]
blue Blue component of color in the range[0.0, 1.0]

Description Constructs a `Color` object with the given `red`, `green`, and `blue` values.

Class Methods

decode

`public static Color decode (String nm)` ★

Parameters *nm* A `String` representing a color as a 24-bit integer.

Returns The color requested.

Throws `NumberFormatException`
If `nm` cannot be converted to a number.

Description Gets color specified by the given string.

getColor

`public static Color getColor (String name)`

Parameters *name* The name of a system property indicating which color to fetch.

Returns Color instance of `name` requested, or `null` if the `name` is invalid.

Description Gets color specified by the system property name.

`public static Color getColor (String name, Color defaultColor)`

Parameters *name* The `name` of a system property indicating which color to fetch.

defaultColor Color to return if `name` is not found in properties, or invalid.

Returns Color instance of `name` requested, or `defaultColor` if the `name` is invalid.

Description Gets color specified by the system property `name`.

`public static Color getColor (String name, int defaultColor)`

Parameters *name* The `name` of a system property indicating which color to fetch.

defaultColor Color to return if `name` is not found in properties, or invalid.

Returns Color instance of `name` requested, or `defaultColor` if the `name` is invalid.

Description Gets color specified by the system property `name`. The default color is specified as a 32-bit RGB value.

getHSBColor

`public static Color getHSBColor (float hue, float saturation, float brightness)`

Parameters *hue* Hue component of `Color` to create, in the range[0.0, 1.0].

saturation Saturation component of `Color` to create, in the range[0.0, 1.0].

brightness Brightness component of `Color` to create, in the range[0.0, 1.0].

Returns Color instance for values provided.

Description Create an instance of `Color` by using hue, saturation, and brightness instead of red, green, and blue values.

HSBtoRGB

`public static int HSBtoRGB (float hue, float saturation, float brightness)`

Parameters *hue* Hue component of `Color` to convert, in the range[0.0, 1.0].

	saturation	Saturation component of `Color` to convert, in the range[0.0, 1.0].
	brightness	Brightness component of `Color` to convert, in the range[0.0, 1.0].
Returns	Color value for hue, saturation, and brightness provided.	
Description	Converts a specific hue, saturation, and brightness to a `Color` and returns the red, green, and blue values in a composite integer value.	

RGBtoHSB

```
public static float[] RGBtoHSB (int red, int green, int
blue, float[] hsbvalues)
```

Parameters	*red*	Red component of `Color` to convert, in the range[0, 255].
	green	Green component of `Color` to convert, in the range[0, 255].
	blue	Blue component of `Color` to convert, in the range[0, 255].
	hsbvalues	Three element array in which to put the result. This array is used as the method's return object. If `null`, a new array is allocated.
Returns	Hue, saturation, and brightness values for `Color` provided, in elements 0, 1, and 2 (respectively) of the returned array.	
Description	Allows you to convert specific red, green, blue value to the hue, saturation, and brightness equivalent.	

Instance Methods

brighter

```
public Color brighter()
```

Returns	Brighter version of current color.
Description	Creates new `Color` that is somewhat brighter than current.

darker

```
public Color darker()
```

Returns	Darker version of current color.
Description	Creates new `Color` that is somewhat darker than current.

equals

`public boolean equals (Object object)`

Parameters	*object*	The object to compare.
Returns	`true` if `object` represents the same color, `false` otherwise.	
Overrides	`Object.equals(Object)`	
Description	Compares two different `Color` instances for equivalence.	

getBlue

`public int getBlue()`

Returns Blue component of current color.

getGreen

`public int getGreen()`

Returns Green component of current color.

getRed

`public int getRed()`

Returns Red component of current color.

getRGB

`public int getRGB()`

Returns Current color as a composite value.
Description Gets integer value of current color.

hashCode

`public int hashCode()`

Returns A hashcode to use when storing `Color` in a `Hashtable`.
Overrides `Object.hashCode()`
Description Generates a hashcode for the `Color`.

toString

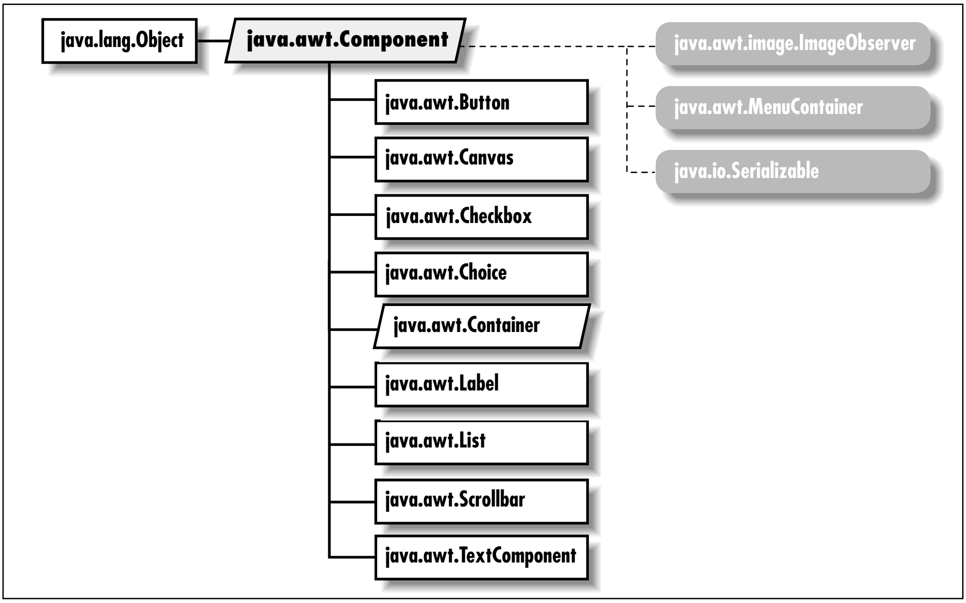
`public String toString()`

Returns A string representation of the `Color` object.
Overrides `Object.toString()`

See Also

`Object`, `Properties`, `Serializable`, `String`

19.15 Component



Description

The `Component` class is the parent of all non-menu GUI components.

Class Definition

```
public abstract class java.awt.Component
    extends java.lang.Object
    implements java.awt.image.ImageObserver
    implements java.awt.MenuContainer
    implements java.io.Serializable {

  // Constants
  public final static float BOTTOM_ALIGNMENT; ★
  public final static float CENTER_ALIGNMENT; ★
  public final static float LEFT_ALIGNMENT; ★
  public final static float RIGHT_ALIGNMENT; ★
  public final static float TOP_ALIGNMENT; ★

  // Variables
  protected Locale locale; ★
```

```
// Constructors
protected Component(); ★

// Instance Methods
public boolean action (Event e, Object o); ☆
public synchronized void add (PopupMenu popup); ★
public synchronized void addComponentListener
    (ComponentListener l); ★
public synchronized void addFocusListener (FocusListener l); ★
public synchronized void addKeyListener (KeyListener l); ★
public synchronized void addMouseListener (MouseListener l); ★
public synchronized void addMouseMotionListener
    (MouseMotionListener l); ★
public void addNotify();
public Rectangle bounds(); ☆
public int checkImage (Image image, ImageObserver observer);
public int checkImage (Image image, int width, int height,
    ImageObserver observer);
public boolean contains (int x, int y); ★
public boolean contains (Point p); ★
public Image createImage (ImageProducer producer);
public Image createImage (int width, int height);
public void deliverEvent (Event e); ☆
public void disable(); ☆
public final void dispatchEvent (AWTEvent e) ★
public void doLayout(); ★
public void enable(); ☆
public void enable (boolean condition); ☆
public float getAlignmentX(); ★
public float getAlignmentY(); ★
public Color getBackground();
public Rectangle getBounds(); ★
public synchronized ColorModel getColorModel();
public Component getComponentAt (int x, int y); ★
public Component getComponentAt (Point p); ★
public Cursor getCursor(); ★
public Font getFont();
public FontMetrics getFontMetrics (Font f);
public Color getForeground();
public Graphics getGraphics();
public Locale getLocale(); ★
public Point getLocation(); ★
public Point getLocationOnScreen(); ★
public Dimension getMaximumSize(); ★
public Dimension getMinimumSize(); ★
public String getName(); ★
public Container getParent();
public ComponentPeer getPeer(); ☆
public Dimension getPreferredSize(); ★
```

```
public Dimension getSize(); ★
public Toolkit getToolkit();
public final Object getTreeLock(); ★
public boolean gotFocus (Event e, Object o); ☆
public boolean handleEvent (Event e); ☆
public void hide(); ☆
public boolean imageUpdate (Image image, int infoflags, int x, int y,
    int width, int height);
public boolean inside (int x, int y); ☆
public void invalidate();
public boolean isEnabled();
public boolean isFocusTraversable(); ★
public boolean isShowing();
public boolean isValid();
public boolean isVisible();
public boolean keyDown (Event e, int key); ☆
public boolean keyUp (Event e, int key); ☆
public void layout(); ☆
public void list();
public void list (PrintStream out);
public void list (PrintStream out, int indentation);
public void list (PrintWriter out); ★
public void list (PrintWriter out, int indentation); ★
public Component locate (int x, int y); ☆
public Point location(); ☆
public boolean lostFocus (Event e, Object o); ☆
public Dimension minimumSize(); ☆
public boolean mouseDown (Event e, int x, int y); ☆
public boolean mouseDrag (Event e, int x, int y); ☆
public boolean mouseEnter (Event e, int x, int y); ☆
public boolean mouseExit (Event e, int x, int y); ☆
public boolean mouseMove (Event e, int x, int y); ☆
public boolean mouseUp (Event e, int x, int y); ☆
public void move (int x, int y); ☆
public void nextFocus(); ☆
public void paint (Graphics g);
public void paintAll (Graphics g);
public boolean postEvent (Event e); ☆
public Dimension preferredSize(); ☆
public boolean prepareImage (Image image, ImageObserver observer);
public boolean prepareImage (Image image, int width, int height,
    ImageObserver observer);
public void print (Graphics g);
public void printAll (Graphics g);
public synchronized void remove (MenuComponent popup); ★
public synchronized void removeComponentListener
    (ComponentListener l); ★
public synchronized void removeFocusListener (FocusListener l); ★
public synchronized void removeKeyListener (KeyListener l); ★
```

```
    public synchronized void removeMouseListener (MouseListener l); ★
    public synchronized void removeMouseMotionListener
        (MouseMotionListener l); ★
    public void removeNotify();
    public void repaint();
    public void repaint (long tm);
    public void repaint (int x, int y, int width, int height);
    public void repaint (long tm, int x, int y, int width, int height);
    public void requestFocus();
    public void reshape (int x, int y, int width, int height); ☆
    public void resize (Dimension d); ☆
    public void resize (int width, int height); ☆
    public void setBackground (Color c);
    public void setBounds (int x, int y, int width, int height); ★
    public void setBounds (Rectangle r); ★
    public synchronized void setCursor (Cursor cursor); ★
    public void setEnabled (boolean b); ★
    public synchronized void setFont (Font f);
    public void setForeground (Color c);
    public void setLocale (Locale l); ★
    public void setLocation (int x, int y); ★
    public void setLocation (Point p); ★
    public void setName (String name); ★
    public void setSize (int width, int height); ★
    public void setSize (Dimension d); ★
    public void setVisible (boolean b); ★
    public void show(); ☆
    public void show (boolean condition); ☆
    public Dimension size(); ☆
    public String toString();
    public void transferFocus(); ★
    public void update (Graphics g);
    public void validate();

    // Protected Instance Methods
    protected final void disableEvents (long eventsToDisable); ★
    protected final void enableEvents (long eventsToEnable); ★
    protected String paramString();
    protected void processComponentEvent (ComponentEvent e); ★
    protected void processEvent (AWTEvent e); ★
    protected void processFocusEvent (FocusEvent e); ★
    protected void processKeyEvent (KeyEvent e); ★
    protected void processMouseEvent (MouseEvent e); ★
    protected void processMouseMotionEvent (MouseEvent e); ★
}
```

Constants

BOTTOM_ALIGNMENT

`public final static float BOTTOM_ALIGNMENT` ★

Constant representing bottom alignment in `getAlignmentY()`.

CENTER_ALIGNMENT

`public final static float CENTER_ALIGNMENT` ★

Constant representing center alignment in `getAlignmentX()` and `getAlignmentY()`.

LEFT_ALIGNMENT

`public final static float LEFT_ALIGNMENT` ★

Constant representing left alignment in `getAlignmentX()`.

RIGHT_ALIGNMENT

`public final static float RIGHT_ALIGNMENT` ★

Constant representing right alignment in `getAlignmentX()`.

TOP_ALIGNMENT

`public final static float TOP_ALIGNMENT` ★

Constant representing top alignment in `getAlignmentY()`.

Variables

locale

`protected Locale locale` ★

Description The locale for the component. Used for internationalization support.

Constructors

Component

`protected Component()` ★

Description This constructor creates a "lightweight" component. This constructor allows `Component` to be directly subclassed using code written entirely in Java.

Instance Methods

action

`public boolean action (Event e, Object o)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	o	Argument specific to the component subclass that generated the event.
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when user performs some action in `Component`. This method is a relic of the old 1.0.2 event model and is replaced by the `process . . . Event()` methods.	

add

`public synchronized void add (PopupMenu popup)` ★

Parameters	*popup*	The menu to add.
Description	After the `PopupMenu` is added to a component, it can be shown in the component's coordinate space.	

addComponentListener

`public void addComponentListener (ComponentListener l)` ★

Description — Adds a listener for the `ComponentEvent` objects this `Component` generates.

addFocusListener

`public void addFocusListener (FocusListener l)` ★

Description — Adds a listener for the `FocusEvent` objects this `Component` generates.

addKeyListener

`public void addKeyListener (KeyListener l)` ★

Description — Adds a listener for the `KeyEvent` objects this `Component` generates.

addMouseListener

`public void addMouseListener (MouseListener l)` ★

Description Adds a listener for the `MouseEvent` objects this `Component` generates.

addMouseMotionListener

`public void addMouseMotionListener (MouseMotionListener l)` ★

Description Adds a listener for the motion `MouseEvent` objects this `Component` generates.

addNotify

`public void addNotify()`

Description Creates peer of `Component`'s subclass.

bounds

`public Rectangle bounds()` ☆

Returns Gets bounding rectangle of `Component`.
Description A `Rectangle` that returns the outer limits of the `Component`. Replaced by `getBounds()` in 1.1.

checkImage

`public int checkImage (Image image, ImageObserver observer)`

Parameters	*image*	`Image` to check.
	observer	The object an image will be rendered onto.
Returns	`ImageObserver` Flags ORed together indicating the image's status.	
Description	Checks status of image construction.	

`public int checkImage (Image image, int width, int height, ImageObserver observer)`

Parameters	*image*	Image to check.
	width	Horizontal size image will be scaled to.
	height	Vertical size image will be scaled to.
	observer	Object image will be rendered onto.
Returns	`ImageObserver` flags ORed together indicating the image's status.	

Description	Checks status of image construction.	

contains

`public boolean contains (int x, int y)` ★

Parameters	*x*	The x coordinate, in this `Component`'s coordinate system.
	y	The y coordinate, in this `Component`'s coordinate system.
Returns	`true` if the `Component` contains the point; `false` otherwise.	

`public boolean contains (Point p)` ★

Parameters	*p*	The point to be tested, in this `Component`'s coordinate system.
Returns	`true` if the `Component` contains the point; `false` otherwise.	

createImage

`public Image createImage (ImageProducer producer)`

Parameters	*producer*	Class that implements `ImageProducer` interface to create the new image.
Returns	Newly created image instance.	
Description	Creates an `Image` based upon an `ImageProducer`.	

`public Image createImage (int width, int height)`

Parameters	*width*	Horizontal size for in-memory `Image`.
	height	Vertical size for in-memory `Image`.
Returns	Newly created image instance.	
Description	Creates an empty in-memory `Image` for double buffering; to draw on the image, use its graphics context.	

deliverEvent

`public void deliverEvent (Event e)` ☆

Parameters	*e*	`Event` instance to deliver.
Description	Delivers event to the component for processing.	

disable

`public void disable()` ☆

Description	Disables component so that it is unresponsive to user interactions. Replaced by `setEnabled(false)`.	

dispatchEvent

`public final void dispatchEvent (AWTEvent e)` ★

Parameters *e* The `AWTEvent` to process.
Description Tells the component to deal with the `AWTEvent e`.

doLayout

`public void doLayout()` ★

Description Lays out component. This method is a replacement for `layout()`.

enable

`public void enable()` ☆

Description Enables component so that it is responsive to user interactions. Use `setEnabled(true)` instead.

`public void enable (boolean condition)` ☆

Parameters *condition* `true` to enable the component; `false` to disable it.
Description Enables or disables the component based upon `condition`. Use `setEnabled(boolean)` instead.

getAlignmentX

`public float getAlignmentX()` ★

Returns A number between 0 and 1 representing the horizontal alignment of this component.
Description One of the constants `LEFT_ALIGNMENT`, `CENTER_ALIGNMENT`, or `RIGHT_ALIGNMENT` may be returned. `CENTER_ALIGNMENT` is returned by default.

getAlignmentY

`public float getAlignmentY()` ★

Returns A number between 0 and 1 representing the vertical alignment of this component.
Description One of the constants `TOP_ALIGNMENT`, `CENTER_ALIGNMENT`, or `BOTTOM_ALIGNMENT` may be returned. `CENTER_ALIGNMENT` is returned by default.

getBackground

`public Color getBackground()`

Returns Background color of the component.

getBounds

`public Rectangle getBounds()` ★

Returns Gets bounding rectangle of `Component`.

Description Returns a `Rectangle` that returns the outer limits of the `Component`.

getColorModel

`public synchronized ColorModel getColorModel()`

Returns `ColorModel` used to display the current component.

getComponentAt

`public Component getComponentAt (int x, int y)` ★

Parameters	*x*	The x coordinate, in this `Component`'s coordinate system.
	y	The y coordinate, in this `Component`'s coordinate system.
Returns	Returns the `Component` containing the given point.	

`public Component getComponentAt (Point p)` ★

Parameters	*p*	The point to be tested, in this `Component`'s coordinate system.
Returns	Returns the `Component` containing the given point.	

getCursor

`public Cursor getCursor()` ★

Returns Current cursor of the component.

getFont

`public Font getFont()`

Returns Current font of the component.

getFontMetrics

`public FontMetrics getFontMetrics (Font f)`

Parameters *f* A `Font` object, whose platform specific information is desired.

Returns Size information for the given `Font`.

getForeground

`public Color getForeground()`

Returns Foreground color of component.

getGraphics

`public Graphics getGraphics()`

Throws `InternalException`

If acquiring graphics context is unsupported.

Returns `Component`'s graphics context.

getLocale

`public Locale getLocale()` ★

Throws `IllegalComponentStateException`

If the component does not have a locale or it has not been added to a hierarchy that does.

Returns `Component`'s locale.

getLocation

`public Point getLocation()` ★

Returns Position of component.

Description Gets the current position of this `Component` in its parent's coordinate space.

getLocationOnScreen

`public Point getLocationOnScreen()` ★

Returns Position of component.

Description Gets the current position of this `Component` in the screen's coordinate space.

getMaximumSize

`public Dimension getMaximumSize()` ★

Returns — The maximum dimensions of the component.
Description — By default, a maximal `Dimension` is returned.

getMinimumSize

`public Dimension getMinimumSize()` ★

Returns — The minimum dimensions of the component.

getName

`public String getName()` ★

Returns — This component's name.

getParent

`public Container getParent()`

Returns — Parent `Container` of `Component`.
Description — Gets container that this `Component` is held in.

getPeer

`public ComponentPeer getPeer()` ☆

Returns — Peer of `Component`.

getPreferredSize

`public Dimension getPreferredSize()` ★

Returns — The preferred dimensions of the component.

getSize

`public Dimension getSize()` ★

Returns — Dimensions of component.
Description — Gets width and height of component.

getToolkit

`public Toolkit getToolkit()`

Returns — `Toolkit` of `Component`.

getTreeLock

`public final Object getTreeLock()` ★

Returns The AWT tree locking object.

Description Returns the object used for tree locking and layout operations.

gotFocus

`public boolean gotFocus (Event e, Object o)` ☆

Parameters *e* `Event` instance identifying what triggered the call to this method.

o Argument specific to the component subclass that generated the event.

Returns `true` if event handled, `false` to propagate it to parent container.

Description Called when `Component` gets input focus. This method is not used in the 1.1 event model.

handleEvent

`public boolean handleEvent (Event e)` ☆

Parameters *e* `Event` instance identifying what triggered the call to this method.

Returns `true` if event handled, `false` to propagate it to parent container.

Description High-level event handling routine that calls helper routines. Replaced by `processEvent(AWTEvent)`.

hide

`public void hide()` ☆

Description Hides component from view. Replaced by `setVisible(false)`.

imageUpdate

```
public boolean imageUpdate (Image image, int infoflags,
int x,
int y, int width, int height)
```

Parameters *image* `Image` being loaded.

infoflags `ImageObserver` flags ORed together of available information.

	x	x coordinate of upper-left corner of `Image`.
	y	y coordinate of upper-left corner of `Image`.
	width	Horizontal dimension of `Image`.
	height	Vertical dimension of `Image`.
Returns	`true` if `Image` fully loaded, `false` otherwise.	
Implements	`ImageObserver.imageUpdate()`	
Description	An asynchronous update interface for receiving notifications about `Image` information as it is loaded. Meaning of parameters changes with values of flags.	

inside

`public boolean inside (int x, int y)` ☆

Parameters	*x*	Horizontal position.
	y	Vertical position.
Returns	`true` if the point (`x`, `y`) falls within the component's bounds, `false` otherwise.	
Description	Checks if coordinates are within bounding box of `Component`. Replaced by `contains(int, int)`.	

invalidate

`public void invalidate()`

Description Sets the component's valid state to `false`.

isEnabled

`public boolean isEnabled()`

Returns	`true` if enabled, `false` otherwise.
Description	Checks to see if the `Component` is currently enabled.

isFocusTraversable

`public boolean isFocusTraversable()` ★

Returns	`true` if this `Component` can be traversed using Tab and Shift-Tab, `false` otherwise.
Description	Checks to see if the `Component` is navigable using the keyboard.

isShowing

`public boolean isShowing()`

Returns	`true` if showing, `false` otherwise.
Description	Checks to see if the `Component` is currently showing.

isValid

`public boolean isValid()`

Returns	`true` if valid, `false` otherwise.
Description	Checks to see if the `Component` is currently valid.

isVisible

`public boolean isVisible()`

Returns	`true` if visible, `false` otherwise.
Description	Checks to see if the `Component` is currently visible.

keyDown

`public boolean keyDown (Event e, int key)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	key	Integer representation of key pressed.
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called whenever the user presses a key. Replaced by `processKeyEvent(KeyEvent)`.	

keyUp

`public boolean keyUp (Event e, int key)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	key	Integer representation of key released.
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called whenever the user releases a key. Replaced by `processKeyEvent(KeyEvent)`.	

layout

`public void layout()` ☆

Description: Lays out component. Replaced by `doLayout()`.

list

`public void list()`

Description: Prints the contents of the `Component` to `System.out`.

`public void list (PrintStream out)`

Parameters: *out* — Output stream to send results to.
Description: Prints the contents of the `Component` to a `PrintStream`.

`public void list (PrintStream out, int indentation)`

Parameters: *out* — Output stream to send results to.
indentation — Indentation to use when printing.
Description: Prints the contents of the `Component` indented to a `PrintStream`.

`public void list (PrintWriter out)`

Parameters: *out* — Output stream to send results to.
Description: Prints the contents of the `Component` to a `PrintWriter`.

`public void list (PrintWriter out, int indentation)`

Parameters: *out* — Output stream to send results to.
indentation — Indentation to use when printing.
Description: Prints the contents of the `Component` indented to a `PrintWriter`.

locate

`public Component locate (int x, int y)` ☆

Parameters: *x* — Horizontal position.
y — Vertical position.
Returns: `Component` if the point (`x`, `y`) falls within the component, `null` otherwise.
Description: Replaced by `getComponentAt(int, int)`.

location

`public Point location()` ☆

Returns: Position of component.

Description	Gets the current position of this `Component` in its parent's coordinate space. Replaced by `getLocation()`.	

`lostFocus`

`public boolean lostFocus (Event e, Object o)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	o	Argument specific to the component subclass that generated the event.
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when `Component` loses input focus. Replaced by `processFocusEvent(FocusEvent)`.	

`minimizeSize`

`public Dimension minimumSize()` ☆

Returns	The minimum dimensions of the component. Replaced by `getMinimumSize()`.

`mouseDown`

`public boolean mouseDown (Event e, int x, int y)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	x	Horizontal position of the mouse within `Component` when `Event` initiated
	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when the user presses a mouse button over `Component`. Replaced by `processMouseEvent(MouseEvent)`.	

`mouseDrag`

`public boolean mouseDrag (Event e, int x, int y)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	x	Horizontal position of the mouse within `Component` when `Event` initiated

	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when the user is pressing a mouse button and moves the mouse. Replaced by `processMouseMotionEvent(MouseEvent)`.	

mouseEnter

`public boolean mouseEnter (Event e, int x, int y)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	x	Horizontal position of the mouse within `Component` when `Event` initiated
	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when the mouse enters `Component`. Replaced by `processMouseEvent(MouseEvent)`.	

mouseExit

`public boolean mouseExit (Event e, int x, int y)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	x	Horizontal position of the mouse within `Component` when `Event` initiated
	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when the mouse exits `Component`. Replaced by `processMouseEvent(MouseEvent)`.	

mouseMove

`public boolean mouseMove (Event e, int x, int y)` ☆

Parameters	*e*	`Event` instance identifying what triggered the call to this method.

	x	Horizontal position of the mouse within `Component` when `Event` initiated
	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event handled, `false` to propagate it to parent container.	
Description	Method called when the user is not pressing a mouse button and moves the mouse. Replaced by `processMouseMotionEvent(MouseEvent)`.	

mouseUp

`public boolean mouseUp (Event e, int x, int y) ☆`

Parameters	*e*	`Event` instance identifying what triggered the call to this method.
	x	Horizontal position of the mouse within `Component` when `Event` initiated
	y	Vertical position of the mouse within `Component` when `Event` initiated
Returns	`true` if event is handled, `false` to propagate it to the parent container.	
Description	Method called when user releases mouse button over `Component`. Replaced by `processMouseEvent(MouseEvent)`.	

move

`public void move (int x, int y) ☆`

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.
Description	Relocates component. Replaced by `setLocation(int, int)`.	

nextFocus

`public void nextFocus() ☆`

Description	Moves focus from current component to next one in parent container. Replaced by `transferFocus()`.

paint

`public void paint (Graphics g)`

Parameters	*g*	Graphics context of component.
Description	Empty method to be overridden to draw something in the graphics context.	

paintAll

`public void paintAll (Graphics g)`

Parameters	*g*	Graphics context of component.
Description	Method to validate component and paint its peer if it is visible.	

postEvent

`public boolean postEvent (Event e)` ☆

Parameters	*e*	`Event` instance to post to component
Returns	If `Event` is handled, `true` is returned. Otherwise, `false` is returned.	
Description	Tells `Component` to deal with `Event`.	

preferredSize

`public Dimension preferredSize()` ☆

Returns	The preferred dimensions of the component. Replaced by `getPreferredSize()`.

prepareImage

`public boolean prepareImage (Image image, ImageObserver observer)`

Parameters	*image*	`Image` to start loading.
	observer	Component on which image will be rendered.
Returns	`true` if `Image` is fully loaded, `false` otherwise.	
Description	Forces `Image` to start loading.	

`public boolean prepareImage (Image image, int width, int height, ImageObserver observer)`

Parameters	*image*	`Image` to start loading.
	width	Horizontal size of the `Image` after scaling.
	height	Vertical size of the `Image` after scaling.
	observer	Component on which image will be rendered.
Returns	`true` if `Image` is fully loaded, `false` otherwise.	

Description Forces `Image` to start loading.

print

`public void print (Graphics g)`

Parameters *g* Graphics context.
Description Empty method to be overridden to print something into the graphics context.

printAll

`public void printAll (Graphics g)`

Parameters *g* Graphics context.
Description Method to print this component and its children.

remove

`public void remove (MenuComponent popup)` ★

Parameters *popup* The menu to remove.
Description After adding a `PopupMenu`, you can use this method to remove it.

removeComponentListener

`public void removeComponentListener (ComponentListener l)` ★

Description Removes the specified `ComponentListener` from this `Component`.

removeFocusListener

`public void removeFocusListener (FocusListener l)` ★

Description Removes the specified `FocusListener` from this `Component`.

removeKeyListener

`public void removeKeyListener (KeyListener l)` ★

Description Removes the specified `KeyListener` from this `Component`.

removeMouseListener

`public void removeMouseListener (MouseListener l)` ★

Description Removes the specified `MouseListener` from this `Component`.

removeMouseMotionListener

`public void removeMouseMotionListener (MouseMotionListener l)` ★

Description Removes the specified `MouseMotionListener` from this `Component`.

removeNotify

`public void removeNotify()`

Description Removes peer of `Component`'s subclass.

repaint

`public void repaint()`

Description Requests scheduler to redraw the component as soon as possible.

`public void repaint (long tm)`

Parameters	*tm*	Millisecond delay allowed before repaint.
Description	Requests scheduler to redraw the component within a time period.	

`public void repaint (int x, int y, int width, int height)`

Parameters	*x*	Horizontal origin of bounding box to redraw.
	y	Vertical origin of bounding box to redraw.
	width	Width of bounding box to redraw.
	height	Height of bounding box to redraw.
Description	Requests scheduler to redraw a portion of component as soon as possible.	

`public void repaint (long tm, int x, int y, int width, int height)`

Parameters	*tm*	Millisecond delay allowed before repaint.
	x	Horizontal origin of bounding box to redraw.
	y	Vertical origin of bounding box to redraw.
	width	Width of bounding box to redraw.
	height	Height of bounding box to redraw.

Description Requests scheduler to redraw a portion of component within a time period.

requestFocus

`public void requestFocus()`

Description Requests the input focus for this `Component`.

reshape

`public void reshape (int x, int y, int width, int height)` ☆

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.
	width	New width for component.
	height	New height for component.

Description Relocates and resizes component. Replaced by `setBounds(int, int, int, int)`.

resize

`public void resize (Dimension d)` ☆

Parameters	*d*	New dimensions for the component.

Description Resizes component. Replaced by `setSize(Dimension)`.

`public void resize (int width, int height)` ☆

Parameters	*width*	New width for component.
	height	New height for component.

Description Resizes component. Replaced by `setSize(int, int)`.

setBackground

`public void setBackground (Color c)`

Parameters	*c*	New background color.

Description Changes the component's background color.

setBounds

`public void setBounds (int x, int y, int width, int height)` ★

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.

	width	New width for component.
	height	New height for component.
Description	Relocates and resizes the component.	

`public void setBounds (Rectangle r)` ★

Parameters	*r*	New coordinates for component.
Description	Relocates and resizes component.	

setCursor

`public synchronized void setCursor (Cursor cursor)` ★

Parameters	*cursor*	The new cursor for the component.
Description	Changes the component's cursor.	

setEnabled

`public void setEnabled (boolean b)` ★

Parameters	*b*	`true` to enable the component, `false` to disable it.
Description	Enables or disables the component. Replaces `enable()`, `enable(boolean)`, and `disable()`.	

setFont

`public synchronized void setFont (Font f)`

Parameters	*f*	Font to change component to.
Description	Changes the font of the component.	

setForeground

`public void setForeground (Color c)`

Parameters	*c*	New foreground color.
Description	Changes the foreground color of component's area.	

setLocale

`public void setLocale (Locale l)` ★

Parameters	*l*	The locale object for the component.
Description	Sets the `Component`'s locale.	

setLocation

`public void setLocation (int x, int y)` ★

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.
Description	Relocates the component.	

`public void setLocation (Point p)` ★

Parameters	*p*	New position for component.
Description	Relocates the component.	

setName

`public void setName (String name)` ★

Parameters	*name*	New name for component.
Description	Sets the component's name.	

setSize

`public void setSize (int width, int height)` ★

Parameters	*width*	New width for component.
	height	New height for component.
Description	Resizes the component.	

`public void setSize (Dimension d)` ★

Parameters	*d*	New dimensions for the component.
Description	Resizes the component.	

setVisible

`public void setVisible (boolean b)` ★

Parameters	*b*	`true` to show component, `false` to hide it.
Description	Shows or hides the component based on the `b` parameter.	

show

`public void show()` ☆

Description	Replaced by `setVisible(true)`.

`public void show (boolean condition)` ☆

Parameters	*condition*	`true` to show the component, `false` to hide it.
Description	Replaced by `setVisible(boolean)`.	

size

`public Dimension size()` ☆

Returns Dimensions of the component.

Description Gets width and height of the component. Replaced by `getSize()`.

toString

`public String toString()`

Returns A string representation of the `Component` object.

Overrides `Object.toString()`

transferFocus

`public void transferFocus()` ★

Description Transfers focus to the next component in the container hierarchy.

update

`public void update (Graphics g)`

Parameters *g* Graphics context of component.

Description Called to update the component's display area.

validate

`public void validate()`

Description Sets the component's valid state to `true`.

Protected Instance Methods

disableEvents

`protected final void disableEvents (long eventsToDisable)` ★

Parameters *eventsToDisable*

A value representing certain kinds of events. This can be constructed by ORing the event mask constants defined in `java.awt.AWTEvent`.

Description By default, a component receives events corresponding to the event listeners that have registered. If a component should not receive events of a certain type, even if there is a listener registered for that type of event, this method can be used to disable that event type.

enableEvents

`protected final void enableEvents (long eventsToEnable) ★`

Parameters *eventsToEnable* A value representing certain kinds of events. This can be constructed by ORing the event mask constants defined in `java.awt.AWTEvent`.

Description By default, a component receives events corresponding to the event listeners that have registered. If a component should receive other types of events as well, this method can be used to request them.

paramString

`protected String paramString()`

Returns A `String` with the current settings of the `Component`.

Description Helper method for `toString()` to generate a string of current settings.

processComponentEvent

`protected void processComponentEvent(ComponentEvent e) ★`

Parameters *e* The event to process.

Description Component events are passed to this method for processing. Normally, this method is called by `processEvent()`.

processEvent

`protected void processEvent(AWTEvent e) ★`

Parameters *e* The event to process.

Description Low level `AWTEvents` are passed to this method for processing.

processFocusEvent

`protected void processFocusEvent(FocusEvent e) ★`

Parameters *e* The event to process.

Description Focus events are passed to this method for processing. Normally, this method is called by `processEvent()`.

processKeyEvent

`protected void processKeyEvent(KeyEvent e) ★`

Parameters *e* The event to process.

Description Key events are passed to this method for processing. Normally, this method is called by `processEvent()`.

processMouseEvent

`protected void processMouseEvent(MouseEvent e) ★`

Parameters *e* The event to process.

Description Mouse events are passed to this method for processing. Normally, this method is called by `processEvent()`.

processMouseMotionEvent

`protected void processMouseMotionEvent(MouseEvent e) ★`

Parameters *e* The event to process.

Description Mouse motion events are passed to this method for processing. Normally, this method is called by `processEvent()`.

See Also

`Button`, `Canvas`, `Checkbox`, `Choice`, `Color`, `ColorModel`, `ComponentPeer`, `Container`, `Dimension`, `Event`, `Font`, `FontMetrics`, `Graphics`, `ImageObserver`, `ImageProducer`, `Label`, `List`, `MenuContainer`, `Object`, `Point`, `PrintStream`, `Rectangle`, `Scrollbar`, `Serializable`, `String`, `TextComponent`, `Toolkit`

19.16 Container

Description

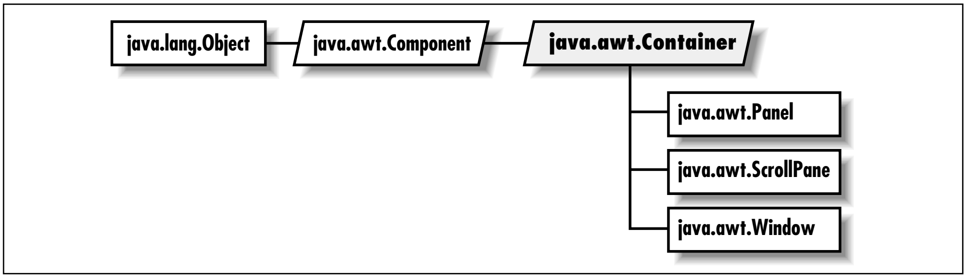
The `Container` class serves as a general purpose holder of other `Component` objects.

Class Definition

```
public abstract class java.awt.Container
    extends java.awt.Component {

  // Constructors
  protected Container(); ★

  // Instance Methods
  public Component add (Component component);
  public Component add (Component component, int position);
```




```
public void add (Component comp, Object constraints); ★
public void add (Component comp, Object constraints,
    int position); ★
public Component add (String name, Component component); ☆
public synchronized void addContainerListener (ContainerListener l); ★
public void addNotify();
public int countComponents();
public void deliverEvent (Event e); ★
public void doLayout(); ★
public float getAlignmentX(); ★
public float getAlignmentY(); ★
public Component getComponent (int n);
public Component getComponentAt (int x, int y);  ★
public Component getComponentAt (Point p);  ★
public int getComponentCount(); ★
public Component[] getComponents();
public Insets getInsets(); ★
public LayoutManager getLayout();
public Dimension getMaximumSize(); ★
public Dimension getMinimumSize();  ★
public Dimension getPreferredSize();  ★
public Insets insets();
public void invalidate(); ★
public boolean isAncestorOf (Component c); ★
public void layout(); ☆
public void list (PrintStream out, int indentation);
public void list (PrintWriter out, int indentation); ★
public Component locate (int x, int y); ☆
public Dimension minimumSize(); ☆
public void paint (Graphics g); ★
public void paintComponents (Graphics g);
public Dimension preferredSize(); ☆
public void print (Graphics g); ★
public void printComponents (Graphics g);
public void remove (int index); ★
public void remove (Component component);
public void removeAll();
public void removeContainerListener (ContainerListener l); ★
```

```
  public void removeNotify();
  public void setLayout (LayoutManager manager);
  public void validate();

  // Protected Instance Methods
  protected void addImpl (Component comp, Object constraints,
      int index); ★
  protected String paramString();
  protected void processContainerEvent (ContainerEvent e); ★
  protected void processEvent (AWTEvent e); ★
  protected void validateTree(); ★
}
```

Constructors

Container

`protected Container()` ★

Description — This constructor creates a "lightweight" container. This constructor allows `Container` to be subclassed using code written entirely in Java.

Instance Methods

add

`public Component add (Component component)`

Parameters	*component*	`Component` to add to container.
Returns	`Component` just added.	
Throws	`IllegalArgumentException` if you add `component` to itself.	
Description	Adds `component` as the last component in the container.	

`public Component add (Component component, int position)`

Parameters	*component*	`Component` to add to container.
	position	Position of component; -1 adds the component as the last in the container.
Returns	`Component just added.`	
Throws	`ArrayIndexOutOfBoundsException`	
		If `position` invalid.
	`IllegalArgumentException`	
		If you add `Component` to itself.
Description	Adds `component` to container at a certain position.	

`public void add (Component component, Object constraints)` ★

Parameters	*component*	`Component` to add to container.
	constraints	An object describing constraints on the component being added.
Description	Adds `component` to container subject to `contraints`.	

`public void add (Component component, Object constraints, int index)` ★

Parameters	*component*	`Component` to add to container.
	constraints	An object describing constraints on the component being added.
	index	The position of the component in the container's list.
Description	Adds `component` to container subject to `contraints` at position `index`.	

`public Component add (String name, Component component)` ☆

Parameters	*name*	Name of component being added. This parameter is often significant to the layout manager of the container (e.g "North", "Center").
	component	`Component` to add to container.
Returns	`Component` just added.	
Throws	*IllegalArgumentException*	
		If you add `component` to itself.
Description	Adds the component to the container with the given `name`. Replaced by the more general `add(Component, Object)`.	

addContainerListener

`public synchronized void addContainerListener (ContainerListener l)` ★

Parameters	*l*	An object that implements the `ContainerListener` interface.
Description	Add a listener for the container events.	

addNotify

`public void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `Container`'s peer and peers of contained components.

countComponents

`public int countComponents()`

Returns	Number of components within `Container`.

deliverEvent

`public void deliverEvent (Event e)` ☆

Parameters	*e*	`Event` instance to deliver.
Overrides	`Component.deliverEvent(Event)`	
Description	Tries to locate the component contained in the container that should receive the event.	

doLayout

`public void doLayout()` ★

Description	Lays out the container. This method is a replacement for `layout()`.

getAlignmentX

`public float getAlignmentX()` ★

Returns	A number between 0 and 1 representing the horizontal alignment of this component.
Overrides	`Component.getAlignmentX()`
Description	If the container's layout manager implements `LayoutManager2`, this method returns the `getLayoutAlignmentX()` value of the layout manager. Otherwise the `getAlignmentX()` value of `Component` is returned.

getAlignmentY

`public float getAlignmentY()` ★

Returns	A number between 0 and 1 representing the vertical alignment of this component.
Overrides	`Component.getAlignmentY()`
Description	If the container's layout manager implements `LayoutManager2`, this method returns the `getLayoutAlignmentY()` value of the layout manager. Otherwise the `getAlignmentY()` value of `Component` is returned.

getComponent

```
public synchronized Component getComponent (int position)
```

Parameters	*position*	Position of component to get.
Throws	`ArrayIndexOutOfBoundsException`	If `position` is invalid.
Returns	`Component` at designated `position` within `Container`.	

getComponentAt

```
public Component getComponentAt (int x, int y) ★
```

Parameters	*x*	The x coordinate, in this `Container`'s coordinate system.
	y	The y coordinate, in this `Container`'s coordinate system.
Returns	Returns the `Component` containing the give point.	

```
public Component getComponentAt (Point p) ★
```

Parameters	*p*	The point to be tested, in this `Container`'s coordinate system.
Returns	Returns the `Component` containing the give point.	

getComponentCount

```
public int getComponentCount() ★
```

Returns — Returns the number of components in the container.

getComponents

```
public Component[] getComponents()
```

Returns — Array of components within the container.

getInsets

```
public Insets getInsets()
```

Returns — The insets of the container.

getLayout

```
public LayoutManager getLayout()
```

Returns — `LayoutManager` of `Container`.

getMaximumSize

`public Dimension getMaximumSize()` ★

Overrides	`Component.getMaximumSize()`
Returns	The maximum dimensions of the component.

getMinimumSize

`public Dimension getMinimumSize()` ★

Overrides	`Component.getMinimumSize()`
Returns	The minimum dimensions of the component.

getPreferredSize

`public Dimension getPreferredSize()` ★

Returns	The preferred dimensions of the component.

insets

`public Insets insets()` ☆

Returns	Current `Insets` of `Container`. Replaced by `getInsets()`.

invalidate

`public void invalidate()`

Overrides	`Component.invalidate()`
Description	Sets the container's valid state to `false`.

isAncestorOf

`public boolean isAncestorOf (Component c)` ★

Parameters	*c*	The component in question.
Returns	If `c` is contained in the container's hierarchy, returns `true`; otherwise `false`.	

layout

`public void layout()` ☆

Overrides	`Component.layout()`
Description	Replaced by `doLayout()`.

list

`public void list (PrintStream out, int indentation)`

Parameters	*out*	Output `Stream` to send results to.
	indentation	Indentation to use when printing.
Overrides	`Component.list(PrintStream, int)`	
Description	Recursively lists all components in `Container`.	

`public void list (PrintWriter out, int indentation)`

Parameters	*out*	Output `Writer` to send results to.
	indentation	Indentation to use when printing.
Overrides	`Component.list(PrintWriter, int)`	
Description	Recursively lists all components in `Container`.	

locate

`public Component locate (int x, int y)` ☆

Parameters	*x*	Horizontal position to check.
	y	Vertical position to check.
Returns	`Component` within `Container` at given coordinates, or `Container`.	
Overrides	`Component.locate(int, int)`	
Description	Replaced by `getComponentAt(int, int)`.	

minimizeSize

`public Dimension minimumSize()` ☆

Returns	Minimum dimensions of contained objects.
Overrides	`Component.minimumSize()`
Description	Replaced by `getMinimumSize()`.

paint

`public void paint (Graphics g)`

Parameters	*g*	Graphics context of container.
Overrides	`Component.paint()`	
Description	This method tells any lightweight components that are children of this container to paint themselves.	

paintComponents

`public void paintComponents (Graphics g)`

Parameters	*g*	Graphics context of `Container`.
Description	Paints the different components in `Container`.	

preferredSize

`public Dimension preferredSize()` ☆

Returns	Preferred dimensions of contained objects.
Overrides	`Component.preferredSize()`
Description	Replaced by `getPreferredSize()`.

print

`public void print (Graphics g)`

Parameters	*g*	Graphics context of container.
Overrides	`Component.print()`	
Description	This method tells any lightweight components that are children of this container to print themselves.	

printComponents

`public void printComponents (Graphics g)`

Parameters	*g*	Graphics context of `Container`.
Description	Prints the different components in `Container`.	

remove

`public void remove (int index)` ★

Parameters	*index*	Index of the component to remove.
Description	Removes the component in position `index` from `Container`.	

`public void remove (Component component)`

Parameters	*component*	`Component` to remove.
Description	Removes `component` from `Container`.	

removeAll

`public void removeAll()`

Description	Removes all components from `Container`.

removeContainerListener

`public void removeContainerListener (ContainerListener l)` ★

Parameters	*l*	One of this `Container`'s `ContainerListeners`.
Description	Remove a container event listener.	

removeNotify

`public void removeNotify()`

Overrides	`Component.removeNotify()`
Description	Removes `Container`'s peer and peers of contained components.

setLayout

`public void setLayout (LayoutManager manager)`

Parameters	*manager*	New `LayoutManager` for `Container`.
Description	Changes `LayoutManager` of `Container`.	

validate

`public void validate()`

Overrides	`Component.validate()`
Description	Sets `Container`'s valid state to `true` and recursively validates its children.

Protected Instance Methods

addImpl

`protected void addImpl (Component comp, Object constraints, int index)` ★

Parameters	*comp*	The component to add.
	constraints	Constraints on the component.
	index	Position at which to add this component. Pass -1 to add the component at the end.
Description	This method adds a component subject to the given constraints at a specific position in the container's list of components. It is a helper method for the various overrides of `add()`.	

paramString

```
protected String paramString()
```

Returns	String with current settings of `Container`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

processContainerEvent

```
protected void processContainerEvent (ContainerEvent e) ★
```

Parameters	*e*	The event to process.
Description	Container events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

processEvent

```
protected void processEvent (AWTEvent e) ★
```

Parameters	*e*	The event to process.
Overrides	`Component.processEvent()`	
Description	Low level `AWTEvents` are passed to this method for processing.	

validateTree

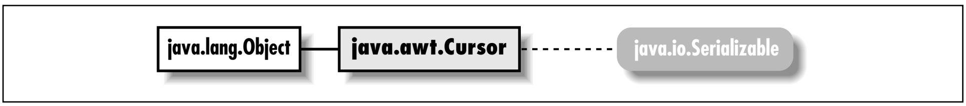
```
protected void validateTree() ★
```

Description	Descends recursively into the `Container`'s components and recalculates layout for any subtrees that are marked invalid.

See Also

`Component`, `Dimension`, `Event`, `Graphics`, `Insets`, `LayoutManager`, `Panel`, `PrintStream`, `String`, `Window`

19.17 Cursor ★



Description

The `Cursor` class represents the mouse pointer. It encapsulates information that used to be in `java.awt.Frame` in the 1.0.2 release.

Class Definition

```
public class java.awt.Cursor
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public final static int CROSSHAIR_CURSOR;
  public final static int DEFAULT_CURSOR;
  public final static int E_RESIZE_CURSOR;
  public final static int HAND_CURSOR;
  public final static int MOVE_CURSOR;
  public final static int N_RESIZE_CURSOR;
  public final static int NE_RESIZE_CURSOR;
  public final static int NW_RESIZE_CURSOR;
  public final static int S_RESIZE_CURSOR;
  public final static int SE_RESIZE_CURSOR;
  public final static int SW_RESIZE_CURSOR;
  public final static int TEXT_CURSOR;
  public final static int W_RESIZE_CURSOR;
  public final static int WAIT_CURSOR;

  // Class Variables
  protected static Cursor[] predefined;

  // Class Methods
  public static Cursor getDefaultCursor();
  public static Cursor getPredefinedCursor (int type);

  // Constructors
  public Cursor (int type);

  // Instance Methods
  public int getType();
}
```

Constants

CROSSHAIR_CURSOR

`public final static int CROSSHAIR_CURSOR`

Constant representing a cursor that looks like a crosshair.

DEFAULT_CURSOR

`public final static int DEFAULT_CURSOR`

Constant representing the platform's default cursor.

E_RESIZE_CURSOR

`public final static int E_RESIZE_CURSOR`

Constant representing the cursor for resizing an object on the left.

HAND_CURSOR

`public final static int HAND_CURSOR`

Constant representing a cursor that looks like a hand.

MOVE_CURSOR

`public final static int MOVE_CURSOR`

Constant representing a cursor used to move an object.

N_RESIZE_CURSOR

`public final static int N_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top.

NE_RESIZE_CURSOR

`public final static int NE_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top left corner.

NW_RESIZE_CURSOR

`public final static int NW_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top right corner.

S_RESIZE_CURSOR

`public final static int S_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom.

SE_RESIZE_CURSOR

`public final static int SE_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom left corner.

SW_RESIZE_CURSOR

`public final static int SW_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom right corner.

TEXT_CURSOR

`public final static int TEXT_CURSOR`

Constant representing a cursor used within text.

W_RESIZE_CURSOR

`public final static int W_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the right side.

WAIT_CURSOR

`public final static int WAIT_CURSOR`

Constant representing a cursor that indicates the program is busy.

Class Variables

predefined

`protected static Cursor[] predefined`

An array of cursor instances corresponding to the predefined cursor types.

Class Methods

getDefaultCursor

`public static Cursor getDefaultCursor()`

Returns	The default system cursor.

getPredefinedCursor

```
public static Cursor getPredefinedCursor (int type)
```

Parameters *type* One of the type constants defined in this class.
Returns A `Cursor` object with the specified type.

Constructors

Cursor

```
public Cursor (int type)
```

Parameters *type* One of the type constants defined in this class.
Description Constructs a `Cursor` object with the specified type.

Instance Methods

getType

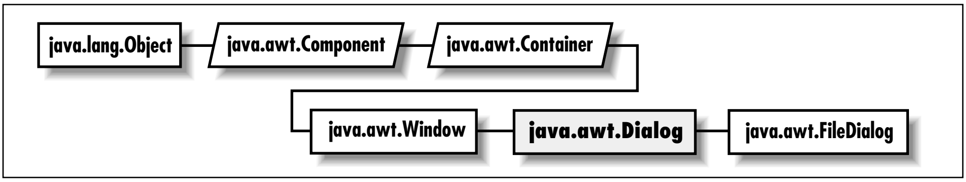
```
public int getType()
```

Returns The type of cursor.

See Also

`Frame`

19.18 Dialog



Description

The `Dialog` class provides a special type of display window that is used for pop-up messages and acquiring input from the user. Unlike most other components, dialogs are hidden by default; you must call `show()` to display them. Dialogs are always associated with a parent `Frame`. A `Dialog` may be either modal or non-modal; a modal dialog attracts all input typed by the user. The default layout for a `Dialog` is `BorderLayout`.

Class Definition

```
public class java.awt.Dialog
    extends java.awt.Window {

  // Constructors
  public Dialog (Frame parent); ★
  public Dialog (Frame parent, boolean modal);
  public Dialog (Frame parent, String title); ★
  public Dialog (Frame parent, String title, boolean modal);

  // Instance Methods
  public void addNotify();
  public String getTitle();
  public boolean isModal();
  public boolean isResizable();
  public void setModal (boolean b); ★
  public synchronized void setResizable (boolean resizable);
  public synchronized void setTitle (String title);
  public void show(); ★

  // Protected Instance Methods
  protected String paramString();
}
```

Constructors

Dialog

`public Dialog (Frame parent)` ★

Parameters	*parent*	`Frame` that is to act as the parent of `Dialog`.
Throws	`IllegalArgumentException`	
		If `parent` is `null`.
Description	Constructs a `Dialog` object.	

`public Dialog (Frame parent, boolean modal)`

Parameters	*parent*	`Frame` that is to act as the parent of `Dialog`.
	modal	`true` if the `Dialog` is modal; `false` otherwise.
Throws	`IllegalArgumentException`	
		If `parent` is `null`.
Description	Replaced with `Dialog(Frame, String, boolean)`.	

`public Dialog (Frame parent, String title)` ★

Parameters	*parent*	`Frame` that is to act as parent of `Dialog`.
	title	Initial title to use for `Dialog`.

Throws	`IllegalArgumentException`	
		If `parent` is `null`.
Description	Constructs a `Dialog` object with given characteristics.	

`public Dialog (Frame parent, String title, boolean modal)`

Parameters	*parent*	`Frame` that is to act as parent of `Dialog`.
	title	Initial title to use for `Dialog`.
	modal	`true` if the `Dialog` is modal; `false` otherwise.
Throws	`IllegalArgumentException`	
		If `parent` is `null`.
Description	Constructs a `Dialog` object with given characteristics.	

Instance Methods

addNotify

`public void addNotify()`

Overrides	`Window.addNotify()`
Description	Creates `Dialog`'s peer and peers of contained components.

getTitle

`public String getTitle()`

Returns	The current title for the `Dialog`.

isModal

`public boolean isModal()`

Returns	`true` if modal, `false` otherwise.

isResizable

`public boolean isResizable()`

Returns	`true` if resizable, `false` otherwise.

setModal

`public void setModal (boolean b)` ★

Parameters	*b*	`true` makes the `Dialog` modal; `false` if the `Dialog` should be modeless.
Description	Changes the modal state of the `Dialog`.	

setResizable

```
public synchronized void setResizable (boolean resizable)
```

Parameters	*resizable*	`true` makes the `Dialog` resizable; `false` if the `Dialog` cannot be resized.
Description	Changes the resize state of the `Dialog`.	

setTitle

```
public synchronized void setTitle (String title)
```

Parameters	*title*	New title for the `Dialog`.
Description	Changes the title of the `Dialog`.	

show

```
public void show() ★
```

Overrides	`Window.show()`
Description	If the dialog is hidden, this method shows it. If the dialog is already visible, this method brings it to the front.

Protected Instance Methods

paramString

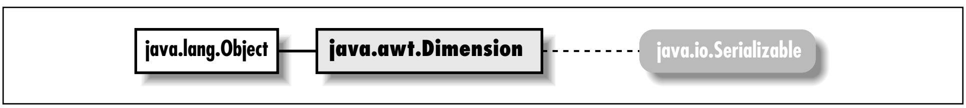
```
protected String paramString()
```

Returns	String with current settings of `Dialog`.
Overrides	`Container.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`FileDialog`, `Frame`, `String`, `Window`, `WindowEvent`, `WindowListener`

19.19 Dimension



Description

The `Dimension` class encapsulates width and height in a single object.

Class Definition

```
public class java.awt.Dimension
    extends java.lang.Object
    implements java.io.Serializable {

  // Variables
  public int height;
  public int width;

  // Constructors
  public Dimension();
  public Dimension (int width, int height);
  public Dimension (Dimension d);

  // Instance Methods
  public boolean equals (Object obj); ★
  public Dimension getSize(); ★
  public void setSize (Dimension d); ★
  public void setSize (int width, int height); ★
  public String toString();
}
```

Variables

height

`public int height`

The height of the `Dimension`.

width

`public int width`

The width of the `Dimension`.

Constructors

Dimension

`public Dimension()`

Description Constructs an empty `Dimension` object.

`public Dimension (int width, int height)`

Parameters *width* Initial width of the object
height Initial height of the object
Description Constructs a `Dimension` object with an initial dimension of `width` x `height`.

`public Dimension (Dimension d)`

Parameters *d* Initial dimensions of the object
Description Constructs a `Dimension` object that is a clone of `d`.

Instance Methods

equals

`public boolean equals (Object obj)` ★

Parameters *obj* The object to compare.
Returns `true` if this `Dimension` is equivalent to `obj`; false otherwise.
Overrides `Object.equals(Object)`
Description Compares two `Dimension` instances.

getSize

`public Dimension getSize()` ★

Returns The size of the `Dimension`.

setSize

`public void setSize (Dimension d)` ★

Parameters *d* The new size.
Description Changes the size of the `Dimension`.

`public void setSize (int width, int height)` ★

Parameters *width* The new width.
height The new height.
Description Changes the size of the `Dimension`.

toString

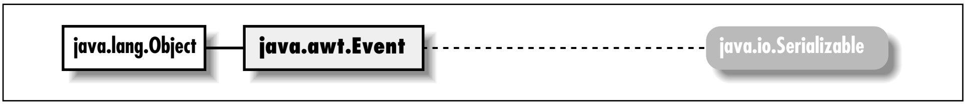
`public String toString()`

Returns A string representation of the `Dimension` object.
Overrides `Object.toString()`

See Also

Object, String, Serializable

19.20 Event



Description

The `Event` class represents events that happen within the Java environment in a platform independent way. Events typically represent user actions, like typing a key or clicking the mouse. Although this class has been updated for the 1.1 release, it is only used for the 1.0 event model. When using the 1.1 event model, all events are represented by subclasses of `java.awt.AWTEvent`.

Class Definition

```
public class java.awt.Event
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public static final int ACTION_EVENT;
  public static final int ALT_MASK;
  public static final int BACK_SPACE; ★
  public static final int CAPS_LOCK; ★
  public static final int CTRL_MASK;
  public static final int DELETE; ★
  public static final int DOWN;
  public static final int END;
  public static final int ENTER; ★
  public static final int ESCAPE; ★
  public static final int F1;
  public static final int F2;
  public static final int F3;
  public static final int F4;
  public static final int F5;
  public static final int F6;
  public static final int F7;
  public static final int F8;
  public static final int F9;
  public static final int F10;
  public static final int F11;
  public static final int F12;
```

```
public static final int GOT_FOCUS;
public static final int HOME;
public static final int INSERT; ★
public static final int KEY_ACTION;
public static final int KEY_ACTION_RELEASE;
public static final int KEY_PRESS;
public static final int KEY_RELEASE;
public static final int LEFT;
public static final int LIST_DESELECT;
public static final int LIST_SELECT;
public static final int LOAD_FILE;
public static final int LOST_FOCUS;
public static final int META_MASK;
public static final int MOUSE_DOWN;
public static final int MOUSE_DRAG;
public static final int MOUSE_ENTER;
public static final int MOUSE_EXIT;
public static final int MOUSE_MOVE;
public static final int MOUSE_UP;
public static final int NUM_LOCK; ★
public static final int PAUSE; ★
public static final int PGDN;
public static final int PGUP;
public static final int PRINT_SCREEN; ★
public static final int RIGHT;
public static final int SAVE_FILE;
public static final int SCROLL_ABSOLUTE;
public static final int SCROLL_BEGIN; ★
public static final int SCROLL_END; ★
public static final int SCROLL_LINE_DOWN;
public static final int SCROLL_LINE_UP;
public static final int SCROLL_LOCK; ★
public static final int SCROLL_PAGE_DOWN;
public static final int SCROLL_PAGE_UP;
public static final int SHIFT_MASK;
public static final int TAB; ★
public static final int UP;
public static final int WINDOW_DEICONIFY;
public static final int WINDOW_DESTROY;
public static final int WINDOW_EXPOSE;
public static final int WINDOW_ICONIFY;
public static final int WINDOW_MOVED;

// Variables
public Object arg;
public int clickCount;
public Event evt;
public int id;
public int key;
```

```
    public int modifiers;
    public Object target;
    public long when;
    public int x;
    public int y;

    // Constructors
    public Event (Object target, int id, Object arg);
    public Event (Object target, long when, int id, int x, int y,
        int key, int modifiers);
    public Event (Object target, long when, int id, int x, int y,
        int key, int modifiers, Object arg);

    // Instance Methods
    public boolean controlDown();
    public boolean metaDown();
    public boolean shiftDown();
    public String toString();
    public void translate (int x, int y);

    // Protected Instance Methods
    protected String paramString();
}
```

Constants

ACTION_EVENT

`public static final int ACTION_EVENT`

ID constant for Action Event.

ALT_MASK

`public static final int ALT_MASK`

Mask for ALT key.

BACK_SPACE

`public static final int BACK_SPACE` ★

ID constant for Backspace.

CAPS_LOCK

`public static final int CAPS_LOCK` ★

ID constant for Caps Lock key.

CTRL_MASK

`public static final int CTRL_MASK`

Mask for Control key.

DELETE

`public static final int DELETE` ★

ID constant for Delete.

DOWN

`public static final int DOWN`

ID constant for the down arrow key.

END

`public static final int END`

ID constant for End key.

ENTER

`public static final int ENTER` ★

ID constant for Enter key.

ESCAPE

`public static final int ESCAPE` ★

ID constant for Escape key.

F1

`public static final int F1`

ID constant for F1 key.

F2

`public static final int F2`

ID constant for F2 key.

F3

`public static final int F3`

ID constant for F3 key.

F4

```
public static final int F4
```

ID constant for F4 key.

F5

```
public static final int F5
```

ID constant for F5 key.

F6

```
public static final int F6
```

ID constant for F6 key.

F7

```
public static final int F7
```

ID constant for F7 key.

F8

```
public static final int F8
```

ID constant for F8 key.

F9

```
public static final int F9
```

ID constant for F9 key.

F10

```
public static final int F10
```

ID constant for F10 key.

F11

```
public static final int F11
```

ID constant for F11 key.

F12

```
public static final int F12
```

ID constant for F12 key.

GOT_FOCUS

`public static final int GOT_FOCUS`

ID constant for getting input focus `Event`.

HOME

`public static final int HOME`

ID constant for Home key.

INSERT

`public static final int INSERT` ★

ID constant for Insert key.

KEY_ACTION

`public static final int KEY_ACTION`

ID constant for Special Key Down Event.

KEY_ACTION_RELEASE

`public static final int KEY_ACTION_RELEASE`

ID constant for Special Key Up Event.

KEY_PRESS

`public static final int KEY_PRESS`

ID constant for Key Down `Event`.

KEY_RELEASE

`public static final int KEY_RELEASE`

ID constant for Key Up `Event`.

LEFT

`public static final int LEFT`

ID constant for the left arrow key.

LIST_DESELECT

`public static final int LIST_DESELECT`

ID constant for List DeSelect `Event`.

LIST_SELECT

`public static final int LIST_SELECT`

ID constant for List Select `Event`.

LOAD_FILE

`public static final int LOAD_FILE`

ID constant for File Load `Event`.

LOST_FOCUS

`public static final int LOST_FOCUS`

ID constant for losing input focus `Event`.

META_MASK

`public static final int META_MASK`

Mask for ALT key.

MOUSE_DOWN

`public static final int MOUSE_DOWN`

ID constant for Mouse Down `Event`.

MOUSE_DRAG

`public static final int MOUSE_DRAG`

ID constant for Mouse Drag `Event`.

MOUSE_ENTER

`public static final int MOUSE_ENTER`

ID constant for Mouse Enter `Event`.

MOUSE_EXIT

`public static final int MOUSE_EXIT`

ID constant for Mouse Exit `Event`.

MOUSE_MOVE

`public static final int MOUSE_MOVE`

ID constant for Mouse Move `Event`.

MOUSE_UP

`public static final int MOUSE_UP`

ID constant for Mouse Up `Event`.

NUM_LOCK

`public static final int NUM_LOCK` ★

ID constant for Num Lock key.

PAUSE

`public static final int PAUSE` ★

ID constant for Pause key.

PGDN

`public static final int PGDN`

ID constant for PageDown key.

PGUP

`public static final int PGUP`

ID constant for PageUp key.

PRINT_SCREEN

`public static final int PRINT_SCREEN` ★

ID constant for Print Screen key.

RIGHT

`public static final int RIGHT`

ID constant for the right arrow key.

SAVE_FILE

`public static final int SAVE_FILE`

ID constant for File Save `Event`.

SCROLL_ABSOLUTE

`public static final int SCROLL_ABSOLUTE`

ID constant for Absolute Scroll `Event`.

SCROLL_BEGIN

`public static final int SCROLL_ BEGIN` ★

ID constant for Begin Scroll `Event`.

SCROLL_END

`public static final int SCROLL_ END` ★

ID constant for End Scroll `Event`.

SCROLL_LINE_DOWN

`public static final int SCROLL_LINE_DOWN`

ID constant for Line Down Scroll `Event`.

SCROLL_LINE_UP

`public static final int SCROLL_LINE_UP`

ID constant for Line Up Scroll `Event`.

SCROLL_LOCK

`public static final int SCROLL_LOCK` ★

Mask for Scroll Lock key.

SCROLL_PAGE_DOWN

`public static final int SCROLL_PAGE_DOWN`

ID constant for Page Down Scroll `Event`.

SCROLL_PAGE_UP

`public static final int SCROLL_PAGE_UP`

ID constant for Page Up Scroll `Event`.

SHIFT_MASK

`public static final int SHIFT_MASK`

Mask for SHIFT key.

TAB

`public static final int TAB` ★

ID constant for Tab key.

UP

`public static final int UP`

ID constant for the up arrow key.

WINDOW_DEICONIFY

`public static final int WINDOW_DEICONIFY`

ID constant for Window DeIconify `Event`.

WINDOW_DESTROY

`public static final int WINDOW_DESTROY`

ID constant for Window Destroy `Event`.

WINDOW_EXPOSE

`public static final int WINDOW_EXPOSE`

ID constant for Window Expose `Event`.

WINDOW_ICONIFY

`public static final int WINDOW_ICONIFY`

ID constant for Window Iconify `Event`.

WINDOW_MOVED

`public static final int WINDOW_MOVED`

ID constant for Window Move `Event`.

Variables

arg

`public Object arg`

A variable argument that is specific to the event type.

clickCount

`public int clickCount`

The number of consecutive MOUSE_DOWN events.

evt

```
public Event evt
```

A means of passing a linked list of events as one.

id

```
public int id
```

The ID constant that identifies the `Event` type.

key

```
public int key
```

Integer value of key pressed, or ID constant identifying a special key.

modifiers

```
public int modifiers
```

The state of the shift/alt/control/meta keys, formed by ORing the masks for the appropriate keys.

target

```
public Object target
```

The `Object` that generated the event.

when

```
public long when
```

The time the event happened.

x

```
public int x
```

The x position at which the event happened.

y

```
public int y
```

The y position at which the event happened.

Constructors

Event

`public Event (Object target, int id, Object arg)`

Parameters	*target*	The component to which the `Event` should be delivered
	id	The identifier of `Event`
	arg	The `Object` that is the cause of the event
Description	Constructs an `Event` object with the given values.	

`public Event (Object target, long when, int id, int x, int y, int key, int modifiers)`

Parameters	*target*	The component to which the `Event` should be delivered
	when	The time the event happened
	id	The identifier of `Event`
	x	The x position at which the event happened
	y	The y position at which the event happened
	key	Integer value of key pressed, or a constant identifying a special key
	modifiers	The state of the shift/alt/control/meta keys
Description	Constructs an `Event` object with the given values.	

`public Event (Object target, long when, int id, int x, int y, int key, int modifiers, Object arg)`

Parameters	*target*	The component to which the `Event` should be delivered
	when	The time the event happened
	id	The identifier of `Event`
	x	The x position at which the event happened
	y	The y position at which the event happened
	key	Integer value of key pressed, or a constant identifying a special key
	modifiers	The state of the shift/alt/control/meta keys
	arg	The `Object` that is the cause of the event
Description	Constructs an `Event` object with the given values.	

Instance Methods

controlDown

`public boolean controlDown()`

Returns	`true` if the control key was down when the event was triggered, `false` otherwise.
Description	Checks current settings for modifiers of the `Event`.

metaDown

`public boolean metaDown()`

Returns	`true` if the meta key was down when the event was triggered, `false` otherwise.
Description	Checks current settings for modifiers of the `Event`.

shiftDown

`public boolean shiftDown()`

Returns	`true` if the shift key was down when the event was triggered, `false` otherwise.
Description	Checks current settings for modifiers of the `Event`.

toString

`public String toString()`

Returns	A string representation of the `Event` object.
Overrides	`Object.toString()`

translate

`public void translate (int x, int y)`

Parameters	*x*	Amount to move `Event` in horizontal direction.
	y	Amount to move `Event` in vertical direction.
Description	Translates x and y coordinates of `Event` instance by `x` and `y`.	

Protected Instance Methods

paramString

`protected String paramString()`

Returns	String with current settings of `Event`.
Description	Helper method for `toString()` to generate string of current settings.

See Also

`AWTEvent`, `Component`, `Object`, `String`

19.21 EventQueue ★

Description

The `EventQueue` class is a facility for queuing Java 1.1 AWT events, either for the system or for some other purpose. You rarely need to create your own event queue; for most purposes, you will want to work with the system's event queue, which you acquire using the `Toolkit`.

Class Definition

```
public class EventQueue extends Object {

  // Constructor
  public EventQueue();

  // Instance Methods
  public synchronized AWTEvent getNextEvent() throws InterruptedException;
  public synchronized AWTEvent peekEvent();
  public synchronized AWTEvent peekEvent (int id);
  public synchronized void postEvent (AWTEvent theEvent);
}
```

Constructor

EventQueue

```
public EventQueue()
```

Description　Creates an `EventQueue` for your own use.

Instance Methods

getNextEvent

```
public synchronized AWTEvent getNextEvent() throws
InterruptedException
```

Throws　`InterruptedException`
　　If the thread is interrupted before an event is posted to the queue.

Returns AWTEvent taken from the event queue.

Description Removes the next event from the event queue and returns it. If there are no events in the queue, this method will block until another thread posts one.

peekEvent

```
public synchronized AWTEvent peekEvent()
```

Returns Next AWTEvent on the event queue.

Description Returns a reference to the next event on the queue without removing it from the queue.

```
public synchronized AWTEvent peekEvent (int id)
```

Parameters *id* Type of event to find.

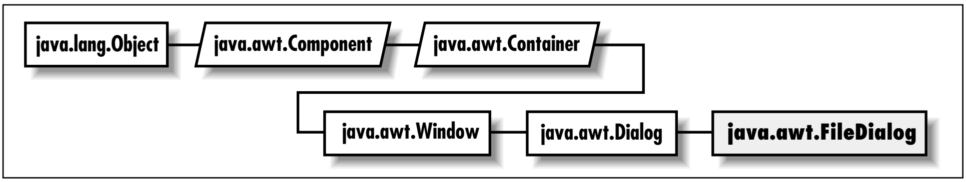
Returns AWTEvent with the given type id; null if no event with the given type is currently in the queue.

Description Returns an event with the given type if one exists, but doesn't remove the event from the queue.

See Also

AWTEvent, Event

19.22 FileDialog



Description

The FileDialog class provides file selection capabilities for opening or saving files. Because FileDialog is a subclass of Dialog, a FileDialog is always associated with a Frame and is hidden by default. FileDialogs are always modal (i.e., they always attract all user input). In addition, FileDialogs have a load/save mode; the LOAD mode is for selecting files for an application to load, SAVE is for selecting a filename to save.

Class Definition

```
public class java.awt.FileDialog
    extends java.awt.Dialog {

  // Constants
  public final static int LOAD;
  public final static int SAVE;

  // Constructors
  public FileDialog (Frame parent); ★
  public FileDialog (Frame parent, String title);
  public FileDialog (Frame parent, String title, int mode);

  // Instance Methods
  public void addNotify();
  public String getDirectory();
  public String getFile();
  public FilenameFilter getFilenameFilter();
  public int getMode();
  public synchronized void setDirectory (String directory);
  public synchronized void setFile (String file);
  public synchronized void setFilenameFilter (FilenameFilter filter);
  public void setMode(int mode); ★

  // Protected Instance Methods
  protected String paramString();
}
```

Constants

LOAD

`public final static int LOAD`

Constant to specify the `FileDialog`'s load mode.

SAVE

`public final static int SAVE`

Constant to specify the `FileDialog`'s save mode.

Constructors

FileDialog

`public FileDialog (Frame parent)` ★

Parameters	*parent*	`Frame` that is to act as parent of `FileDialog`.

Description	Constructs a `FileDialog` object in `LOAD` mode.	

`public FileDialog (Frame parent, String title)`

Parameters	*parent*	`Frame` that is to act as parent of `FileDialog`.
	title	Title to use for `FileDialog`.
Description	Constructs a `FileDialog` object in `LOAD` mode.	

`public FileDialog (Frame parent, String title, int mode)`

Parameters	*parent*	`Frame` that is to act as parent of `Dialog`.
	title	Title to use for `FileDialog`.
	mode	The constant `LOAD` or `SAVE`, specifying the dialog's mode.
Description	Constructs a `FileDialog` object in the given mode.	

Instance Methods

addNotify

`public void addNotify()`

Overrides	`Dialog.addNotify()`
Description	Creates `FileDialog`'s peer for the native platform.

getDirectory

`public String getDirectory()`

Returns	The current directory for the `FileDialog`.

getFile

`public String getFile()`

Returns	The current file selected by the `FileDialog`.

getFilenameFilter

`public FilenameFilter getFilenameFilter()`

Returns	The current filename filter for the `FileDialog`.

getMode

`public int getMode()`

Returns	The current mode of the `FileDialog`.

setDirectory

`public synchronized void setDirectory (String directory)`

Parameters	*directory*	Directory to be displayed by the `FileDialog`.
Description	Changes the directory displayed in the `FileDialog`.	

setFile

`public synchronized void setFile (String file)`

Parameters	*file*	Initial file string for `FileDialog`.
Description	Change the default file selected by the `FileDialog`.	

setFilenameFilter

`public synchronized void setFilenameFilter (FilenameFilter filter)`

Parameters	*filter*	Initial filter for `FileDialog`.
Description	Changes the current filename filter of the `FileDialog`.	

setMode

`public void setMode (int mode)` ★

Parameters	*mode*	The constant `LOAD` or `SAVE`, specifying the dialog's mode.
Description	Change the mode of the file dialog.	

Protected Instance Methods

paramString

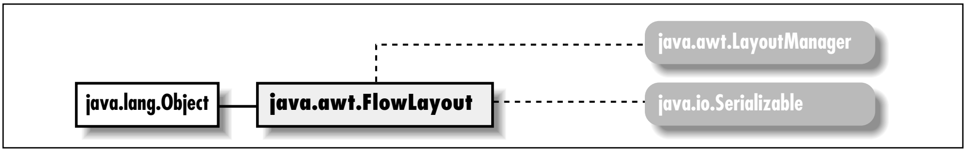
`protected String paramString()`

Returns	String with current settings of `FileDialog`.
Overrides	`Dialog.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`Dialog`, `FilenameFilter`, `String`

19.23 FlowLayout



Description

The `FlowLayout` `LayoutManager` provides the means to lay out components in a row by row fashion. As each row fills up, the components continue on the next row.

Class Definition

```
public class java.awt.FlowLayout
    extends java.lang.Object
    implements java.awt.LayoutManager, java.io.Serializable {

  // Constants
  public static final int CENTER;
  public static final int LEFT;
  public static final int RIGHT;

  // Constructors
  public FlowLayout();
  public FlowLayout (int alignment);
  public FlowLayout (int alignment, int hgap, int vgap);

  // Instance Methods
  public void addLayoutComponent (String name, Component component);
  public int getAlignment(); ★
  public int getHgap(); ★
  public int getVgap(); ★
  public void layoutContainer (Container target);
  public Dimension minimumLayoutSize (Container target);
  public Dimension preferredLayoutSize (Container target);
  public void removeLayoutComponent (Component component);
  public void setAlignment (int align); ★
  public void setHgap (int hgap); ★
  public void setVgap (int vgap); ★
  public String toString();
}
```

Constants

CENTER

```
public static final int CENTER
```

The default alignment for a `FlowLayout` object; rows of components are centered within the container.

LEFT

```
public static final int LEFT
```

An alignment for a `FlowLayout` object; rows of components start on the left side of the container.

RIGHT

```
public static final int RIGHT
```

An alignment for a `FlowLayout` object; rows of components start on the right side of the container.

Constructors

FlowLayout

```
public FlowLayout()
```

Description	Constructs a `FlowLayout` object with `CENTER` alignment.	

```
public FlowLayout (int alignment)
```

Parameters	*alignment*	Alignment of components within the container.
Description	Constructs a `FlowLayout` object with the given `alignment`.	

```
public FlowLayout (int alignment, int hgap, int vgap)
```

Parameters	*alignment*	Alignment of components within container
	hgap	Horizontal space between each component in a row
	vgap	Vertical space between each row
Description	Constructs a `FlowLayout` object with the given `alignment` and the values specified as the gaps between each component in the container managed by this instance of `FlowLayout`.	

Instance Methods

addLayoutComponent

`public void addLayoutComponent (String name, Component component)`

Parameters	*name*	Name of component to add.
	component	Actual component being added.
Implements	`LayoutManager.addLayoutComponent()`	
Description	Does nothing.	

getAlignment

`public int getAlignment()` ★

Returns	The alignment constant for this `FlowLayout`.

getHgap

`public int getHgap()` ★

Returns	The horizontal gap between components.

getVgap

`public int getVgap()` ★

Returns	The vertical gap between components.

layoutContainer

`public void layoutContainer (Container target)`

Parameters	*target*	The container that needs to be redrawn.
Implements	`LayoutManager.layoutContainer()`	
Description	Draws the components contained within the `target` container.	

minimumLayoutSize

`public Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of container `target`	
Implements	`LayoutManager.minimumLayoutSize()`	
Description	Calculates minimum size of `target` container.	

preferredLayoutSize

`public Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of container `target`	
Implements	`LayoutManager.preferredLayoutSize()`	
Description	Calculates preferred size of `target` container.	

removeLayoutComponent

`public void removeLayoutComponent (Component component)`

Parameters	*component*	Component to stop tracking.
Implements	`LayoutManager.removeLayoutComponent()`	
Description	Does nothing.	

setAlignment

`public void setAlignment(int align)` ★

Parameters	*alignment*	Alignment of components within container
Description	Sets the alignment for the `FlowLayout`.	

setHgap

`public void setHgap(int hgap)` ★

Parameters	*hgap*	The horizontal gap value.
Description	Sets the horizontal gap between components.	

setVgap

`public void setVgap(int vgap)` ★

Parameters	*vgap*	The vertical gap value.
Description	Sets the vertical gap between components.	

toString

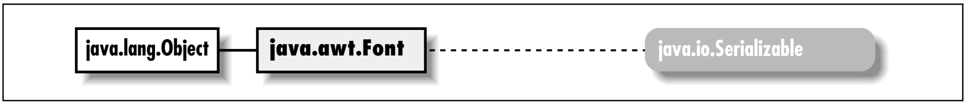
`public String toString()`

Returns	A string representation of the `FlowLayout` object.
Overrides	`Object.toString()`

See Also

`Component`, `Container`, `Dimension`, `LayoutManager`, `Object`, `Serializable`, `String`

19.24 Font



Description

The `Font` class represents a specific font to the system.

Class Definition

```
public class java.awt.Font
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public static final int BOLD;
  public static final int ITALIC;
  public static final int PLAIN;

  // Variables
  protected String name;
  protected int size;
  protected int style;

  // Constructors
  public Font (String name, int style, int size);

  // Class Methods
  public static Font decode (String str); ★
  public static Font getFont (String name)
  public static Font getFont (String name, Font defaultFont)

  // Instance Methods
  public boolean equals (Object object);
  public String getFamily();
  public String getName();
  public FontPeer getPeer(); ★
  public int getSize();
  public int getStyle();
  public int hashCode();
  public boolean isBold();
  public boolean isItalic();
  public boolean isPlain();
  public String toString();
}
```

Constants

BOLD

```
public static final int BOLD
```

Constant for specifying bold fonts.

ITALIC

```
public static final int ITALIC
```

Constant for specifying fonts.

PLAIN

```
public static final int PLAIN
```

Constant for specifying plain fonts.

Variables

name

```
protected String name
```

The font's logical name.

size

```
protected int size
```

The font size; allegedly in points, though probably not true typographer's points.

style

```
protected int style
```

The font style, e.g., bold or italic or a combination thereof.

Constructors

Font

```
public Font (String name, int style, int size)
```

Parameters	*name*	The name of the desired font.
	style	One of the style flags (`PLAIN`, `BOLD`, or `ITALIC`) or a combination.
	size	The size of the font to create.
Description	Constructs a `Font` object with the given characteristics.	

Class Methods

decode

`public static Font decode (String str)` ★

Parameters	*str*	The string describing the font.
Returns	`Font` instance requested, or default if `str` is invalid.	
Description	Gets font specified by `str`.	

getFont

`public static Font getFont (String name)`

Parameters	*name*	The name of a system property specifying a font to fetch.
Returns	`Font` instance for name requested, or null if `name` is invalid.	
Description	Gets font specified by the system property `name`.	

`public static Font getFont (String name, Font defaultFont)`

Parameters	*name*	The name of a system property specifying a font to fetch.
	defaultFont	Font to return if `name` not found in properties.
Returns	`Font` instance of name requested, or `defaultFont` if `name` is invalid	
Description	Gets font specified by the system property `name`.	

Instance Methods

equals

`public boolean equals (Object object)`

Parameters	*object*	The object to compare.
Returns	`true` if the objects are equivalent fonts (same name, style, and point size), `false` otherwise.	
Overrides	`Object.equals(Object)`	
Description	Compares two different `Font` instances for equivalence.	

getFamily

`public String getFamily()`

Returns	Retrieves the actual name of the font.

getName

`public String getName()`

Returns — Retrieves the logical name of the font.

getPeer

`public FontPeer getPeer()` ★

Returns — The font's peer.

getSize

`public int getSize()`

Returns — Retrieves the `size` parameter from creation

getStyle

`public int getStyle()`

Returns — Retrieves the `style` parameter from creation.

hashCode

`public int hashCode()`

Returns — A hashcode to use when using the `Font` as a key in a `Hashtable`.
Overrides — `Object.hashCode()`
Description — Generates a hashcode for the `Font`.

isBold

`public boolean isBold()`

Returns — `true` if `Font` style is bold, `false` otherwise.

isItalic

`public boolean isItalic()`

Returns — `true` if `Font` style is italic, `false` otherwise.

isPlain

`public boolean isPlain()`

Returns — `true` if `Font` style is neither bold nor italic, `false` otherwise.

toString

```
public String toString()
```

Returns A string representation of the `Font` object.
Overrides `Object.toString()`

See Also

`FontMetrics`, `Object`, `Properties`, `String`

19.25 FontMetrics

Description

The `FontMetrics` class provides the means to calculate actual width and height of text if drawn on the screen.

Class Definition

```
public abstract class java.awt.FontMetrics
    extends java.lang.Object
    implements java.io.Serializable {

  // Variables
  protected Font font;

  // Constructors
  protected FontMetrics (Font font);

  // Instance Methods
  public int bytesWidth (byte data[], int offset, int length);
  public int charsWidth (char data[], int offset, int length);
  public int charWidth (char character);
  public int charWidth (int character);
  public int getAscent();
  public int getDescent();
  public Font getFont();
  public int getHeight();
  public int getLeading();
  public int getMaxAdvance();
  public int getMaxAscent();
  public int getMaxDecent();
  public int getMaxDescent();
```

```
  public int[] getWidths();
  public int stringWidth (String string);
  public String toString();
}
```

Variables

font

```
protected Font font
```

The `Font` object whose metrics are represented by this object.

Constructors

FontMetrics

```
protected FontMetrics (Font font)
```

Parameters	*font*	The `Font` object whose metrics you want.
Description	Constructs a platform specific `FontMetrics` object for the given `font`.	

Instance Methods

bytesWidth

```
public int bytesWidth (byte data[], int offset, int
length)
```

Parameters	*data[]*	Array of characters to lookup.
	offset	Initial character position.
	length	Number of characters to lookup.
Returns	Advance width of characters in the array, starting with `offset` and ending with `offset+length`, in pixels.	
Throws	*ArrayIndexOutOfBoundsException*	
		If `offset` or `length` is invalid.

charsWidth

```
public int charsWidth (char data[], int offset, int
length)
```

Parameters	*data[]*	Array of characters to lookup.
	offset	Initial character position.
	length	Number of characters to lookup.
Returns	Advance width of characters in the array, starting with `offset` and ending with `offset+length-1`, in pixels.	

Throws *ArrayIndexOutOfBoundsException*
If `offset` or `length` is invalid.

`charWidth`

`public int charWidth (char character)`

Parameters *character* character to lookup
Returns Advanced pixel width of character.

`public int charWidth (int character)`

Parameters *character* int value of character to lookup
Returns Advanced pixel width of character.

`getAscent`

`public int getAscent()`

Returns Amount of space above the baseline required for the tallest character in the font.

`getDescent`

`public int getDescent()`

Returns Amount of space below the baseline required for the lowest descender (e.g., the tail on "p") in the font.

`getFont`

`public Font getFont()`

Returns The `Font` whose metrics are represented by this object.

`getHeight`

`public int getHeight()`

Returns The sum of `getDescent()`, `getAscent()`, and `getLeading()`; recommended total space between baselines.

`getLeading`

`public int getLeading()`

Returns Retrieves recommended amount of space between lines of text.

getMaxAdvance

```
public int getMaxAdvance()
```

Returns — Retrieves advance pixel width of widest character in the font.

getMaxAscent

```
public int getMaxAscent()
```

Returns — Retrieves maximum amount of space above the baseline required for the tallest character within the font's `FontMetrics`. May differ from `getAscent()` for characters with diacritical marks.

getMaxDecent

```
public int getMaxDecent()
```

Returns — Retrieves the maximum amount of space below the baseline required for the deepest character for the font.

Description — A misspelling of `getMaxDescent()`.

getMaxDescent

```
public int getMaxDescent()
```

Returns — Retrieves the maximum amount of space below the baseline required for the deepest character for the font.

getWidths

```
public int[] getWidths()
```

Returns — 255 element array of character widths.

Description — Retrieves an integer array of the advance widths of the first 255 characters in the `FontMetrics`' font.

stringWidth

```
public int stringWidth (String string)
```

Parameters — *string* — Character string to lookup.

Returns — Advance pixel width of `string`.

toString

```
public String toString()
```

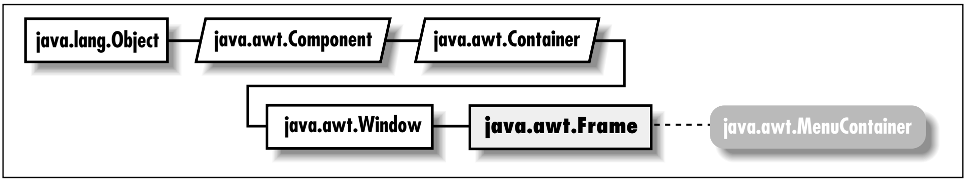
Returns A string representation of the FontMetrics object.

Overrides `Object.toString()`

See Also

Font, Object, String

19.26 Frame



Description

The `Frame` class is a special type of `Window` that will appear like other high-level programs in your windowing environment. It adds a `MenuBar`, window title, and window gadgets (like resize, maximize, minimize, window menu) to the basic `Window` object. Frames are initially invisible; call `show()` to display them. Frames may also be associated with an `Image` to be used as an icon. The `Frame` class includes many constants to represent different cursor styles. All styles aren't necessarily available on any platform. In 1.1, these constants are defined in `java.awt.Cursor`.

Class Definition

```
public class java.awt.Frame
    extends java.awt.Window
    implements java.awt.MenuContainer {

  // Constants
  public final static int CROSSHAIR_CURSOR;
  public final static int DEFAULT_CURSOR;
  public final static int E_RESIZE_CURSOR;
  public final static int HAND_CURSOR;
  public final static int MOVE_CURSOR;
  public final static int N_RESIZE_CURSOR;
  public final static int NE_RESIZE_CURSOR;
  public final static int NW_RESIZE_CURSOR;
  public final static int S_RESIZE_CURSOR;
  public final static int SE_RESIZE_CURSOR;
  public final static int SW_RESIZE_CURSOR;
```

```
  public final static int TEXT_CURSOR;
  public final static int W_RESIZE_CURSOR;
  public final static int WAIT_CURSOR;

  // Constructors
  public Frame();
  public Frame (String title);

  // Instance Methods
  public void addNotify();
  public synchronized void dispose();
  public int getCursorType(); ☆
  public Image getIconImage();
  public MenuBar getMenuBar();
  public String getTitle();
  public boolean isResizable();
  public synchronized void remove (MenuComponent component);
  public synchronized void setCursor (int cursorType); ☆
  public synchronized void setIconImage (Image image);
  public synchronized void setMenuBar (MenuBar bar);
  public synchronized void setResizable (boolean resizable);
  public synchronized void setTitle (String title);

  // Protected Instance Methods
  protected String paramString();
}
```

Constants

CROSSHAIR_CURSOR

`public final static int CROSSHAIR_CURSOR`

Constant representing a cursor that looks like a crosshair.

DEFAULT_CURSOR

`public final static int DEFAULT_CURSOR`

Constant representing the platform's default cursor.

E_RESIZE_CURSOR

`public final static int E_RESIZE_CURSOR`

Constant representing the cursor for resizing an object on the left.

HAND_CURSOR

`public final static int HAND_CURSOR`

Constant representing a cursor that looks like a hand.

MOVE_CURSOR

`public final static int MOVE_CURSOR`

Constant representing a cursor used to move an object.

N_RESIZE_CURSOR

`public final static int N_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top.

NE_RESIZE_CURSOR

`public final static int NE_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top left corner.

NW_RESIZE_CURSOR

`public final static int NW_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the top right corner.

S_RESIZE_CURSOR

`public final static int S_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom.

SE_RESIZE_CURSOR

`public final static int SE_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom left corner.

SW_RESIZE_CURSOR

`public final static int SW_RESIZE_CURSOR`

Constant representing a cursor for resizing an object on the bottom right corner.

TEXT_CURSOR

```
public final static int TEXT_CURSOR
```

Constant representing a cursor used within text.

W_RESIZE_CURSOR

```
public final static int W_RESIZE_CURSOR
```

Constant representing a cursor for resizing an object on the right side.

WAIT_CURSOR

```
public final static int WAIT_CURSOR
```

Constant representing a cursor that indicates the program is busy.

Constructors

Frame

```
public Frame()
```

Description	Constructs a `Frame` object, with no title.

```
public Frame (String title)
```

Parameters	*title*	Initial title to use for `Frame`.
Description	Constructs a `Frame` object, with the given title.	

Instance Methods

addNotify

```
public void addNotify()
```

Overrides	`Window.addNotify()`
Description	Creates `Frame`'s peer and peers of contained components.

dispose

```
public synchronized void dispose()
```

Overrides	`Window.dispose()`
Description	Releases the resources of the `Frame`.

getCursorType

`public int getCursorType()` ☆

Returns	The constant for the current cursor. Replaced by `Component.getCursor()`

getIconImage

`public Image getIconImage()`

Returns — The image used as the icon, or `null` if there is no icon for this frame.

getMenuBar

`public MenuBar getMenuBar()`

Returns — The `Frame`'s current menu bar, or `null` if there is no menu bar for this frame.

getTitle

`public String getTitle()`

Returns — The current title for the `Frame`, or `null` if there is no title for this frame.

isResizable

`public boolean isResizable()`

Returns — `true` if resizable, `false` otherwise.

remove

`public synchronized void remove (MenuComponent component)`

Parameters	*component*	`MenuBar` to remove from `Frame`.
Implements	`MenuContainer.remove()`	
Description	Removes `component` from `Frame` if `component` is the `Frame`'s menu bar.	

setCursor

`public synchronized void setCursor (int cursorType)` ☆

Parameters	*cursorType*	One of `Frame`'s cursor constants.
Throws	*IllegalArgumentException*	If `cursorType` invalid.
Description	Changes the cursor of the `Frame`. Replaced by `Component.setCursor(Cursor)`.	

setIconImage

```
public synchronized void setIconImage (Image image)
```

Parameters *image* New image to use for the `Frame`'s icon.
Description Changes the icon's image for the `Frame`.

setMenuBar

```
public synchronized void setMenuBar (MenuBar bar)
```

Parameters *bar* New `MenuBar` to use for the `Frame`.
Description Changes the menu bar of the `Frame`.

setResizable

```
public synchronized void setResizable (boolean resizable)
```

Parameters *resizable* `true` to make the frame resizable, `false` to prevent resizing.
Description Changes the resize state of the `Frame`.

setTitle

```
public synchronized void setTitle (String title)
```

Parameters *title* New title to use for the `Frame`.
Description Changes the title of the `Frame`.

Protected Instance Methods

paramString

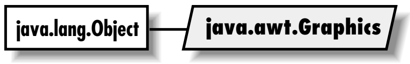
```
protected String paramString()
```

Returns String with current settings of `Frame`.
Overrides `Container.paramString()`
Description Helper method for `toString()` to generate a string of current settings.

See Also

`Container`, `Image`, `MenuBar`, `MenuContainer`, `String`, `Window`

19.27 Graphics



Description

The `Graphics` class is an abstract class that represents an object on which you can draw. The concrete classes that are actually used to represent graphics objects are platform dependent, but because they extend the `Graphics` class, must implement the methods here.

Class Definition

```
public abstract class java.awt.Graphics
    extends java.lang.Object {

  // Constructors
  protected Graphics();

  // Instance Methods
  public abstract void clearRect (int x, int y, int width, int height);
  public abstract void clipRect (int x, int y, int width, int height);
  public abstract void copyArea (int x, int y, int width, int height,
      int deltax, int deltay);
  public abstract Graphics create();
  public Graphics create (int x, int y, int width, int height);
  public abstract void dispose();
  public void draw3DRect (int x, int y, int width, int height,
      boolean raised);
  public abstract void drawArc (int x, int y, int width, int height,
      int startAngle, int arcAngle);
  public void drawBytes (byte text[], int offset, int length,
      int x, int y);
  public void drawChars (char text[], int offset, int length,
      int x, int y);
  public abstract boolean drawImage (Image image, int x, int y,
      ImageObserver observer);
  public abstract boolean drawImage (Image image, int x, int y,
      int width, int height, ImageObserver observer);
  public abstract boolean drawImage (Image image, int x, int y,
      Color backgroundColor, ImageObserver observer);
  public abstract boolean drawImage (Image image, int x, int y,
      int width, int height, Color backgroundColor, ImageObserver observer);
  public abstract boolean drawImage(Image img, int dx1, int dy1,
      int dx2, int dy2, int sx1, int sy1, int sx2, int sy2, ImageObserver
      observer); ★
```

```
  public abstract boolean drawImage(Image img, int dx1, int dy1,
      int dx2, int dy2, int sx1, int sy1, int sx2, int sy2, Color bgcolor,
      ImageObserver observer); ★
  public abstract void drawLine (int x1, int y1, int x2, int y2);
  public abstract void drawOval (int x, int y, int width, int height);
  public abstract void drawPolygon (int xPoints[], int yPoints[],
      int numPoints);
  public void drawPolygon (Polygon p);
  public abstract void drawPolyline(int[ ] xPoints, int[ ] yPoints,
      int nPoints); ★
  public void drawRect (int x, int y, int width, int height);
  public abstract void drawRoundRect (int x, int y, int width,
      int height, int arcWidth, int arcHeight);
  public abstract void drawString (String text, int x, int y);
  public void fill3DRect (int x, int y, int width, int height,
      boolean raised);
  public abstract void fillArc (int x, int y, int width, int height,
      int startAngle, int arcAngle);
  public abstract void fillOval (int x, int y, int width, int height);
  public abstract void fillPolygon (int xPoints[], int yPoints[],
      int numPoints);
  public void fillPolygon (Polygon p);
  public abstract void fillRect (int x, int y, int width, int height);
  public abstract void fillRoundRect (int x, int y, int width,
      int height, int arcWidth, int arcHeight);
  public void finalize();
  public abstract Shape getClip(); ★
  public abstract Rectangle getClipBounds(); ★
  public abstract Rectangle getClipRect();
  public abstract Color getColor();
  public abstract Font getFont();
  public FontMetrics getFontMetrics();
  public abstract FontMetrics getFontMetrics (Font font);
  public abstract void setClip (int x, int y, int width, int height); ★
  public abstract void setClip (Shape clip); ★
  public abstract void setColor (Color color);
  public abstract void setFont (Font font);
  public abstract void setPaintMode();
  public abstract void setXORMode (Color xorColor);
  public String toString();
  public abstract void translate (int x, int y);
}
```

Constructors

Graphics

```
protected Graphics()
```

Description Called by constructors of platform specific subclasses.

Instance Methods

clearRect

```
public abstract void clearRect (int x, int y, int width,
int height)
```

Parameters	*x*	x coordinate of origin of area to clear.
	y	y coordinate of origin of area to clear.
	width	size in horizontal direction to clear.
	height	size in vertical direction to clear.
Description	Resets a rectangular area to the background color.	

clipRect

```
public abstract void clipRect (int x, int y, int width,
int height)
```

Parameters	*x*	x coordinate of origin of clipped area.
	y	y coordinate of origin of clipped area.
	width	size in horizontal direction to clip.
	height	size in vertical direction to clip.
Description	Reduces the drawing area to the intersection of the current drawing area and the rectangular area defined by `x`, `y`, `width`, and `height`.	

copyArea

```
public abstract void copyArea (int x, int y, int width,
int height, int deltax, int deltay)
```

Parameters	*x*	x coordinate of origin of area to copy.
	y	y coordinate of origin of area to copy.
	width	size in horizontal direction to copy.
	height	size in vertical direction to copy.
	deltax	offset in horizontal direction to copy area to.
	deltay	offset in vertical direction to copy area to.
Description	Copies a rectangular area to a new area, whose top left corner is (`x+deltax`, `y+deltay`).	

create

`public abstract Graphics create()`

Returns	New graphics context.
Description	Creates a second reference to the same graphics context.

`public Graphics create (int x, int y, int width, int height)`

Parameters	*x*	x coordinate of origin of new graphics context.
	y	y coordinate of origin of new graphics context.
	width	size in horizontal direction.
	height	size in vertical direction.
Returns	New graphics context	
Description	Creates a second reference to a subset of the same graphics context.	

dispose

`public abstract void dispose()`

Description	Frees system resources used by graphics context.

draw3DRect

`public void draw3DRect (int x, int y, int width, int height, boolean raised)`

Parameters	*x*	x coordinate of the rectangle origin.
	y	y coordinate of the rectangle origin
	width	Width of the rectangle to draw.
	height	Height of the rectangle to draw.
	raised	Determines if rectangle drawn is raised or not; `true` for a raised rectangle.
Description	Draws an unfilled 3-D rectangle from (`x`, `y`) of size `width` x `height`.	

drawArc

`public abstract void drawArc (int x, int y, int width, int height, int startAngle, int arcAngle)`

Parameters	*x*	x coordinate of the bounding rectangle's origin.
	y	y coordinate of the bounding rectangle's origin
	width	Width of the bounding rectangle for the arc.

	height	Height of the bounding rectangle for the arc.
	startAngle	Angle at which arc begins, in degrees
	arcAngle	length of arc, in degrees
Description	Draws an unfilled arc from `startAngle` to `arcAngle` within bounding rectangle from (`x`, `y`) of size `width` x `height`. Zero degrees is at three o'clock; positive angles are counter clockwise.	

drawBytes

```
public void drawBytes (byte text[], int offset, int
length, int x, int y)
```

Parameters	*text*	Text to draw, as a byte array.
	offset	Starting position within `text` to draw.
	length	Number of bytes to draw.
	x	x coordinate of baseline origin.
	y	y coordinate of baseline origin.
Throws	*ArrayIndexOutOfBoundsException*	
		If `offset` or `length` is invalid.
Description	Draws text on screen, starting with `text[offset]` and ending with `text[offset+length-1]`.	

drawChars

```
public void drawChars (char text[], int offset, int
length, int x, int y)
```

Parameters	*text*	Text to draw, as a char array.
	offset	Starting position within `text` to draw.
	length	Number of bytes to draw.
	x	x coordinate of baseline origin.
	y	y coordinate of baseline origin.
Throws	*ArrayIndexOutOfBoundsException*	
		If `offset` or `length` is invalid.
Description	Draws text on screen, starting with `text[offset]` and ending with `text[offset+length-1]`.	

drawImage

```
public abstract boolean drawImage (Image image, int x, int
y, ImageObserver observer)
```

Parameters	*image*	Image to draw.

	x	x coordinate of image origin.
	y	y coordinate of image origin.
	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws image to screen at (`x`, `y`), at its original size. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information made available.	

```
public abstract boolean drawImage (Image image, int x, int
y, int width, int height, ImageObserver observer)
```

Parameters	*image*	Image to draw.
	x	x coordinate of image origin.
	y	y coordinate of image origin.
	width	New image size in horizontal direction.
	height	New image size in vertical direction.
	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws image to screen at (`x`, `y`), scaled to `width` x `height`. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information made available.	

```
public abstract boolean drawImage (Image image, int x, int
y, Color backgroundColor, ImageObserver observer)
```

Parameters	*image*	Image to draw.
	x	x coordinate of image origin.
	y	y coordinate of image origin.
	backgroundColor	Color to show through image where transparent.
	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws image to screen at (`x`, `y`), at its original size. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information made available. The background color is visible through any transparent pixels.	

```
public abstract boolean drawImage (Image image, int x, int
y, int width, int height, Color backgroundColor,
ImageObserver observer)
```

Parameters	*image*	Image to draw.
	x	x coordinate of image origin.
	y	y coordinate of image origin.
	width	New image size in horizontal direction.
	height	New image size in vertical direction.
	backgroundColor	Color to show through image where transparent.
	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws image to screen at (`x`, `y`), scaled to `width` x `height`. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information made available. The background color is visible through any transparent pixels.	

```
public abstract boolean drawImage (Image image, int dx1,
int dy1, int dx2, int dy2, int sx1, int sy1, int sx2, int
sy2, ImageObserver observer) ★
```

Parameters	*image*	Image to draw.
	dx1	x coordinate of one corner of destination (device) rectangle.
	dy1	y coordinate of one corner of destination (device) rectangle.
	dx2	x coordinate of the opposite corner of destination (device) rectangle.
	dy2	y coordinate of the opposite corner of destination (device) rectangle.
	sx1	x coordinate of one corner of source (image) rectangle.
	sy1	y coordinate of one corner of source (image) rectangle.
	sx2	x coordinate of the opposite corner of source (image) rectangle.
	sy2	y coordinate of the opposite corner of source (image) rectangle.

	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws the part of image described by `dx1`, `dy1`, `dx2`, and `dy2` to the screen into the rectangle described by `sx1`, `sy1`, `sx2`, and `sy2`. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information is made available.	

```
public abstract boolean drawImage (Image image, int dx1,
int dy1, int dx2, int dy2, int sx1, int sy1, int sx2, int
sy2, Color backgroundColor, ImageObserver observer) ★
```

Parameters	*image*	Image to draw.
	dx1	x coordinate of one corner of destination (device) rectangle.
	dy1	y coordinate of one corner of destination (device) rectangle.
	dx2	x coordinate of the opposite corner of destination (device) rectangle.
	dy2	y coordinate of the opposite corner of destination (device) rectangle.
	sx1	x coordinate of one corner of source (image) rectangle.
	sy1	y coordinate of one corner of source (image) rectangle.
	sx2	x coordinate of the opposite corner of source (image) rectangle.
	sy2	y coordinate of the opposite corner of source (image) rectangle.
	backgroundColor	Color to show through image where transparent.
	observer	Object that watches for image information; almost always `this`.
Returns	`true` if the image has fully loaded when the method returns, `false` otherwise.	
Description	Draws the part of image described by `dx1`, `dy1`, `dx2`, and `dy2` to the screen into the rectangle described by `sx1`, `sy1`, `sx2`, and `sy2`. Drawing may be asynchronous. If `image` is not fully loaded when the method returns, `observer` is notified when additional information made available. The background color is visible through any transparent pixels.	

drawLine

```
public abstract void drawLine (int x1, int y1, int x2, int
y2)
```

Parameters	*x1*	x coordinate of one point on line.
	y1	y coordinate of one point on line.
	x2	x coordinate of the opposite point on line.
	y2	y coordinate of the opposite point on line.
Description	Draws a line connecting `(x1, y1)` and `(x2, y2)`.	

drawOval

```
public abstract void drawOval (int x, int y, int width,
int height)
```

Parameters	*x*	x coordinate of bounding rectangle origin.
	y	y coordinate of bounding rectangle origin
	width	Width of bounding rectangle to draw in.
	height	Height of bounding rectangle to draw in.
Description	Draws an unfilled oval within bounding rectangle from `(x`, `y)` of size `width` x `height`.	

drawPolygon

```
public abstract void drawPolygon (int xPoints[], int
yPoints[], int numPoints)
```

Parameters	*xPoints[]*	The array of x coordinates for each point.
	yPoints[]	The array of y coordinates for each point.
	numPoints	The number of elements in both `xPoints` and `yPoints` arrays to use.
Description	Draws an unfilled polygon based on first `numPoints` elements in `xPoints` and `yPoints`.	

```
public void drawPolygon (Polygon p)
```

Parameters	*p*	Points of object to draw.
Description	Draws an unfilled polygon based on points within the `Polygon` `p`.	

drawPolyline

```
public abstract void drawPolyline (int xPoints[], int
yPoints[], int nPoints) ★
```

Parameters	*xPoints[]*	The array of x coordinates for each point.
	yPoints[]	The array of y coordinates for each point.
	nPoints	The number of elements in both `xPoints` and `yPoints` arrays to use.
Description	Draws a series of line segments based on first `numPoints` elements in `xPoints` and `yPoints`.	

`drawRect`

```
public void drawRect (int x, int y, int width, int height)
```

Parameters	*x*	x coordinate of rectangle origin.
	y	y coordinate of rectangle origin
	width	Width of rectangle to draw.
	height	Height of rectangle to draw.
Description	Draws an unfilled rectangle from `(x, y)` of size `width` x `height`.	

`drawRoundRect`

```
public abstract void drawRoundRect (int x, int y, int
width, int height, int arcWidth, int arcHeight)
```

Parameters	*x*	x coordinate of bounding rectangle origin.
	y	y coordinate of bounding rectangle origin
	width	Width of rectangle to draw.
	height	Height of rectangle to draw.
	arcWidth	Width of arc of rectangle corner.
	arcHeight	Height of arc of rectangle corner.
Description	Draws an unfilled rectangle from `(x, y)` of size `width` x `height` with rounded corners.	

`drawString`

```
public abstract void drawString (String text, int x, int
y)
```

Parameters	*text*	Text to draw.
	x	x coordinate of baseline origin.
	y	y coordinate of baseline origin.
Description	Draws text on screen.	

fill3DRect

```
public void fill3DRect (int x, int y, int width, int
height, boolean raised)
```

Parameters	*x*	x coordinate of rectangle origin.
	y	y coordinate of rectangle origin
	width	Width of rectangle to draw.
	height	Height of rectangle to draw.
	raised	`true` to draw a rectangle that appears raised; `false` to draw a rectangle that appears depressed.
Description	Draws a filled 3-D rectangle from (`x`, `y`) of size `width` x `height`.	

fillArc

```
public abstract void fillArc (int x, int y, int width, int
height, int startAngle, int arcAngle)
```

Parameters	*x*	x coordinate of bounding rectangle origin.
	y	y coordinate of bounding rectangle origin
	width	Width of bounding rectangle to draw in.
	height	Height of bounding rectangle to draw in.
	startAngle	Starting angle of arc.
	arcAngle	The extent of the arc, measured from startAngle
Description	Draws a filled arc from `startAngle` to `arcAngle` within bounding rectangle from (`x`, `y`) of size `width` x `height`. Zero degrees is at three o'clock; positive angles are counter clockwise.	

fillOval

```
public abstract void fillOval (int x, int y, int width,
int height)
```

Parameters	*x*	x coordinate of bounding rectangle origin.
	y	y coordinate of bounding rectangle origin
	width	Width of bounding rectangle to draw in.
	height	Height of bounding rectangle to draw in.
Description	Draws filled oval within bounding rectangle from (`x`, `y`) of size `width` x `height`.	

fillPolygon

`public abstract void fillPolygon (int xPoints[], int yPoints[], int numPoints)`

Parameters	*xPoints[]*	The array of x coordinates for each point.
	yPoints[]	The array of y coordinates for each point.
	numPoints	The number of elements in both `xPoints` and `yPoints` arrays to use.
Throws	*ArrayIndexOutOfBoundsException*	If `numPoints > xPoints.length` or `numPoints > yPoints.length`.
Description	Draws filled polygon based on first `numPoints` elements in `xPoints` and `yPoints`.	

`public void fillPolygon (Polygon p)`

Parameters	*p*	Points of object to draw.
Description	Draws filled polygon based on points within the `Polygon p`.	

fillRect

`public abstract void fillRect (int x, int y, int width, int height)`

Parameters	*x*	x coordinate of rectangle origin.
	y	y coordinate of rectangle origin
	width	Width of rectangle to draw.
	height	Height of rectangle to draw.
Description	Draws filled rectangle from (`x`, `y`) of size `width` x `height`.	

fillRoundRect

`public abstract void fillRoundRect (int x, int y, int width, int height, int arcWidth, int arcHeight)`

Parameters	*x*	x coordinate of bounding rectangle origin.
	y	y coordinate of bounding rectangle origin
	width	Width of rectangle to draw.
	height	Height of rectangle to draw.
	arcWidth	Width of arc of rectangle corner.
	arcHeight	Height of arc of rectangle corner.
Description	Draws a filled rectangle from (`x`, `y`) of size `width` x `height` with rounded corners.	

finalize

`public void finalize()`

Overrides `Object.finalize()`
Description Tells the garbage collector to dispose of graphics context.

getClip

`public abstract Shape getClip ()` ★

Returns Shape describing the clipping are of the graphics context.

getClipBounds

`public abstract Rectangle getClipBounds()` ★

Returns Rectangle describing the clipping area of the graphics context.

getClipRect

`public abstract Rectangle getClipRect()` ☆

Returns Replaced by `getClipBounds()`.

getColor

`public abstract Color getColor()`

Returns The current drawing `Color` of the graphics context.

getFont

`public abstract Font getFont()`

Returns The current `Font` of the graphics context.

getFontMetrics

`public FontMetrics getFontMetrics()`

Returns The `FontMetrics` of the current font of the graphics context.

`public abstract FontMetrics getFontMetrics (Font font)`

Parameters *font* Font to get metrics for.
Returns The `FontMetrics` of the given font for the graphics context.

setClip

```
public abstract void setClip (int x, int y, int width, int
height) ★
```

Parameters	*x*	x coordinate of rectangle
	y	y coordinate of rectangle
	width	width of rectangle
	height	height of rectangle
Description	Changes current clipping region to the specified rectangle.	

```
public abstract void setClip (Shape clip) ★
```

Parameters	*clip*	The new clipping shape.
Description	Changes current clipping region to the specified shape.	

setColor

```
public abstract void setColor (Color color)
```

Parameters	*color*	New color.
Description	Changes current drawing color of graphics context.	

setFont

```
public abstract void setFont (Font font)
```

Parameters	*font*	New font.
Description	Changes current font of graphics context.	

setPaintMode

```
public abstract void setPaintMode()
```

Description Changes painting mode to normal mode.

setXORMode

```
public abstract void setXORMode (Color xorColor)
```

Parameters	*xorColor*	XOR mode drawing color.
Description	Changes painting mode to XOR mode; in this mode, drawing the same object in the same color at the same location twice has no net effect.	

toString

```
public String toString()
```

Returns	A string representation of the `Graphics` object.
Overrides	`Object.toString()`

translate

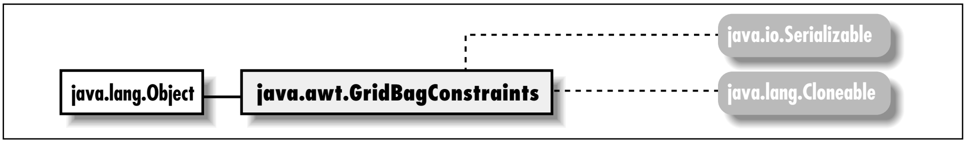
```
public void translate (int x, int y)
```

Parameters	*x*	x coordinate of new drawing origin.
	y	y coordinate of new drawing origin.
Description	Moves the origin of drawing operations to (x, y).	

See Also

Color, Font, FontMetrics, Image, ImageObserver, Object, Polygon, Rectangle, Shape, String

19.28 GridBagConstraints



Description

The GridBagConstraints class provides the means to control the layout of components within a Container whose LayoutManager is GridBagLayout.

Class Definition

```
public class java.awt.GridBagConstraints
    extends java.lang.Object
    implements java.lang.Cloneable, java.io.Serializable {

  // Constants
  public final static int BOTH;
  public final static int CENTER;
  public final static int EAST;
  public final static int HORIZONTAL;
  public final static int NONE;
  public final static int NORTH;
  public final static int NORTHEAST;
  public final static int NORTHWEST;
  public final static int RELATIVE;
  public final static int REMAINDER;
  public final static int SOUTH;
  public final static int SOUTHEAST;
  public final static int SOUTHWEST;
  public final static int VERTICAL;
  public final static int WEST;
```

```
    // Variables
    public int anchor;
    public int fill;
    public int gridheight;
    public int gridwidth;
    public int gridx;
    public int gridy;
    public Insets insets;
    public int ipadx;
    public int ipady;
    public double weightx
    public double weighty

    // Constructors
    public GridBagConstraints();

    // Instance Methods
    public Object clone();
  }
```

Constants

BOTH

`public final static int BOTH`

Constant for possible `fill` value.

CENTER

`public final static int CENTER`

Constant for possible `anchor` value.

EAST

`public final static int EAST`

Constant for possible `anchor` value.

HORIZONTAL

`public final static int HORIZONTAL`

Constant for possible `fill` value.

NONE

`public final static int NONE`

Constant for possible `fill` value.

NORTH

`public final static int NORTH`

Constant for possible `anchor` value.

NORTHEAST

`public final static int NORTHEAST`

Constant for possible `anchor` value.

NORTHWEST

`public final static int NORTHWEST`

Constant for possible `anchor` value.

RELATIVE

`public final static int RELATIVE`

Constant for possible `gridx`, `gridy`, `gridwidth`, or `gridheight` value.

REMAINDER

`public final static int REMAINDER`

Constant for possible `gridwidth` or `gridheight` value.

SOUTH

`public final static int SOUTH`

Constant for possible `anchor` value.

SOUTHEAST

`public final static int SOUTHEAST`

Constant for possible `anchor` value.

SOUTHWEST

`public final static int SOUTHWEST`

Constant for possible `anchor` value.

VERTICAL

`public final static int VERTICAL`

Constant for possible `fill` value.

WEST

`public final static int WEST`

Constant for possible `anchor` value.

Variables

anchor

`public int anchor`

Specifies the alignment of the component in the event that it is smaller than the space allotted for it by the layout manager; e.g., `CENTER` centers the object within the region.

fill

`public int fill`

The component's resize policy if additional space available.

gridheight

`public int gridheight`

Number of columns a component occupies.

gridwidth

`public int gridwidth`

Number of rows a component occupies.

gridx

`public int gridx`

Horizontal grid position at which to add component.

gridy

`public int gridy`

Vertical grid position at which to add component.

insets

`public Insets insets`

Specifies the outer padding around the component.

ipadx

`public int ipadx`

Serves as the internal padding within the component in both the right and left directions.

ipady

`public int ipady`

Serves as the internal padding within the component in both the top and bottom directions.

weightx

`public double weightx`

Represents the percentage of extra horizontal space that will be given to this component if there is additional space available within the container.

weighty

`public double weighty`

Represents the percentage of extra vertical space that will be given to this component if there is additional space available within the container.

Constructors

GridBagConstraints

`public GridBagConstraints()`

Description — Constructs a `GridBagConstraints` object.

Instance Methods

clone

`public Object clone()`

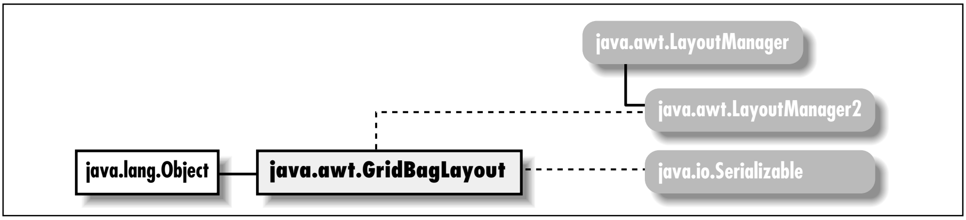
Returns — A new instance of `GridBagConstraints` with same values for constraints.

Overrides — `Object.clone()`

See Also

Cloneable, GridBagLayout, Insets, Object, Serializable

19.29 GridBagLayout



Description

The GridBagLayout LayoutManager provides the means to layout components in a flexible grid-based display model.

Class Definition

```
public class java.awt.GridBagLayout
    extends java.lang.Object
    implements java.awt.LayoutManager2, java.io.Serializable {

  // Protected Constants
  protected static final MAXGRIDSIZE;
  protected static final MINSIZE;
  protected static final PREFERREDSIZE;

  // Variables
  public double columnWeights[];
  public int columnWidths[];
  public int rowHeights[];
  public double rowWeights[];

  // Protected Variables
  protected Hashtable comptable;
  protected GridBagConstraints defaultConstraints;
  protected GridBagLayoutInfo layoutInfo;

  // Constructors
  public GridBagLayout();

  // Instance Methods
  public void addLayoutComponent (Component comp, Object constraints); ★
  public void addLayoutComponent (String name, Component component);
  public GridBagConstraints getConstraints (Component component);
```

```
public abstract float getLayoutAlignmentX(Container target); ★
public abstract float getLayoutAlignmentY(Container target); ★
public int[][] getLayoutDimensions();
public Point getLayoutOrigin();
public double[][] getLayoutWeights();
public abstract void invalidateLayout(Container target); ★
public void layoutContainer (Container target);
public Point location (int x, int y);
public abstract Dimension maximumLayoutSize(Container target); ★
public Dimension minimumLayoutSize (Container target);
public Dimension preferredLayoutSize (Container target);
public void removeLayoutComponent (Component component);
public void setConstraints (Component component,
    GridBagConstraints constraints);
public String toString();

// Protected Instance Methods
protected void AdjustForGravity (GridBagConstraints constraints,
    Rectangle r);
protected void ArrangeGrid (Container target);
protected GridBagLayoutInfo GetLayoutInfo (Container target,
    int sizeFlag);
protected Dimension GetMinSize (Container target,
    GridBagLayoutInfo info);
protected GridBagConstraints lookupConstraints (Component comp);
}
```

Protected Constants

MAXGRIDSIZE

`protected static final MAXGRIDSIZE`

Maximum number of rows and columns within container managed by `GridBagLayout`.

MINSIZE

`protected static final MINSIZE`

Used for internal sizing purposes.

PREFERREDSIZE

`protected static final PREFERREDSIZE`

Used for internal sizing purposes.

Variables

columnWeights

`public double[] columnWeights`

The `weightx` values of the components in the row with the most elements.

columnWidths

`public int[] columnWidths`

The `width` values of the components in the row with the most elements.

rowHeights

`public int[] rowHeights`

The `height` values of the components in the column with the most elements.

rowWeights

`public double[] rowWeights`

The `weighty` values of the components in the column with the most elements.

Protected Variables

comptable

`protected Hashtable comptable`

Internal table to manage components.

defaultConstraints

`protected GridBagConstraints defaultConstraints`

Constraints to use for `Components` that have none.

layoutInfo

`protected GridBagLayoutInfo layoutInfo`

Internal information about the `GridBagLayout`.

Constructors

GridBagLayout

`public GridBagLayout()`

Description Constructs a `GridBagLayout` object.

Instance Methods

addLayoutComponent

`public void addLayoutComponent (Component comp, Object constraints)` ★

Parameters	*comp*	The component being added.
	constraints	An object describing the constraints on this component.
Implements	`LayoutManager2.addLayoutComponent()`	
Description	Adds the component `comp` to container subject to the given `constraints`. This is a more generalized version of `addLayoutComponent(String, Component)`. It corresponds to `java.awt.Container's add(Component, Object)`.	

`public void addLayoutComponent (String name, Component component)`

Parameters	*name*	Name of component to add.
	component	Actual component being added.
Implements	`LayoutManager.addLayoutComponent()`	
Description	Does nothing.	

getConstraints

`public GridBagConstraints getConstraints (Component component)`

Parameters	*component*	Component whose constraints are desired
Returns	`GridBagConstraints` for component requested.	

getLayoutAlignmentX

`public abstract float getLayoutAlignmentX (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is left aligned, .5 is centered, and 1 is right aligned.	

getLayoutAlignmentY

`public abstract float getLayoutAlignmentY (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	The value .5 for all containers.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is top aligned, .5 is centered, and 1 is bottom aligned.	

getLayoutDimensions

`public int[][] getLayoutDimensions()`

Returns — Returns two single dimension arrays as a multi-dimensional array. Index 0 is an array of widths (`columnWidths` instance variable), while index 1 is an array of heights (`rowHeights` instance variable).

getLayoutOrigin

`public Point getLayoutOrigin()`

Returns — Returns the origin of the components within the `Container` whose `LayoutManager` is `GridBagLayout`.

getLayoutWeights

`public double[][] getLayoutWeights()`

Returns — Returns two single dimension arrays as a multi-dimensional array. Index 0 is an array of columns weights (`columnWeights` instance variable), while index 1 is an array of row weights (`rowWeights` instance variable).

invalidateLayout

`public abstract void invalidateLayout (Container target)` ★

Parameters	*target*	The container to invalidate.
Description	Does nothing.	

layoutContainer

`public void layoutContainer (Container target)`

Parameters	*target*	The container that needs to be redrawn.

Implements	`LayoutManager.layoutContainer()`
Description	Draws components contained within `target`.

location

`public Point location (int x, int y)`

Parameters	*x*	The x coordinate of the grid position to find.
	y	The y coordinate of the grid position to find.
Returns	Returns the grid element under the location provided at position (`x`, `y`) in pixels. Note that the returned Point uses the `GridBagLayout`'s grid for its coordinate space.	
Description	Locates the grid position in the `Container` under the given location.	

maximumLayoutSize

`public abstract Dimension maximumLayoutSize (Container target)` ★

Parameters	*target*	The container to inspect.
Returns	A `Dimension` whose horizontal and vertical components are `Integer.MAX_VALUE`.	
Description	For `GridBagLayout`, a maximal `Dimension` is always returned.	

minimumLayoutSize

`public Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of container target.	
Implements	`LayoutManager.minimumLayoutSize()`	
Description	Calculates minimum size of `target` container.	

preferredLayoutSize

`public Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of container target	
Implements	`LayoutManager.preferredLayoutSize()`	
Description	Calculates preferred size of `target` container.	

`removeLayoutComponent`

`public void removeLayoutComponent (Component component)`

Parameters	*component*	Component to stop tracking.
Implements	`LayoutManager.removeLayoutComponent()`	
Description	Does nothing.	

`setConstraints`

`public void setConstraints (Component component, GridBagConstraints constraints)`

Parameters	*component*	Component to set constraints for
	constraints	Constraints for component
Description	Changes the `GridBagConstraints` on `component` to those provided.	

`toString`

`public String toString()`

Returns	A string representation of the `GridBagLayout` object.
Overrides	`Object.toString()`

Protected Instance Methods

`AdjustForGravity`

`protected void AdjustForGravity (GridBagConstraints constraints, Rectangle r)`

Parameters	*constraints*	Constraints to use for adjustment of Rectangle.
	r	Rectangular area that needs to be adjusted.
Description	Helper routine for laying out a cell of the grid. The routine adjusts the values for `r` based upon the `constraints`.	

`ArrangeGrid`

`protected void ArrangeGrid (Container target)`

Parameters	*target*	`Container` to layout.
Description	Helper routine that does the actual arrangement of components in `target`.	

`GetLayoutInfo`

`protected GridBagLayoutInfo GetLayoutInfo (Container target, int sizeFlag)`

Parameters	*target*	`Container` to get information about.
	sizeFlag	One of the constants `MINSIZE` or `PREFERREDSIZE`.
Returns	Returns an internal class used to help size the container.	

GetMinSize

`protected Dimension GetMinSize (Container target, GridBagLayoutInfo info)`

Parameters	*target*	`Container` to calculate size.
	info	Specifics about the container's constraints.
Returns	Minimum `Dimension` of container target based on info.	
Description	Helper routine for calculating size of container.	

lookupConstraints

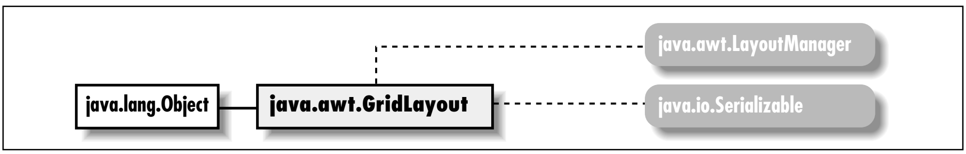
`protected GridBagConstraints lookupConstraints (Component comp)`

Parameters	*comp*	`Component` in question.
Returns	A reference to the `GridBagConstraints` object for this component.	
Description	Helper routine for calculating size of container.	

See Also

`Component`, `Container`, `Dimension`, `GridBagConstraints`, `Hashtable`, `LayoutManager`, `LayoutManager2`, `Object`, `Point`, `Rectangle`, `String`

19.30 GridLayout



Description

The `GridLayout` `LayoutManager` provides the means to layout components in a grid of rows and columns.

Class Definition

```
public class java.awt.GridLayout
        extends java.lang.Object
        implements java.awt.LayoutManager, java.io.Serializable
 {

// Constructors
  public GridLayout(); ★
  public GridLayout (int rows, int cols);
  public GridLayout (int rows, int cols, int hgap, int vgap);

// Instance Methods
  public void addLayoutComponent (String name, Component component);
  public int getColumns(); ★
  public int getHgap(); ★
  public int getRows(); ★

  public int getVgap(); ★
  public void layoutContainer (Container target);
  public Dimension minimumLayoutSize (Container target);
  public Dimension preferredLayoutSize (Container target);
  public void removeLayoutComponent (Component component);
  public int setColumns(int cols); ★
  public int setHgap(int hgap); ★
  public int setRows(int rows); ★

  public int setVgap(int vgap); ★
  public String toString();
}
```

Constructors

GridLayout

`public GridLayout()` ★

Description — Constructs a `GridLayout` object with a default single row and one column per component.

`public GridLayout (int rows, int cols)`

Parameters	*rows*	Requested number of rows in container.
	cols	Requested number of columns in container.

Description Constructs a `GridLayout` object with the requested number of rows and columns. Note that the actual number of rows and columns depends on the number of objects in the layout, not the constructor's parameters.

`public GridLayout (int rows, int cols, int hgap, int vgap)`

Parameters	*rows*	Requested number of rows in container.
	cols	Requested number of columns in container.
	hgap	Horizontal space between each component in a row.
	vgap	Vertical space between each row.
Description	Constructs a `GridLayout` object with the requested number of rows and columns and the values specified as the gaps between each component. Note that the actual number of rows and columns depends on the number of objects in the layout, not the constructor's parameters.	

Instance Methods

addLayoutComponent

`public void addLayoutComponent (String name, Component component)`

Parameters	*name*	Name of component to add.
	component	Actual component being added.
Implements	`LayoutManager.addLayoutComponent()`	
Description	Does nothing.	

getColumns

`public int getColumns()` ★

Returns The number of columns.

getHgap

`public int getHgap()` ★

Returns The horizontal gap for this `GridLayout` instance.

getRows

`public int getRows()` ★

Returns The number of rows.

getVgap

`public int getVgap()` ★

Returns	The vertical gap for this `GridLayout` instance.

layoutContainer

`public void layoutContainer (Container target)`

Parameters	*target*	The container that needs to be redrawn.
Implements	`LayoutManager.layoutContainer()`	
Description	Draws the components contained within the `target`.	

minimumLayoutSize

`public Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of the container `target`.	
Implements	`LayoutManager.minimumLayoutSize()`	
Description	Calculates the minimum size of the `target` container.	

preferredLayoutSize

`public Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of the container `target`.	
Implements	`LayoutManager.preferredLayoutSize()`	
Description	Calculates the preferred size of the `target` container.	

removeLayoutComponent

`public void removeLayoutComponent (Component component)`

Parameters	*component*	Component to stop tracking.
Implements	`LayoutManager.removeLayoutComponent()`	
Description	Does nothing.	

setColumns

`public void setColumns(int cols)` ★

Parameters	*cols*	The new number of columns.
Description	Sets the number of columns.	

setHgap

`public void setHgap(int hgap) ★`

Parameters *hgap* The horizontal gap value.
Description Sets the horizontal gap between components.

setRows

`public void setRows(int rows) ★`

Parameters *rows* The new number of rows.
Description Sets the number of rows.

setVgap

`public void setVgap(int vgap) ★`

Parameters *vgap* The vertical gap value.
Description Sets the vertical gap between components.

toString

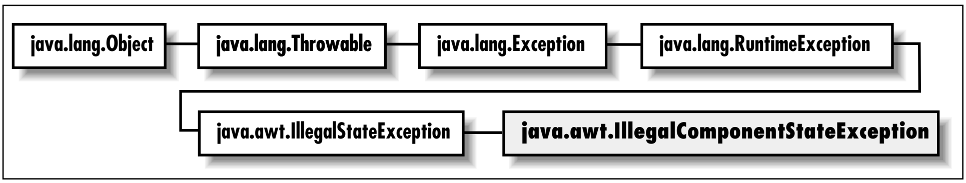
`public String toString()`

Returns A string representation of the `GridLayout` object.
Overrides `Object.toString()`

See Also

`Component`, `Container`, `Dimension`, `LayoutManager`, `Object`, `String`

19.31 IllegalComponentStateException ★



Description

An `Exception` indicating that a `Component` was not in an appropriate state to perform a requested action.

Class Definition

```
public class java.awt.IllegalComponentStateException
    extends java.lang.IllegalStateException {

  // Constructors
  public IllegalComponentStateException();
  public IllegalComponentStateException (String s);
}
```

Constructors

IllegalComponentStateException

`public IllegalComponentStateException()`

Description Constructs the exception object with no detail message.

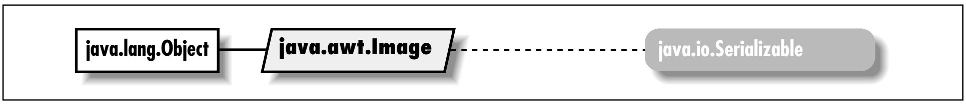
`public IllegalComponentStateException (String s)`

Parameters *s* Detail message
Description Constructs the exception object with the given detail message.

See Also

`Exception`, `String`

19.32 Image



Description

The `Image` class represents a displayable object maintained in memory. Because `Image` is an abstract class, you never work with the `Image` class itself, but with a platform specific subclass. However, you should never need to know what that subclass is. To draw on an `Image`, get its graphics context.

Class Definition

```
public abstract class java.awt.Image
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public final static int SCALE_AREA_AVERAGING; ★
  public final static int SCALE_DEFAULT; ★
  public final static int SCALE_FAST; ★
```

```
  public final static int SCALE_REPLICATE; ★
  public final static int SCALE_SMOOTH; ★
  public final static Object UndefinedProperty;

  // Instance Methods
  public abstract void flush();
  public abstract Graphics getGraphics();
  public abstract int getHeight (ImageObserver observer);
  public abstract Object getProperty (String name, ImageObserver observer);
  public Image getScaledInstance (int width, int height, int hints); ★
  public abstract ImageProducer getSource();
  public abstract int getWidth (ImageObserver observer);
}
```

Constants

SCALE_AREA_AVERAGING

`public final static int SCALE_AREA_AVERAGING` ★

Flag that requests use of `AreaAveragingScaleFilter`.

SCALE_DEFAULT

`public final static int SCALE_DEFAULT` ★

Flag that requests use of the default image scaling algorithm.

SCALE_FAST

`public final static int SCALE_FAST` ★

Flag that requests use of an image scaling algorithm that is faster rather than smoother.

SCALE_REPLICATE

`public final static int SCALE_REPLICATE` ★

Flag that requests use of ReplicateScaleFilter.

SCALE_SMOOTH

`public final static int SCALE_SMOOTH` ★

Flag that requests use of an image scaling algorithm that is smoother rather than faster.

UndefinedProperty

```
public final static Object UndefinedProperty
```

Possible return object from `getProperty()`.

Instance Methods

flush

```
public abstract void flush()
```

Description	Resets image to initial state.

getGraphics

```
public abstract Graphics getGraphics()
```

Throws	*ClassCastException*	
		If image created from file or URL.
Returns	The graphics context of the image.	
Description	Gets the graphics context of the image for drawing.	

getHeight

```
public abstract int getHeight (ImageObserver observer)
```

Parameters	*observer*	An image observer; usually the `Component` on which the image is rendered.
Returns	Image height, or -1 if the height is not yet available.	

getProperty

```
public abstract Object getProperty (String name,
ImageObserver observer)
```

Parameters	*name*	Name of the property to fetch.
	observer	An image observer; usually the `Component` on which the image is rendered.
Returns	`Object` representing the requested property, `null`, or `UndefinedProperty`.	
Throws	*ArrayIndexOutOfBoundsException*	
		If `offset` or `length` is invalid.
Description	Retrieves a property from the image's private property list.	

getScaledInstance

```
public Image getScaledInstance (int width, int height, int
hints) ★
```

Parameters	*width*	The width for the scaled image. Use -1 to preserve the aspect ratio with reference to `height`.
	height	The height for the scaled image. Use -1 to preserve the aspect ratio with reference to `width`.
	hints	One or more of the `SCALE_` constants.
Returns	The scaled image. It may be loaded asynchronously, even if the original image was fully loaded.	
Description	Creates a copy of an image, scaled to `width` x `height` and using an algorithm chosen based on the `hints` given.	

getSource

```
public abstract ImageProducer getSource()
```

Returns The `ImageProducer` of the image.

getWidth

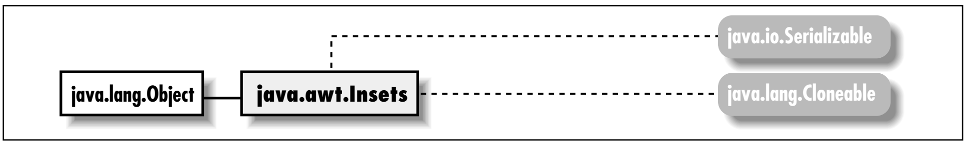
```
public abstract int getWidth (ImageObserver observer)
```

Parameters	*observer*	An image observer; usually the `Component` on which the image is rendered.
Returns	Image width, or -1 if the width is not yet available.	

See Also

`Graphics`, `ImageObserver`, `ImageProducer`, `Object`, `Properties`, `String`

19.33 Insets



Description

The `Insets` class provides a way to encapsulate the layout margins of the four different sides of a `Container`.

Class Definition

```
public class java.awt.Insets
    extends java.lang.Object
    implements java.io.Serializable, java.lang.Cloneable {

  // Variables
```

```
  public int bottom;
  public int left;
  public int right;
  public int top;

  // Constructors
  public Insets (int top, int left, int bottom, int right);

  // Instance Methods
  public Object clone();
  public boolean equals (Object obj); ★
  public String toString();
}
```

Variables

bottom

`public int bottom`

The border width for the bottom of a `Container`.

left

`public int left`

The border width for the left side of a `Container`.

right

`public int right`

The border width for the right side of a `Container`.

top

`public int top`

The border width for the top of a `Container`.

Constructors

Insets

`public Insets (int top, int left, int bottom, int right)`

Parameters	*top*	The border width for the top of a `Container`.
	left	The border width for the left side of a `Container`.
	bottom	The border width for the bottom of a `Container`.

	right	The border width for the right side of a Container.
Description	Constructs an `Insets` object with the appropriate border settings.	

Instance Methods

clone

```
public Object clone()
```

Returns	Clone of original object.
Overrides	`Object.clone()`
Description	Creates a copy of the original instance of an object.

equals

```
public boolean equals (Object obj) ★
```

Parameters	*obj*	The object to be tested.
Returns	`true` if the objects are equal; `false` otherwise.	
Overrides	`Object.equals(Object)`	
Description	Tests two `Insets` objects for equality.	

toString

```
public String toString()
```

Returns	A string representation of the `Insets` object.
Overrides	`Object.toString()`

See Also

`Cloneable`, `Container`, `Object`, `Serializable`, `String`

19.34 ItemSelectable ★

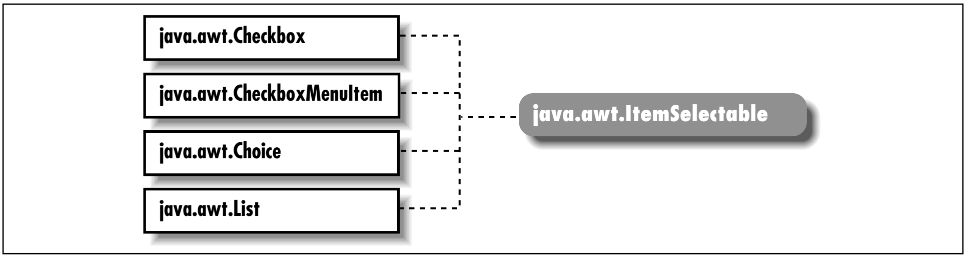
Description

An interface that describes an object that has one or more items that can be selected.

Interface Definition

```
public abstract interface ItemSelectable {

  // Instance Methods
  public abstract void addItemListener (ItemListener l);
  public abstract Object[] getSelectedObjects();
  public abstract void removeItemListener (ItemListener l);
```




```
}
```

Interface Methods

addItemListener

```
public abstract void addItemListener (ItemListener l)
```

Parameters	*l*	The listener to be added.
Description	Adds a listener for `ItemEvent` objects.	

getSelectedObjects

```
public abstract Object[] getSelectedObjects()
```

Description — This method returns an array containing `Objects` representing the items that are currently selected. If no items are selected, `null` is returned.

removeItemListener

```
public abstract void removeItemListener (ItemListener l)
```

Parameters	*l*	The listener to be removed.
Description	Removes the specified `ItemListener` so it will not receive `ItemEvent` objects.	

See Also

`Checkbox`, `CheckboxMenuItem`, `Choice`, `ItemEvent`, `ItemListener`, `List`

19.35 Label

Description

The `Label` is a `Component` that displays a single line of static text.

Class Definition

```
public class java.awt.Label
    extends java.awt.Component {

  // Constants
  public static final int CENTER;
  public static final int LEFT;
  public static final int RIGHT;

  // Constructors
  public Label();
  public Label (String label);
  public Label (String label, int alignment);

  // Instance Methods
  public void addNotify();
  public int getAlignment();
  public String getText();
  public synchronized void setAlignment (int alignment);
  public synchronized void setText (String label);

  // Protected Instance Methods
  protected String paramString();
}
```

Constants

CENTER

`public static final int CENTER`

Description   Constant to center text within the label.

LEFT

`public static final int LEFT`

Description   Constant to left justify text within the label.

RIGHT

`public static final int RIGHT`

Description Constant to right justify text within the label.

Constructors

Label

`public Label()`

Description Constructs a `Label` object with the text centered within the label.

`public Label (String label)`

Parameters *label* The text for the label

Description Constructs a `Label` object with the text `label` centered within the label.

`public Label (String label, int alignment)`

Parameters *label* The text for the label

alignment The alignment for the label; one of the constants `CENTER`, `LEFT`, or `RIGHT`.

Throws *IllegalArgumentException*

If alignment is not one of `CENTER`, `LEFT`, or `RIGHT`.

Description Constructs a `Label` object, with a given `alignment` and text of `label`.

Instance Methods

addNotify

`public void addNotify()`

Overrides `Component.addNotify()`

Description Creates `Label`'s peer.

getAlignment

`public int getAlignment()`

Returns Current alignment.

getText

```
public String getText()
```

Returns Current text of `Label`.

`setAlignment`

```
public synchronized void setAlignment (int alignment)
```

Parameters *alignment* New alignment for `Label`; `CENTER`, `LEFT`, or `RIGHT`.
Throws *IllegalArgumentException* If `alignment` is not one of `CENTER`, `LEFT`, or `RIGHT`.
Description Changes the current alignment of `Label`.

`setText`

```
public synchronized void setText (String label)
```

Parameters *label* New text for `Label`.
Description Changes the current text of `Label`.

Protected Instance Methods

`paramString`

```
protected String paramString()
```

Returns String with current settings of `Label`.
Overrides `Component.paramString()`
Description Helper method for `toString()` to generate string of current settings.

See Also

`Component`, `String`

19.36 LayoutManager

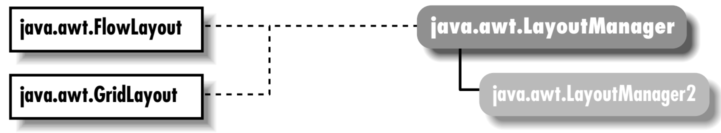
Description

`LayoutManager` is an interface that defines the responsibilities of an object that wants to lay out `Components` to the display in a `Container`.

Interface Definition

```
public abstract interface java.awt.LayoutManager {

   // Interface Methods
   public abstract void addLayoutComponent (String name,
       Component component);
```




```
    public abstract void layoutContainer (Container target);
    public abstract Dimension minimumLayoutSize (Container target);
    public abstract Dimension preferredLayoutSize (Container target);
    public abstract void removeLayoutComponent (Component component);
}
```

Interface Methods

addLayoutComponent

`public abstract void addLayoutComponent (String name, Component component)`

Parameters	*name*	Name of component to add.
	component	Actual component being added.
Description	Called when you call `Container.add(String, Component)` to add an object to a container.	

layoutContainer

`public abstract void layoutContainer (Container target)`

Parameters	*target*	The container who needs to be redrawn.
Description	Called when `target` needs to be redrawn.	

minimumLayoutSize

`public abstract Dimension minimumLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Minimum `Dimension` of the container `target`	
Description	Called when the minimum size of the `target` container needs to be calculated.	

preferredLayoutSize

`public abstract Dimension preferredLayoutSize (Container target)`

Parameters	*target*	The container whose size needs to be calculated.
Returns	Preferred `Dimension` of the container `target`	
Description	Called when the preferred size of the `target` container needs to be calculated.	

`removeLayoutComponent`

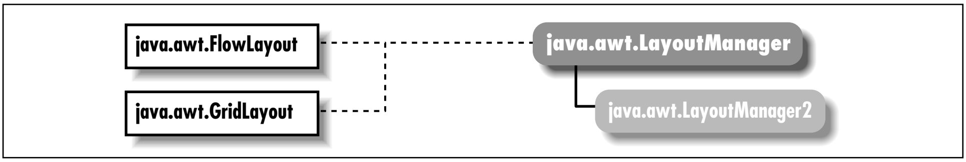
```
public abstract void removeLayoutComponent (Component
component)
```

Parameters	*component*	Component to no longer track.
Description	Called when you call `Container.remove(Component)` to remove a component from the layout.	

See Also

`Component`, `Container`, `FlowLayout`, `GridLayout`, `Object`, `String`

19.37 LayoutManager2 ★



Description

`LayoutManager2` is an extension of `LayoutManager`. It provides a more generalized way to add components to a container, as well as more sizing and alignment methods.

Interface Definition

```
public abstract interface java.awt.LayoutManager2
    extends java.awt.LayoutManager {

  // Interface Methods
  public abstract void addLayoutComponent (Component comp,
      Object constraints);
  public abstract float getLayoutAlignmentX(Container target);
  public abstract float getLayoutAlignmentY(Container target);
  public abstract void invalidateLayout(Container target);
  public abstract Dimension maximumLayoutSize(Container target);
}
```

Interface Methods

addLayoutComponent

`public abstract void addLayoutComponent (Component comp, Object constraints)`

Parameters	*comp*	Component to add.
	constraints	Constraints on the component.
Description	Called to add an object to a container. This is slightly more generic than `LayoutManager`'s `addLayoutComponent(String, Component)`.	

getLayoutAlignmentX

`public abstract float getLayoutAlignmentX (Container target)`

Parameters	*target*	The container to inspect.
Returns	A value between 0 and 1.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is left aligned, .5 is centered, and 1 is right aligned.	

getLayoutAlignmentY

`public abstract float getLayoutAlignmentY (Container target)`

Parameters	*target*	The container to inspect.
Returns	A value between 0 and 1.	
Description	This method returns the preferred alignment of the given container `target`. A return value of 0 is top aligned, .5 is centered, and 1 is bottom aligned.	

invalidateLayout

`public abstract void invalidateLayout (Container target)`

Parameters	*target*	The container to invalidate.
Description	Sophisticated layout managers may cache information to improve performance. This method can be used to signal the manager to discard any cached information and start fresh.	

maximumLayoutSize

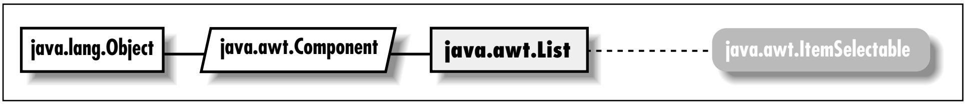
```
public abstract Dimension maximumLayoutSize (Container
target)
```

Returns	The maximum size of `target`.	
Parameters	*target*	The container to inspect.
Description	This method returns the maximum size of `target` using this layout manager.	

See Also

`BorderLayout`, `CardLayout`, `Component`, `Container`, `GridBagLayout`, `Object`, `String`

19.38 List



Description

The `List` is a `Component` that provides a scrollable list of choices to select from. A `List` can be in one of two modes: single selection mode, in which only one item may be selected at a time; and multiple selection mode, in which several items may be selected at one time. A list does not necessarily display all of the choices at one time; one of the constructors lets you specify the number of choices to display simultaneously. Although the changes in 1.1 are extensive, almost all of them can be boiled down to (1) using the 1.1 event model, and (2) standardizing method names (e.g. set/get pairs).

Class Definition

```
public class java.awt.List
    extends java.awt.Component
    implements java.awt.ItemSelectable {

  // Constructors
  public List();
  public List (int rows); ★
  public List (int rows, boolean multipleSelections);

  // Instance Methods
  public void add (String item); ★
  public synchronized void add (String item, int index); ★
  public void addActionListener (ActionListener l); ★
  public void addItem (String item);
```

```
  public synchronized void addItem (String item, int index); ☆
  public void addItemListener (ItemListener l); ★
  public void addNotify();
  public boolean allowsMultipleSelections(); ☆
  public synchronized void clear(); ☆
  public int countItems(); ☆
  public synchronized void delItem (int position);
  public synchronized void delItems (int start, int end); ☆
  public synchronized void deselect (int index);
  public String getItem (int index);
  public int getItemCount(); ★
  public synchronized String[] getItems(); ★
  public Dimension getMinimumSize(); ★
  public Dimension getMinimumSize (int rows); ★
  public Dimension getPreferredSize(); ★
  public Dimension getPreferredSize (int rows); ★
  public int getRows();
  public synchronized int getSelectedIndex();
  public synchronized int[] getSelectedIndexes();
  public synchronized String getSelectedItem();
  public synchronized String[] getSelectedItems();
  public Object[] getSelectedObjects(); ★
  public int getVisibleIndex();
  public boolean isIndexSelected(int index); ★
  public boolean isMultipleMode(); ★
  public boolean isSelected (int index); ☆
  public synchronized void makeVisible (int index);
  public Dimension minimumSize(); ☆
  public Dimension minimumSize (int rows); ☆
  public Dimension preferredSize(); ☆
  public Dimension preferredSize (int rows); ☆
  public synchronized void remove (int position); ★
  public synchronized void remove (String item); ★
  public void removeActionListener (ActionListener l); ★
  public synchronized void removeAll(); ★
  public void removeItemListener (ItemListener l); ★
  public void removeNotify();
  public synchronized void replaceItem (String newItem, int index);
  public synchronized void select (int position);
  public synchronized void setMultipleMode (boolean b); ★
  public synchronized void setMultipleSelections (boolean value); ☆

  // Protected Instance Methods
  protected String paramString();
  protected void processActionEvent (ActionEvent e); ★
  protected void processEvent (AWTEvent e); ★
  protected void processItemEvent (ItemEvent e); ★
}
```

Constructors

List

`public List()`

Description — Constructs a `List` object in single-selection mode.

`public List (int rows)` ★

Parameters — *rows* — Requested number of rows to display.

Description — Constructs a `List` object with the specified number of rows, in single-selection mode.

`public List (int rows, boolean multipleSelections)`

Parameters — *rows* — Requested number of rows to display.

multipleSelections — `true` to allow multiple selections; `false` to select one item at a time.

Description — Constructs a `List` object.

Instance Methods

add

`public void add (String item)` ★

Parameters — *item* — Text for entry to add.

Description — Adds a new entry to the available choices.

`public synchronized void add (String item, int index)` ★

Parameters — *item* — Text for entry to add.

index — Position at which to add entry; the first entry has an `index` of zero.

Description — Adds a new entry to the available choices at the designated position.

addActionListener

`public void addActionListener (ActionListener l)` ★

Parameters — *l* — An object that implements the `ActionListener` interface.

Description — Add a listener for the action event.

`addItem`

`public void addItem (String item)`

Parameters *item* Text for entry to add.
Description Replaced by `add(String)`.

`public synchronized void addItem (String item, int index)` ☆

Parameters *item* Text for entry to add.
index Position at which to add entry; the first entry has an index of zero.
Description Replaced by `add(String, int)`.

`addItemListener`

`public void addItemListener (ItemListener l)` ★

Parameters *l* The listener to be added.
Implements `ItemSelectable.addItemListener(ItemListener l)`
Description Adds a listener for the `ItemEvent` objects this `List` fires off.

`addNotify`

`public void addNotify()`

Overrides `Component.addNotify()`
Description Creates `List`'s peer.

`allowsMultipleSelections`

`public boolean allowsMultipleSelections()` ☆

Returns `true` if multi-selection active, `false` otherwise. Replaced by `isMultipleMode()`.

`clear`

`public synchronized void clear()` ☆

Description Clears all the entries out of the `List`. Replaced by `removeAll()`.

`countItems`

`public int countItems()` ☆

Returns Number of items in the `List`. Replaced by `getItemCount()`.

delItem

`public synchronized void delItem (int position)`

Parameters *position* Position of item to delete.

Description Removes a single entry from the `List`. Replaced by `remove(int)` and `remove(String)`.

delItems

`public synchronized void delItems (int start, int end)` ☆

Parameters *start* Starting position of entries to delete.

end Ending position of entries to delete.

Description Removes a set of entries from the `List`.

deselect

`public synchronized void deselect (int index)`

Parameters *index* Position to deselect.

Description Deselects the entry at the designated position, if selected.

getItem

`public String getItem (int index)`

Parameters *index* Position of entry to get.

Throws *ArrayIndexOutOfBoundsException*

If `index` is invalid.

Returns String for entry at given position.

getItemCount

`public int getItemCount()` ★

Returns Number of items in the `List`.

getItems

`public String[] getItems()` ★

Returns The string items in the `List`.

getMinimumSize

`public Dimension getMinimumSize()` ★

Returns The minimum dimensions of the `List`.

`public Dimension getMinimumSize (int rows)` ★

Parameters *rows* Number of rows within `List` to size.
Returns The minimum dimensions of a `List` of the given size.

getPreferredSize

`public Dimension getPreferredSize()` ★

Returns The preferred dimensions of the `List`.

`public Dimension getPreferredSize (int rows)` ★

Parameters *rows* Number of rows within `List` to size.
Returns The preferred dimensions of a `List` of the given size.

getRows

`public int getRows()`

Returns Returns number of rows requested to be displayed in `List`.

getSelectedIndex

`public synchronized int getSelectedIndex()`

Returns Position of currently selected entry, or -1 if nothing is selected, or if multiple entries are selected.

getSelectedIndexes

`public synchronized int[] getSelectedIndexes()`

Returns An array whose elements are the indices of the currently selected entries.

getSelectedItem

`public synchronized String getSelectedItem()`

Returns Currently selected entry as a String, or null if nothing is selected, or if multiple entries are selected.

getSelectedItems

`public synchronized String[] getSelectedItems()`

Returns An array of strings whose elements are the labels of the currently selected entries.

`getSelectedObjects`

`public Object[] getSelectedObjects()` ★

Implements	`ItemSelectable.getSelectedObjects()`
Returns	An array of strings whose elements are the labels of the currently selected entries.

`getVisibleIndex`

`public int getVisibleIndex()`

Returns	The last index from a call to `makeVisible()`.

`isIndexSelected`

`public boolean isIndexSelected (int index)` ★

Parameters	*index*	Position to check.
Returns	`true` if index selected, `false` otherwise.	
Description	Checks to see if a particular entry is currently selected.	

`isMultipleMode`

`public boolean isMultipleMode()` ★

Returns	`true` if multiple selection is allowed, `false` otherwise.

`isSelected`

`public boolean isSelected (int index)` ☆

Parameters	*index*	Position to check.
Returns	`true` if index selected, `false` otherwise.	
Description	Checks to see if a particular entry is currently selected. Replaced by `isIndexSelected(int)`.	

`makeVisible`

`public synchronized void makeVisible (int index)`

Parameters	*index*	Position to make visible on screen.
Description	Ensures an item is displayed on the screen.	

`minimumSize`

`public Dimension minimumSize()` ☆

Returns	The minimum dimensions of the `List`. Replaced by `getMinimumSize()`.

`public Dimension minimumSize (int rows)` ☆

Parameters	*rows*	Number of rows within `List` to size.
Returns	The minimum dimensions of a `List` of the given size. Replaced by `getMinimumSize(int)`.	

preferredSize

`public Dimension preferredSize()` ☆

Returns	The preferred dimensions of the `List`. Replaced by `getPreferredSize()`.

`public Dimension preferredSize (int rows)` ☆

Parameters	*rows*	Number of rows within `List` to size.
Returns	The preferred dimensions of a `List` of the given size. Replaced by `getPreferredSize(int)`.	

remove

`public synchronized void remove (int position)` ★

Parameters	*position*	Position of item to remove.
Description	Removes a single entry from the `List`.	

`public synchronized void remove (String item)` ★

Parameters	*item*	Item to remove.
Throws	*IllegalArgumentException*	If `item` is not in the `List`.
Description	Removes a single entry from the `List`.	

removeActionListener

`public void removeActionListener (ActionListener l)` ★

Parameters	*l*	One of this `List`'s `ActionListeners`.
Description	Remove an action event listener.	

removeAll

`public synchronized removeAll()` ★

Description	Removes all items from the `List`.

removeItemListener

`public void removeItemListener (ItemListener l) ★`

Parameters *l* The listener to be removed.

Implements `ItemSelectable.removeItemListener (ItemListener l)`

Description Removes the specified `ItemListener` so it will not receive `ItemEvent` objects from this `List`.

removeNotify

`public void removeNotify()`

Description Destroys the peer of the `List`.

replaceItem

`public synchronized void replaceItem (String newItem, int index)`

Parameters *newItem* Label for entry to add.
index Position of entry to replace.

Description Replaces the contents at a particular position with a new entry.

select

`public synchronized void select (int position)`

Parameters *position* Position to make selected entry.

Description Makes the given entry the selected one for the `List`.

setMultipleMode

`public synchronized void setMultipleMode (boolean b) ★`

Parameters *b* `true` to enable multiple selections; `false` to disable multiple selections.

Description Changes `List`'s selection mode based upon flag.

setMultipleSelections

`public synchronized void setMultipleSelections (boolean value) ☆`

Parameters *value* `true` to enable multiple selections; `false` to disable multiple selections.

Description Changes `List`'s selection mode based upon flag. Replaced by `setMultipleMode(boolean)`.

Protected Instance Methods

paramString

```
protected String paramString()
```

Returns	String with current settings of `List`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

processActionEvent

```
protected void processActionEvent (ActionEvent e) ★
```

Parameters	*e*	The action event to process.
Description	Action events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

processEvent

```
protected void processEvent (AWTEvent e) ★
```

Parameters	*e*	The event to process.
Description	Low-level `AWTEvents` are passed to this method for processing.	

processItemEvent

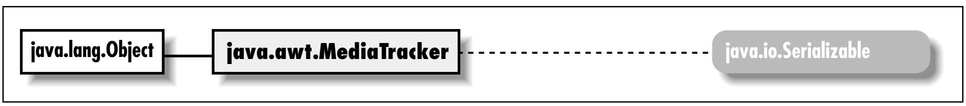
```
protected void processItemEvent(ItemEvent e) ★
```

Parameters	*e*	The item event to process.
Description	Item events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

See Also

`Component`, `Dimension`, `ItemSelectable`, `String`

19.39 MediaTracker



Description

The `MediaTracker` class assists in the loading of multimedia objects across the network. It can be used to wait until an object (or group of objects) has been loaded completely. Tracked objects are assigned to groups; if there is more than one object in a group, you can only track the behavior of the group as a whole (i.e., it isn't possible to track an individual object unless it is the only object in its group). Currently (1.0.2 and 1.1) `MediaTracker` only works for `Image` objects; future releases may extend `MediaTracker` to other multi-media types.

Class Definition

```
public abstract class java.awt.MediaTracker
    extends java.lang.Object
    implements java.io.Serializable {

  // Constants
  public static final int ABORTED;
  public static final int COMPLETE;
  public static final int ERRORED;
  public static final int LOADING;

  // Constructors
  public MediaTracker (Component component);

  // Instance Methods
  public void addImage (Image image, int id);
  public synchronized void addImage (Image image, int id, int width, int height);
  public boolean checkAll();
  public synchronized boolean checkAll (boolean load);
  public boolean checkID (int id);
  public synchronized boolean checkID (int id, boolean load);
  public synchronized Object[] getErrorsAny();
  public synchronized Object[] getErrorsID (int id);
  public synchronized boolean isErrorAny();
  public synchronized boolean isErrorID (int id);
  public synchronized void removeImage(Image image); ★
  public synchronized void removeImage(Image image, int id); ★
  public synchronized void removeImage(Image image, int id, int width, int height); ★
  public synchronized int statusAll (boolean load);
  public synchronized int statusID (int id, boolean load);
  public void waitForAll() throws InterruptedException;
  public synchronized boolean waitForAll (long ms) throws InterruptedException;
  public void waitForID (int id) throws InterruptedException;
  public synchronized boolean waitForID (int id, long ms) throws InterruptedExceptio
}
```

Constants

ABORTED

```
public static final int ABORTED
```

Flag that indicates that the loading process aborted while loading a particular image.

COMPLETE

```
public static final int COMPLETE
```

Flag that indicates a particular image loaded successfully.

ERRORED

```
public static final int ERRORED
```

Flag that indicates an error occurred while a particular image was loading.

LOADING

```
public static final int LOADING
```

Flag that indicates a particular image is still loading.

Constructors

MediaTracker

```
public MediaTracker (Component component)
```

Parameters	*component*	`Component` that eventually renders objects being tracked.
Description	Constructs an `MediaTracker` object.	

Instance Methods

addImage

```
public void addImage (Image image, int id)
```

Parameters	*image*	`Image` to track.
	id	ID of a group.
Description	Tells a MediaTracker to track the loading of `image`, placing the image in the group identified by `id`.	

```
public synchronized void addImage (Image image, int id,
int width, int height)
```

Parameters	*image*	Image to track.
	id	ID of a group.

	width	Eventual rendering width.
	height	Eventual rendering height.
Description	Tells a MediaTracker to track the loading of `image`, which will be scaled to the given `height` and `width`, placing the image in the group identified by `id`.	

checkAll

```
public boolean checkAll()
```

Returns	`true` if images completed loading (successfully or unsuccessfully), `false` otherwise.
Description	Determines if all images have finished loading.

```
public synchronized boolean checkAll (boolean load)
```

Parameters	*load*	Flag to force image loading to start.
Returns	`true` if all images have completed loading (successfully or unsuccessfully), `false` otherwise.	
Description	Determines if all images have finished loading; the `load` parameter may be used to force images to start loading.	

checkID

```
public boolean checkID (int id)
```

Parameters	*id*	ID of a group.
Returns	`true` if all images have completed loading (successfully or unsuccessfully), `false` otherwise.	
Description	Determines if all images with the given ID tag have finished loading.	

```
public synchronized boolean checkID (int id, boolean load)
```

Parameters	*id*	ID of a group.
	load	Flag to force image loading to start.
Returns	`true` if all images have completed loading (successfully or unsuccessfully), `false` otherwise.	
Description	Determines if all images with the given ID tag have finished loading; the `load` parameter may be used to force images to start loading.	

getErrorsAny

```
public synchronized Object[] getErrorsAny()
```

Returns — An array of objects managed by this media tracker that encountered a loading error.

Description — Checks to see if any media encountered an error while loading.

getErrorsID

```
public synchronized Object[] getErrorsID (int id)
```

Parameters — *id* — ID of a group.

Returns — An array of objects that encountered a loading error.

Description — Checks to see if any media with the given ID tag encountered an error while loading.

isErrorAny

```
public synchronized boolean isErrorAny()
```

Returns — `true` if an error occurred, `false` otherwise.

Description — Checks to see if any media monitored by this media tracker encountered an error while loading.

isErrorID

```
public synchronized boolean isErrorID (int id)
```

Parameters — *id* — ID of a group.

Returns — `true` if error happened, `false` otherwise.

Description — Checks to see if any media in the given group encountered an error while loading.

removeImage

```
public synchronized void removeImage (Image image) ★
```

Parameters — *image* — The image to remove.

Description — Removes the specified image from this `MediaTracker`.

```
public synchronized void removeImage (Image image, int id)
★
```

Parameters — *image* — The image to remove.
id — ID of a group.

Description — Removes the specified image from this `MediaTracker`. Only instances matching the given `id` will be removed.

`public synchronized void removeImage (Image image, int id, int width, int height)` ★

Parameters	*image*	The image to remove.
	id	ID of a group.
	width	Width of the scaled image, or -1 for unscaled.
	height	Height of the scaled image, or -1 for unscaled.
Description	Removes the specified image from this `MediaTracker`. Only instances matching the given `id` and scale sizes will be removed.	

statusAll

`public synchronized int statusAll (boolean load)`

Parameters	*load*	Flag to force image loading to start.
Returns	`MediaTracker` status flags ORed together.	
Description	Checks load status of all the images monitored by this media tracker; the `load` parameter may be used to force images to start loading.	

statusID

`public synchronized int statusID (int id, boolean load)`

Parameters	*id*	ID of a group.
	load	Flag to force image loading to start.
Returns	`MediaTracker` status flags ORed together.	
Description	Checks load status of all the images in the given group; the `load` parameter may be used to force images to start loading.	

waitForAll

`public void waitForAll() throws InterruptedException`

Throws	*InterruptedException*	
		If waiting interrupted.
Description	Waits for all the images monitored by this media tracker to load.	

`public synchronized boolean waitForAll (long ms) throws InterruptedException`

Parameters	*ms*	Time to wait for loading.
Throws	*InterruptedException*	
		If waiting interrupted.

Returns `true` if images fully loaded, `false` otherwise.

Description Waits at most `ms` milliseconds for all images monitored by this media tracker to load.

`waitForID`

```
public void waitForID (int id) throws InterruptedException
```

Parameters *id* ID of a group.

Throws *InterruptedException*
If waiting interrupted.

Description Waits for images in the given group to load.

```
public synchronized boolean waitForID (int id, long ms)
throws InterruptedException
```

Parameters *id* ID of a group.
ms Maximum time to wait for loading.

Throws *InterruptedException*
If waiting interrupted.

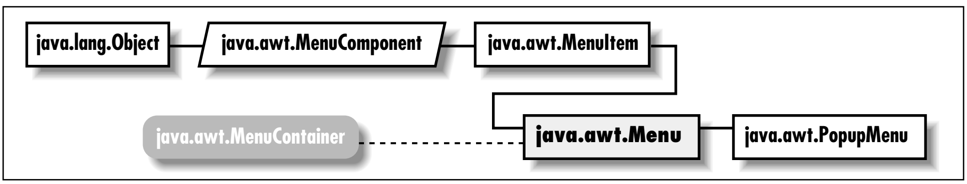
Returns `true` if images fully loaded, `false` otherwise.

Description Waits at most `ms` milliseconds for the images in the given group to load.

See Also

`Component`, `Image`, `Object`

19.40 Menu



Description

The `Menu` class represents a group of `MenuItem` objects. `Menus` themselves are menu items, allowing you to build multi-level menus. `Menus` are always attached to `MenuBars`, which currently can only belong to frames.

Class Definition

```
public class java.awt.Menu
    extends java.awt.MenuItem
    implements java.awt.MenuContainer {

  // Constructors
  public Menu(); ★
  public Menu (String label);
  public Menu (String label, boolean tearOff);

  // Instance Methods
  public synchronized MenuItem add (MenuItem item);
  public void add (String label);
  public void addNotify();
  public void addSeparator();
  public int countItems(); ☆
  public MenuItem getItem (int index);
  public int getItemCount(); ★
  public void insert (String label, int index); ★
  public synchronized void insert (MenuItem menuitem, int index); ★
  public void insertSeparator (int index); ★
  public boolean isTearOff();
  public String paramString();  ★
  public synchronized void remove (int index);
  public synchronized void remove (MenuComponent component);
  public synchronized void removeAll(); ★
  public void removeNotify();
}
```

Constructors

Menu

`public Menu()` ★

Description Constructs a `Menu` object.

`public Menu (String label)`

Parameters *label* Text that appears on `Menu`.
Description Constructs a `Menu` object with the given label.

`public Menu (String label, boolean tearOff)`

Parameters *label* Text that appears on `Menu`.
tearOff `true` to create a tear-off menu, `false` otherwise.
Description Constructs a `Menu` object; this will be a tear-off menu if `tearOff` is set to `true`.

Instance Methods

add

`public synchronized MenuItem add (MenuItem item)`

Parameters	*item*	A `MenuItem` to add to the `Menu`.
Returns	Item just added.	
Description	Adds a new item to a `Menu`.	

`public void add (String label)`

Parameters	*label*	Text for a `MenuItem`
Description	Constructs a new `MenuItem` object with the given label, and adds it to a `Menu`.	

addNotify

`public void addNotify()`

Overrides	`MenuItem.addNotify()`
Description	Creates a `Menu` peer, and peers for all `MenuItem` objects that appear on it.

addSeparator

`public void addSeparator()`

Description	Adds a separator bar to the `Menu`.

countItems

`public int countItems()` ☆

Returns	The number of items on the menu. Replaced by `getItemCount()`.

getItem

`public MenuItem getItem (int index)`

Parameters	*index*	The position of the `MenuItem` to fetch; the first item has index 0.
Returns	The `MenuItem` at the designated position.	

getItemCount

`public int getItemCount()` ★

Returns	The number of items on the menu.

`insert`

`public void insert (String label, int index) ★`

Parameters	*label*	The label for the new item.
	index	The position for the new item.
Description	Adds a new item to this menu.	

`public synchronized void insert (MenuItem menuitem, int index) ★`

Parameters	*menuitem*	The item to add.
	index	The position for the new item.
Throws	*IllegalArgumentException*	
		If `index` is less than zero.
Description	Adds a new item to this menu.	

`insertSeparator`

`public void insertSeparator (int index) ★`

Parameters	*index*	The position for the separator.
Throws	*IllegalArgumentException*	
		If `index` is less than zero.
Description	Adds a separator to this menu.	

`isTearOff`

`public boolean isTearOff()`

Returns	`true` if the menu is a tear-off menu, `false` otherwise.

`paramString`

`public String paramString() ★`

Returns	String with current settings of `Menu`.
Overrides	`MenuItem.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

`remove`

`public synchronized void remove (int index)`

Parameters	*index*	The position of the `MenuItem` to remove.
Description	Removes an item from the `Menu`.	

```
public synchronized void remove (MenuComponent component)
```

Parameters *component* The element to remove.
Implements `MenuContainer.remove()`
Description Removes an item from the Menu.

removeAll

```
public synchronized void removeAll() ★
```

Description Removes all items from the `Menu`.

removeNotify

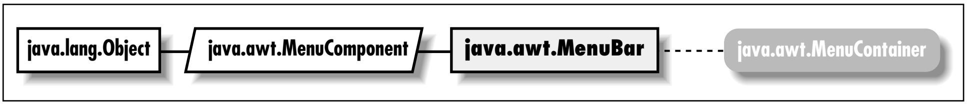
```
public void removeNotify()
```

Description Destroys `Menu` peer, and peers for all `MenuItem` objects that appear on it.

See Also

`Frame`, `MenuComponent`, `MenuContainer`, `MenuItem`, `String`

19.41 MenuBar



Description

A `MenuBar` holds menus. `MenuBars` are always attached to frames, and displayed on the top line of the `Frame`. One menu in a `MenuBar` may be designated a "help" menu.

Class Definition

```
public class java.awt.MenuBar
    extends java.awt.MenuComponent
    implements java.awt.MenuContainer {

  // Constructors
  public MenuBar();

  // Instance Methods
  public synchronized Menu add (Menu m);
  public void addNotify();
  public int countMenus(); ☆
  public void deleteShortcut (MenuShortcut s); ★
```

```
    public Menu getHelpMenu();
    public Menu getMenu (int index);
    public int getMenuCount(); ★
    public MenuItem getShortcutMenuItem (MenuShortcut s); ★
    public synchronized void remove (int index);
    public synchronized void remove (MenuComponent component);
    public void removeNotify();
    public synchronized void setHelpMenu (Menu m);
    public synchronized Enumeration shortcuts(); ★
}
```

Constructors

MenuBar

`public MenuBar()`

Description Constructs a `MenuBar` object.

Instance Methods

add

`public synchronized Menu add (Menu m)`

Parameters *m* A `Menu` to add to `MenuBar`.
Returns Item just added.
Description Adds a new menu to the `MenuBar`.

addNotify

`public void addNotify()`

Description Creates `MenuBar`'s peer and peers of contained menus.

countMenus

`public int countMenus()` ☆

Returns The number of menus on the menu bar. Replaced by `getMenuCount()`.

deleteShortcut

`public void deleteShortcut (MenuShortcut s)` ★

Parameters *s* The shortcut to remove.
Description Removes a menu shortcut.

getHelpMenu

`public Menu getHelpMenu()`

Returns The menu that was designated the help menu.

getMenu

`public Menu getMenu (int index)`

Parameters *index* The position of the Menu to fetch.
Returns The Menu at the designated position.

getMenuCount

`public int getMenuCount()` ★

Returns The number of menus on the menu bar.

getShortcutMenuItem

`public MenuItem getShortcutMenuItem (MenuShortcut s)` ★

Parameters *s* A menu shortcut.
Returns The corresponding menu item.
Description Finds the MenuItem corresponding to the given MenuShortcut, or null if no match is found.

remove

`public synchronized void remove (int index)`

Parameters *index* The position of the Menu to remove.
Description Removes a Menu from the MenuBar.

`public synchronized void remove (MenuComponent component)`

Parameters *component* The element of the MenuBar to remove.
Implements MenuContainer.remove()
Description Removes a Menu from the MenuBar.

removeNotify

`public void removeNotify()`

Description Destroys the MenuBar peer, and peers for all Menu objects that appear on it.

setHelpMenu

```
public synchronized void setHelpMenu (Menu m)
```

Parameters *m* Menu to designate as the help menu.
Description Designates a `Menu` as the `MenuBar`'s help menu.

shortcuts

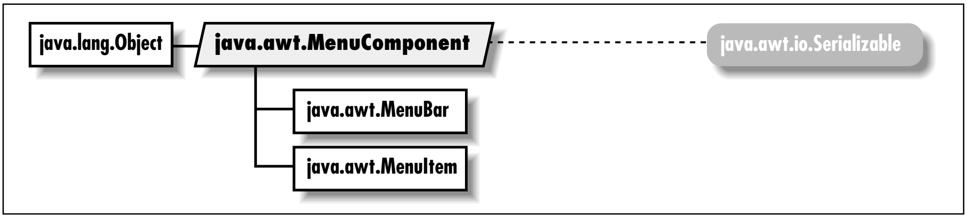
```
public synchronized Enumeration shortcuts() ★
```

Returns An `Enumeration` of `MenuShortcut` objects.
Description Returns an `Enumeration` of all `MenuShortcut` objects managed by this `MenuBar`.

See Also

`Frame`, `Menu`, `MenuComponent`, `MenuContainer`

19.42 MenuComponent



Description

The abstract `MenuComponent` class represents the parent of all menu GUI components.

Class Definition

```
public abstract class java.awt.MenuComponent
    extends java.lang.Object
    implements java.io.Serializable {

  // Instance Methods
  public final void dispatchEvent (AWTEvent e); ★
  public Font getFont();
  public String getName(); ★
  public MenuContainer getParent();
  public MenuComponentPeer getPeer(); ☆
  public boolean postEvent (Event e); ☆
  public void removeNotify();
  public void setFont (Font f);
```

```
    public void setName (String name); ★
    public String toString();

    // Protected Instance Methods
    protected String paramString(); ★
    protected void processEvent (AWTEvent e); ★
}
```

Instance Methods

dispatchEvent

`public final void dispatchEvent (AWTEvent e)`

Parameters *e* The `AWTEvent` to process.

Description Tells the menu component to deal with the `AWTEvent e`.

getFont

`public Font getFont()`

Returns The font for the current `MenuComponent`.

getName

`public Font getName()` ★

Returns The name for the current `MenuComponent`.

getParent

`public MenuContainer getParent()`

Returns The parent `MenuContainer` for the `MenuComponent`.

getPeer

`public MenuComponentPeer getPeer()` ★

Returns A reference to the `MenuComponent`'s peer.

postEvent

`public boolean postEvent (Event e)` ☆

Parameters *e* `Event` instance to post to component.
Returns Ignored for menus.
Description Tells the `Frame` that contains the `MenuBar` containing the `MenuComponent` to deal with `Event`.

removeNotify

`public void removeNotify()`

Description — Removes peer of `MenuComponent`'s subclass.

setFont

`public void setFont (Font f)`

Parameters — *f* — New font for `MenuComponent`.
Description — Changes the font of the label of the `MenuComponent`.

setName

`public void setName (String name)` ★

Parameters — *name* — New name for `MenuComponent`.
Description — Changes the name of the `MenuComponent`.

toString

`public String toString()`

Returns — A string representation of the `MenuComponent` object.

Overrides — `Object.toString()`

Protected Instance Methods

paramString

`protected String paramString()` ★

Returns — String with current settings of `MenuComponent`.
Overrides — `Component.paramString()`
Description — Helper method for `toString()` to generate string of current settings.

processEvent

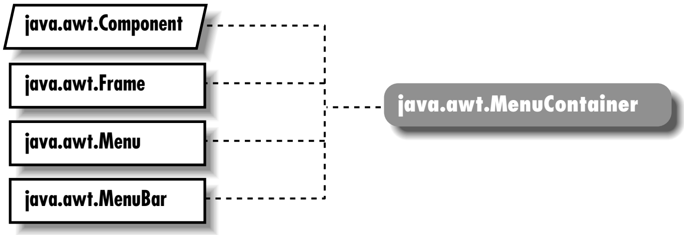
`protected void processEvent (AWTEvent e)` ★

Parameters — *e* — The event to process.
Description — Low-level `AWTEvents` are passed to this method for processing.

See Also

`Event`, `Font`, `MenuBar`, `MenuComponentPeer`, `MenuContainer`, `MenuItem`, `Object`, `Serializable`, `String`

19.43 MenuContainer



Description

`MenuContainer` is an interface that defines the responsibilities for objects that can have a menu.

Interface Definition

```
public abstract interface java.awt.MenuContainer
    extends java.lang.Object {

  // Interface Methods
  public abstract Font getFont();
  public abstract boolean postEvent (Event e);  ☆
  public abstract void remove (MenuComponent component);
}
```

Interface Methods

getFont

`public abstract Font getFont()`

Returns — Current font of the object implementing this method.

postEvent

`public abstract boolean postEvent (Event e)` ☆

Parameters — *e* — Event to post.
Returns — Ignores return value.
Description — Posts event to the object implementing this method.

remove

```
public abstract void remove (MenuComponent component)
```

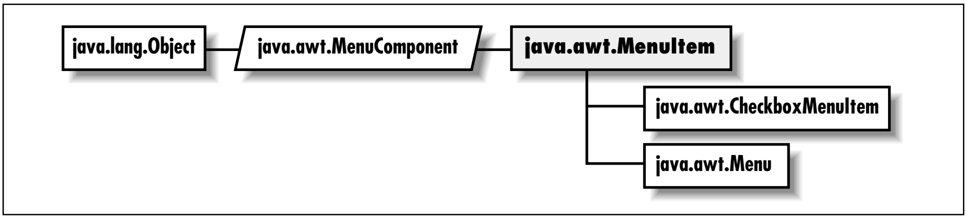
Parameters *component* Menu object to remove

Description Tells the object implementing this method to remove a menu component.

See Also

`Event`, `Font`, `Frame`, `Menu`, `MenuBar`, `MenuComponent`, `Object`

19.44 MenuItem



Description

The `MenuItem` class represents a selectable item on a menu.

Class Definition

```
public class java.awt.MenuItem
    extends java.awt.MenuComponent {

  // Constructors
  public MenuItem(); ★
  public MenuItem (String label);
  public MenuItem (String label, MenuShortcut s); ★

  // Instance Methods
  public void addActionListener (ActionListener l); ★
  public void addNotify();
  public void deleteShortcut(); ★
  public synchronized void disable(); ☆
  public synchronized void enable(); ☆
  public void enable (boolean condition); ☆
  public String getActionCommand(); ★
  public String getLabel();
  public MenuShortcut getShortcut(); ★
  public boolean isEnabled();
  public String paramString();
  public void removeActionListener (ActionListener l); ★
```

```
  public void setActionCommand (String command); ★
  public synchronized void setEnabled (boolean b); ★
  public synchronized void setLabel (String label);
  public void setShortcut (MenuShortcut s); ★

  // Protected Instance Methods
  protected final void disableEvents (long eventsToDisable); ★
  protected final void enableEvents (long eventsToEnable); ★
  protected void processActionEvent (ActionEvent e); ★
  protected void processEvent (AWTEvent e); ★
}
```

Constructors

MenuItem

`public MenuItem()` ★

Description Constructs a `MenuItem` object with no label or shortcut.

`public MenuItem (String label)`

Parameters *label* Text that appears on the `MenuItem`.
Description Constructs a `MenuItem` object.

`public MenuItem (String label, MenuShortcut s)` ★

Parameters *label* Text that appears on the `MenuItem`.
s Shortcut for the `MenuItem`.
Description Constructs a `MenuItem` object with the given shortcut.

Instance Methods

addActionListener

`public void addActionListener(ActionListener l)` ★

Parameters *l* An object that implements the `ActionListener` interface.
Description Add a listener for the action event.

addNotify

`public void addNotify()`

Description Creates the `MenuItem`'s peer.

deleteShortcut

`public void deleteShortcut()` ★

Description Removes the shortcut associated with this item.

disable

`public synchronized void disable()` ☆

Description Disables the menu component so that it is unresponsive to user interactions. Replaced by `setEnabled(false)`.

enable

`public synchronized void enable()` ☆

Description Enables the menu component so that it is responsive to user interactions. Replaced by `setEnabled(true)`.

`public void enable (boolean condition)` ☆

Parameters *condition* `true` to enable the menu component; `false` to disable it.

Description Enables or disables the menu component, depending on the `condition` parameter. Replaced by `setEnabled(boolean)`.

getActionCommand

`public String getActionCommand()` ★

Returns Current action command string.

Description Returns the string used for the action command.

getLabel

`public String getLabel()`

Returns The current text associated with the `MenuItem`.

getShortcut

`public MenuShortcut getShortcut()` ★

Returns The current shortcut for this item, or `null` if there is none.

isEnabled

`public boolean isEnabled()`

Returns `true` if the menu item is enabled, `false` otherwise.

paramString

`public String paramString()`

Returns String with current settings of `MenuItem`.
Description Helper method for `toString()` to generate string of current settings.

removeActionListener

`public void removeActionListener(ActionListener l)` ★

Parameters *l* One of this `Button`'s `ActionListeners`.
Description Remove an action event listener.

setActionCommand

`public void setActionCommand(String command)` ★

Parameters *command* New action command string.
Description Specify the string used for the action command.

setEnabled

`public synchronized void setEnabled (boolean b)` ★

Parameters *b* `true` to enable the item, `false` to disable it.
Description Enables or disables the item. Replaces `enable()`, `enable(boolean)`, and `disable()`.

setLabel

`public synchronized void setLabel (String label)`

Parameters *label* New text to appear on `MenuItem`.
Description Changes the label of the `MenuItem`.

setShortcut

`public void setShortcut (MenuShortcut s)` ★

Parameters *s* New shortcut for the `MenuItem`.
Description Changes the shortcut of the `MenuItem`.

Protected Instance Methods

disableEvents

`protected final void disableEvents (long eventsToDisable)` ★

Parameters	*eventsToDisable*	A value representing certain kinds of events. This can be constructed by ORing the event mask constants defined in `java.awt.AWTEvent`.
Description	By default, a menu item receives events corresponding to the event listeners that have registered. If a menu item should not receive events of a certain type, even if there is a listener registered for that type of event, this method can be used to disable that event type.	

enableEvents

`protected final void enableEvents (long eventsToEnable)` ★

Parameters	*eventsToDisable*	A value representing certain kinds of events. This can be constructed by ORing the event mask constants defined in `java.awt.AWTEvent`.
Description	By default, a menu item receives events corresponding to the event listeners that have registered. If a menu item should receive other types of events as well, this method can be used to get them.	

processActionEvent

`protected void processActionEvent (ActionEvent e)` ★

Parameters	*e*	The action event to process.
Description	Action events are passed to this method for processing. Normally, this method is called by `processEvent()`.	

processEvent

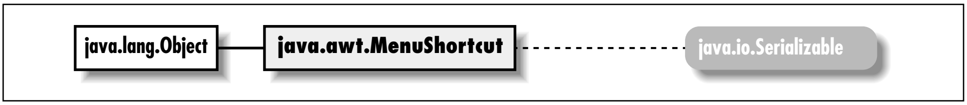
`protected void processEvent (AWTEvent e)` ★

Parameters	*e*	The event to process.
Description	Low-level `AWTEvents` are passed to this method for processing.	

See Also

CheckboxMenuItem, Menu, MenuComponent, MenuShortcut, String

19.45 MenuShortcut ★



Description

A MenuShortcut is used to associate a keystroke with a menu item. MenuShortcuts are constructed using their corresponding key; they are associated with menu items via MenuItem.setShortcut(MenuShortcut).

Class Definition

```
public class java.awt.MenuShortcut
    extends java.awt.Event {

  // Constructors
  public MenuShortcut (int key);
  public MenuShortcut (int key, boolean useShiftModifier);

  // Instance Methods
  public boolean equals (MenuShortcut s);
  public int getKey();
  public String toString();
  public boolean usesShiftModifier();

  // Protected Instance Methods
  protected String paramString();
}
```

Constructors

MenuShortcut

```
public MenuShortcut (int key)
```

Parameters	*key*	A keycode like those returned with key press Event objects.
Description	Constructs a MenuShortcut object for the given key.	

```
public MenuShortcut (int key, boolean useShiftModifier)
```

Parameters *key* — A keycode like those returned with key press `Event` objects.

useShiftModifier — `true` if the Shift key must be used, `false` otherwise.

Description — Constructs a `MenuShortcut` object with the given values.

Instance Methods

equals

```
public boolean equals (MenuShortcut s)
```

Parameters *s* — The `MenuShortcut` to compare.

Returns — `true` if `s` is equal to this `MenuShortcut`, `false` otherwise.

getKey

```
public int getKey()
```

Returns — The key for this `MenuShortcut`.

toString

```
public String toString()
```

Returns — A string representation of the `MenuShortcut` object.

Overrides — `Event.toString()`

usesShiftModifier

```
public boolean usesShiftModifier()
```

Returns — `true` if this `MenuShortcut` must be invoked with the Shift key pressed, `false` otherwise.

Protected Instance Methods

paramString

```
protected String paramString()
```

Returns — String with current settings of `MenuShortcut`.

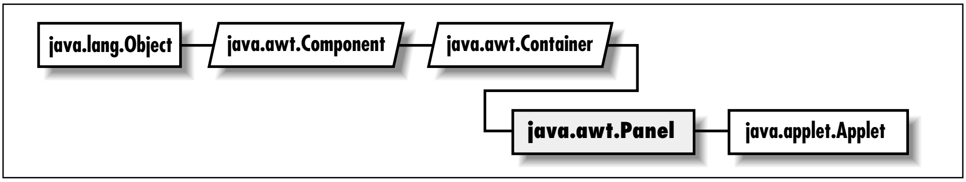
Overrides — `Event.paramString()`

Description — Helper method for `toString()` to generate string of current settings.

See Also

`Event`, `MenuItem`

19.46 Panel



Description

The `Panel` class provides a generic `Container` within an existing display area.

Class Definition

```
public class java.awt.Panel
    extends java.awt.Container {

  // Constructors
  public Panel();
  public Panel(LayoutManager layout); ★

  // Instance Methods
  public void addNotify();
}
```

Constructors

Panel

`public Panel()`

Description Constructs a `Panel` object.

`public Panel (LayoutManager layout)` ★

Description Constructs a `Panel` object with the specified layout manager.

Instance Methods

addNotify

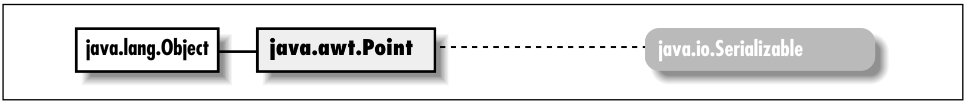
`public void addNotify()`

Overrides	`Container.addNotify()`
Description	Creates `Panel`'s peer and peers of contained components.

See Also

`Applet`, `Container`

19.47 Point



Description

The `Point` class encapsulates a pair of x and y coordinates within a single object.

Class Definition

```
public class java.awt.Point
    extends java.lang.Object
    implements java.io.Serializable {

  // Variables
  public int x;
  public int y;

  // Constructors
  public Point(); ★
  public Point (int width, int height);
  public Point (Point p); ★

  // Instance Methods
  public boolean equals (Object object);
  public Point getLocation(); ★
  public int hashCode();
  public void move (int x, int y);
  public void setLocation (int x, int y); ★
  public void setLocation (Point p); ★
  public String toString();
  public void translate (int deltax, int deltay);
}
```

Variables

x

`public int x`

The coordinate that represents the horizontal position.

y

`public int y`

The coordinate that represents the vertical position.

Constructors

Point

`public Point()` ★

Description	Constructs a `Point` object initialized to (0, 0).	

`public Point (int x, int y)`

Parameters	*x*	Coordinate that represents the horizontal position.
	y	Coordinate that represents the vertical position.
Description	Constructs a `Point` object with an initial position of (`x`, `y`).	

`public Point (Point p)` ★

Parameters	*p*	Initial position.
Description	Constructs a `Point` object with the same position as `p`.	

Instance Methods

equals

`public boolean equals (Object object)`

Parameters	*object*	The object to compare.
Returns	`true` if both points have the same x and y coordinates, `false` otherwise.	
Overrides	`Object.equals()`	
Description	Compares two different `Point` instances for equivalence.	

getLocation

`public Point getLocation()` ★

Returns	Position of this point.
Description	Gets the current position of this `Point`.

hashCode

`public int hashCode()`

Returns	A hashcode to use the `Point` is used as a key in a `Hashtable`.
Overrides	`Object.hashCode()`
Description	Generates a hashcode for the `Point`.

move

`public void move (int x, int y)`

Parameters	*x*	The new x coordinate.
	y	The new y coordinate.
Description	Changes the `Point`'s location to (`x`, `y`).	

setLocation

`public void setLocation (int x, int y)` ★

Parameters	*x*	The new x coordinate.
	y	The new y coordinate.
Description	Changes the `Point`'s location to (`x`, `y`).	

`public void setLocation (Point p)` ★

Parameters	*p*	The new location.
Description	Changes the `Point`'s location to `p`.	

toString

`public String toString()`

Returns	A string representation of the `Point` object.
Overrides	`Object.toString()`

translate

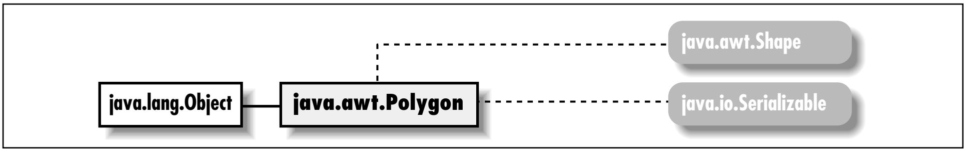
`public void translate (int deltax, int deltay)`

Parameters	*deltax*	Amount to move horizontally.
	deltay	Amount to move vertically.
Description	Moves the `Point` to the location (`x+deltax`, `y+deltay`).	

See Also

`Object`, `String`

19.48 Polygon



Description

The `Polygon` class encapsulates a collection of points used to create a series of line segments.

Class Definition

```
public class java.awt.Polygon
    extends java.lang.Object
    implements java.awt.Shape, java.io.Serializable {

  // Variables
  protected Rectangle bounds; ★
  public int npoints;
  public int xpoints[];
  public int ypoints[];

  // Constructors
  public Polygon();
  public Polygon (int xpoints[], int ypoints, int npoints);

  // Instance Methods
  public void addPoint (int x, int y);
  public boolean contains (int x, int y); ★
  public boolean contains (Point p); ★
  public Rectangle getBoundingBox(); ☆
  public Rectangle getBounds(); ★
  public boolean inside (int x,int y); ☆
  public void translate (int deltaX, int deltaY); ★
}
```

Variables

bounds

`protected Rectangle bounds` ★

The rectangle that describes the boundaries of the `Polygon`.

npoints

`public int npoints`

The number of elements to use in the `xpoints` and `ypoints` arrays.

xpoints

`public int xpoints[]`

The array of x coordinates for each point.

ypoints

`public int ypoints[]`

The array of y coordinates for each point.

Constructors

Polygon

`public Polygon()`

Description Constructs an empty `Polygon` object with no points.

`public Polygon (int xPoints[], int yPoints[], int numPoints)`

Parameters
xPoints[] The initial array of x coordinates for each point.
yPoints[] The initial array of y coordinates for each point.
numPoints The number of elements in both `xPoints` and `yPoints` arrays to use.

Throws `ArrayIndexOutOfBoundsException`
If `numPoints > xPoints.length` or `numPoints > yPoints.length`.

Description Constructs a `Polygon` object with the set of points provided.

Instance Methods

addPoint

`public void addPoint (int x, int y)`

Parameters	*x*	The x coordinate of the point to be added.
	y	The y coordinate of the point to be added.
Description	Adds the point (`x`, `y`) to the end of the list of points for the `Polygon`.	

contains

`public boolean contains (int x, int y)` ★

Parameters	*x*	The x coordinate to test.
	y	The y coordinate to test.
Returns	`true` if the `Polygon` contains the point; `false` otherwise.	

`public boolean contains (Point p)` ★

Parameters	*p*	The point to be tested.
Returns	`true` if the `Polygon` contains the point; `false` otherwise.	

getBoundingBox

`public Rectangle getBoundingBox()` ☆

Returns	Bounding Rectangle of the points within the `Polygon`.
Description	Returns the smallest `Rectangle` that contains all the points within the `Polygon`. Replaced by `getBounds()`.

getBounds

`public Rectangle getBounds()` ★

Implements	`Shape.getBounds()`
Returns	Bounding Rectangle of the points within the `Polygon`.
Description	Returns the smallest `Rectangle` that contains all the points within the `Polygon`.

inside

`public boolean inside (int x,int y)` ☆

Parameters	*x*	The x coordinate of the point to be checked.
	y	The y coordinate of the point to be checked.
Returns	`true` if (`x`, `y`) within `Polygon`, `false` otherwise.	
Description	Checks to see if the (`x`, `y`) point is within an area that would be filled if the `Polygon` was drawn with `Graphics.fillPolygon()`. Replaced by `contains(int, int)`.	

translate

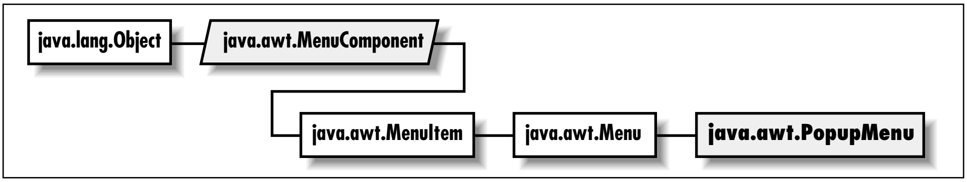
`public void translate (int deltaX, int deltaY)` ★

Parameters	*deltaX*	Amount to move horizontally.
	deltaY	Amount to move vertically.
Description	Moves the `Polygon` to the location (`x+deltaX`, `y+deltaY`).	

See Also

`Graphics`, `Object`, `Rectangle`

19.49 PopupMenu ★



Description

A `PopupMenu` is a menu that can be popped up on a `Component`.

Class Definition

```
public class java.awt.PopupMenu
    extends java.awt.Menu {

  // Constructors
  public PopupMenu();
  public PopupMenu (String label);

  // Instance Methods
  public synchronized void addNotify();
  public void show (Component origin, int x, int y);
}
```

Constructors

PopupMenu

`public PopupMenu()`

Description   Constructs a PopupMenu object.

```
public PopupMenu (String label)
```

Parameters	*label*	Text that appears on `Menu`.
Description	Constructs a PopupMenu object with the given label.	

Instance Methods

addNotify

```
public synchronized void addNotify()
```

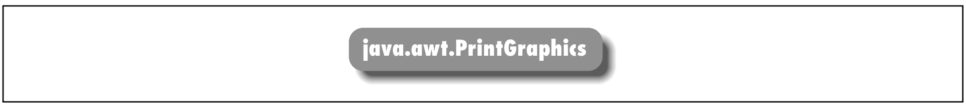
Overrides	`Menu.addNotify()`
Description	Creates a PopupMenu peer.

show

```
public void show (Component origin, int x, int y)
```

Parameters	*origin*	The `Component` upon which the `PopupMenu` will be displayed.
	x	The `PopupMenu`'s horizontal position on the component.
	y	The `PopupMenu`'s vertical position on the component.
Description	Shows the menu on the given `Component`. The origin specified must be contained in the hierarchy of the `PopupMenu`'s parent component, which is determined by the call to `Component.add(PopupMenu)`.	

19.50 PrintGraphics ★



Description

`PrintGraphics` is an interface for classes that provide a printing graphics context.

Interface Definition

```
public abstract interface java.awt.PrintGraphics {

  // Interface Methods
  public abstract PrintJob getPrintJob();
}
```

Interface Methods

getPrintJob

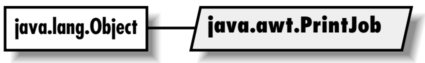
```
public abstract PrintJob getPrintJob()
```

Returns	The `PrintJob` from which the `PrintGraphics` object originated.

See Also

`PrintJob`

19.51 PrintJob ★



Description

`PrintJob` encapsulates printing information. When you call `Toolkit.getPrintJob()`, this is the object that is returned. From the `PrintJob`, you can access a `Graphics` object, which can be used for drawing to the printer.

Class Definition

```
public abstract class jav.awt.PrintJob
    extends java.lang.Object {

  // Instance Methods
  public abstract void end();
  public void finalize();
  public abstract Graphics getGraphics();
  public abstract Dimension getPageDimension();
  public abstract int getPageResolution();
  public abstract boolean lastPageFirst();
}
```

Instance Methods

end

`public abstract void end()`

Description Ends printing and cleans up.

finalize

`public void finalize()`

Overrides `Object.finalize()`
Description Cleans up when this object is garbage collected.

getGraphics

`public abstract Graphics getGraphics()`

Returns A `Graphics` object representing the next page. The object returned will also implement the `PrintGraphics` interface.
Description Returns a `Graphics` object for printing.

getPageDimension

`public abstract Dimension getPageDimension()`

Returns The page dimensions in pixels.

getPageResolution

`public abstract int getPageResolution`

Returns The page resolution, in pixels per inch.

lastPageFirst

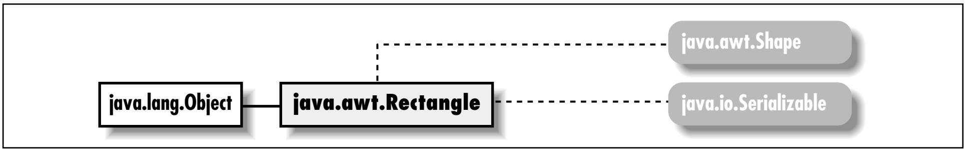
`public abstract boolean lastPageFirst()`

Returns `true` if pages are printed in reverse order; `false` otherwise.

See Also

`Dimension`, `Graphics`, `PrintGraphics`, `Toolkit`

19.52 Rectangle



Description

The `Rectangle` class represents a rectangle by combining its origin (a pair of x and y coordinates) with its size (a width and a height).

Class Definition

```
public class java.awt.Rectangle
    extends java.lang.Object
    implements java.awt.Shape, java.io.Serializable {

  // Variables
  pubic int height;
  public int width;
  public int x;
  public int y;

  // Constructors
  public Rectangle();
  public Rectangle (int width, int height);
  public Rectangle (int x, int y, int width, int height);
  public Rectangle (Dimension d);
  public Rectangle (Point p);
  public Rectangle (Point p, Dimension d);
  public Rectangle (Rectangle r); ★

  // Instance Methods
  public void add (int newX, int newY);
  public void add (Point p);
  public void add (Rectangle r);
  public boolean contains (int x, int y); ★
  public boolean contains (Point p); ★
  public boolean equals (Object object);
  public Rectangle getBounds(); ★
  public Point getLocation(); ★
  public Dimension getSize(); ★
  public void grow (int horizontal, int vertical);
  public int hashCode();
  public boolean inside (int x, int y); ☆
  public Rectangle intersection (Rectangle r);
  public boolean intersects (Rectangle r);
```

```
  public boolean isEmpty();
  public void move (int x, int y); ☆
  public void reshape (int x, int y, int width, int height); ☆
  public void resize (int width, int height); ☆
  public void setBounds (Rectangle r); ★
  public void setBounds (int x, int y, int width, int height); ★
  public void setLocation (int x, int y); ★
  public void setLocation (Point p); ★
  public void setSize (int width, int height); ★
  public void setSize (Dimension d); ★
  public String toString();
  public void translate (int x, int y);
  public Rectangle union (Rectangle r);
}
```

Variables

height

`public int height`

The height of the `Rectangle`.

width

`public int width`

The width of the `Rectangle`.

x

`public int x`

The x coordinate of the `Rectangle`'s upper left corner (its origin).

y

`public int y`

The y coordinate of the `Rectangle`'s upper left corner (its origin).

Constructors

Rectangle

`public Rectangle()`

Description Constructs an empty `Rectangle` object with an origin of (0, 0) and dimensions of 0 x 0.

`public Rectangle (int width, int height)`

Parameters	*width*	width of `Rectangle`
	height	height of `Rectangle`
Description	Constructs a `Rectangle` object with an origin of (0, 0) and dimensions of `width` x `height`.	

`public Rectangle (int x, int y, int width, int height)`

Parameters	*x*	x coordinate of the `Rectangle`'s origin
	y	y coordinate of the `Rectangle`'s origin
	width	width of `Rectangle`
	height	height of `Rectangle`
Description	Constructs a `Rectangle` object with an origin of (`x`, `y`) and dimensions of `width` x `height`.	

`public Rectangle (Dimension d)`

Parameters	*d*	dimensions of `Rectangle`
Description	Constructs a `Rectangle` object with an origin of (0, 0) and dimensions of `d.width` x `d.height`.	

`public Rectangle (Point p)`

Parameters	*p*	origin of `Rectangle`
Description	Constructs an empty `Rectangle` object with an origin of (`p.x`, `p.y`) and dimensions of 0 x 0.	

`public Rectangle (Point p, Dimension d)`

Parameters	*p*	origin of `Rectangle`
	d	dimensions of `Rectangle`
Description	Constructs a `Rectangle` object with an origin of (`p.x`, `p.y`) and dimensions of `d.width` x `d.height`.	

`public Rectangle (Rectangle r)` ★

Parameters	*r*	original `Rectangle`
Description	Constructs copy of the given `Rectangle`.	

Instance Methods

add

`public void add (int newX, int newY)`

Parameters	*newX*	The x-coordinate of a point to incorporate within the `Rectangle`.

	newY	The y-coordinate of a point to incorporate within the `Rectangle`.
Description	Extends the `Rectangle` so that the point (`newX`, `newY`) is within it.	

`public void add (Point p)`

Parameters	*p*	The new `Point` to add to the `Rectangle`.
Description	Extends the `Rectangle` so that the point `p` is within it.	

`public void add (Rectangle r)`

Parameters	*r*	The `Rectangle` being added to the current `Rectangle`.
Description	Extends the `Rectangle` to include the `Rectangle` `r`.	

contains

`public boolean contains (int x, int y)` ★

Parameters	*x*	The x coordinate to test.
	y	The y coordinate to test.
Returns	`true` if the `Rectangle` contains the point; `false` otherwise.	

`public boolean contains (Point p)` ★

Parameters	*p*	The point to be tested.
Returns	`true` if the `Rectangle` contains the point; `false` otherwise.	

equals

`public boolean equals (Object object)`

Parameters	*object*	The object to compare.
Returns	`true` if both `Rectangles` have the same origin, width, and height; `false` otherwise.	
Overrides	`Object.equals(Object)`	
Description	Compares two different `Rectangle` instances for equivalence.	

getBounds

`public Rectangle getBounds()` ★

Implements	`Shape.getBounds()`
Returns	Bounding `Rectangle`.

getLocation

`public Point getLocation()` ★

Returns	Position of the rectangle.
Description	Gets the current position of this `Rectangle`.

getSize

`public Dimension getSize()` ★

Returns	Dimensions of the rectangle.
Description	Gets width and height of the rectangle.

grow

`public void grow (int horizontal, int vertical)`

Parameters	*horizontal*	Amount to extend `Rectangle` in horizontal direction on both the left and right sides.
	vertical	Amount to extend `Rectangle` in vertical direction on both the top and the bottom.
Description	Increases the rectangle's dimensions.	

hashCode

`public int hashCode()`

Returns	A hashcode to use when using the `Rectangle` as a key in a `Hashtable`.
Overrides	`Object.hashCode()`
Description	Generates a hashcode for the `Rectangle`.

inside

`public boolean inside (int x, int y)` ☆

Parameters	*x*	The x coordinate to check.
	y	The y coordinate to check.
Returns	`true` if (`x`, `y`) falls within the `Rectangle`, `false` otherwise.	
Description	Checks to see if the point (`x`, `y`) is within the `Rectangle`. Replaced by `contains(int, int)`.	

intersection

`public Rectangle intersection (Rectangle r)`

Parameters	*r*	`Rectangle` to add to the current `Rectangle`.
Returns	A new `Rectangle` consisting of all points in both the current `Rectangle` and `r`.	
Description	Generates a new `Rectangle` that is the intersection of `r` and the current `Rectangle`.	

intersects

`public boolean intersects (Rectangle r)`

Parameters	*r*	`Rectangle` to check.
Returns	`true` if any points in `r` are also in the current `Rectangle`, `false` otherwise.	
Description	Checks to see if `r` crosses the `Rectangle`.	

isEmpty

`public boolean isEmpty()`

Returns	`true` if the `Rectangle` is empty, `false` otherwise.
Description	Determines if the rectangle is dimensionless (i.e., width or height are less than or equal to 0).

move

`public void move (int x, int y)` ☆

Parameters	*x*	The new x coordinate of the `Rectangle`'s upper left corner.
	y	The new y coordinate of the `Rectangle`'s upper left corner.
Description	Changes the `Rectangle`'s origin to (`x`, `y`). Replaced by `setLocation(int, int)`.	

reshape

`public void reshape (int x, int y, int width, int height)`
☆

Parameters	*x*	The new x coordinate of the `Rectangle`'s upper left corner.
	y	The new y coordinate of the `Rectangle`'s upper left corner.

	width	The new width.
	height	The new height.
Description	Changes `Rectangle`'s origin and dimensions. Replaced by `setBounds(int, int, int, int)`.	

resize

`public void resize (int width, int height)` ☆

Parameters	*width*	The new width.
	height	The new height.
Description	Changes `Rectangle`'s dimensions. Replaced by `setSize(int, int)`.	

setBounds

`public void setBounds (Rectangle r)` ★

Parameters	*r*	A `Rectangle` describing the new bounds.
Description	Changes `Rectangle`'s location and size.	

`public void setBounds (int x, int y, int width, int height) [New in 1.1]`

Parameters	*x*	The new x coordinate of the `Rectangle`'s upper left corner.
	y	The new y coordinate of the `Rectangle`'s upper left corner.
	width	The new width.
	height	The new height.
Description	Changes `Rectangle`'s location and size.	

setLocation

`public void setLocation (int x, int y)` ★

Parameters	*x*	New horizontal position.
	y	New vertical position.
Description	Relocates the rectangle.	

`public void setLocation (Point p)` ★

Parameters	*p*	New position for component.
Description	Relocates the rectangle.	

setSize

`public void setSize (int width, int height)` ★

Parameters	*width*	New width.
	height	New height.
Description	Resizes the rectangle.	

`public void setSize (Dimension d)` ★

Parameters	*d*	New dimensions.
Description	Resizes the rectangle.	

toString

`public String toString()`

Returns	A string representation of the `Rectangle` object.
Overrides	`Object.toString()`

translate

`public void translate (int deltax, int deltay)`

Parameters	*deltax*	Amount to move `Rectangle` horizontally.
	deltay	Amount to move `Rectangle` vertically.
Description	Moves the `Rectangle`'s origin to (`x+deltax`, `y+deltay`).	

union

`public Rectangle union (Rectangle r)`

Parameters	*r*	Rectangle to determine union with.
Returns	The smallest `Rectangle` containing both `r` and the current `Rectangle`.	
Description	Generates a new `Rectangle` by combining `r` and the current `Rectangle`.	

See Also

`Dimension`, `Object`, `Point`, `String`

19.53 ScrollPane ★

Description

The `ScrollPane` class provides automatic scrolling of a child component.

Class Definition

```
public class java.awt.ScrollPane
    extends java.awt.Container {

  // Constants
  public final static int SCROLLBARS_ALWAYS;
  public final static int SCROLLBARS_AS_NEEDED;
  public final static int SCROLLBARS_NEVER;

  // Constructors
  public ScrollPane();
  public ScrollPane (int scrollbarDisplayPolicy);

  // Public Instance Methods
  public void addNotify();
  public void doLayout();
  public Adjustable getHAdjustable();
  public int getHScrollbarHeight();
  public Point getScrollPosition();
  public int getScrollbarDisplayPolicy();
  public Adjustable getVAdjustable();
  public int getVScrollbarWidth();
  public Dimension getViewportSize();
  public void layout(); ☆
  public String paramString();
  public void printComponents (Graphics g);
  public final void setLayout (LayoutManager mgr);
  public void setScrollPosition (int x, int y);
  public void setScrollPosition (Point p);

  //Protected Instance Methods
  protected final void addImpl (Component comp, Object constraints,
    int index);
}
```

Constants

SCROLLBARS_ALWAYS

`public final static int SCROLLBARS_ALWAYS`

Always show the scrollbars.

SCROLLBARS_AS_NEEDED

`public final static int SCROLLBARS_AS_NEEDED`

Only show the scrollbars if the contents of the `ScrollPane` are larger than what is visible.

SCROLLBARS_NEVER

`public final static int SCROLLBARS_NEVER`

Don't ever show the scrollbars. The `ScrollPane` can still be scrolled programmatically.

Constructors

ScrollPane

`public ScrollPane()`

Description Constructs a `ScrollPane` object with `SCROLLBARS_AS_NEEDED`.

`public ScrollPane (int scrollbarDisplayPolicy)`

Parameters *scrollbarDisplayPolicy*
One of the `SCROLLBARS_` constants.

Description Constructs a `ScrollPane` object with the specified scrollbar display policy.

Instance Methods

addImpl

```
protected final void addImpl (Component comp, Object
constraints, int index)
```

Parameters *comp* The component to add to the `Scrollpane`.
constraints Layout constraints; ignored.
index The position at which to add the component; should always be less than or equal to 0.

Returns The component that was added.

Overrides `Container.addImpl (Component, Object, int)`

Throws *IllegalArgumentException*

If `pos` is greater than 0.

Description Adds a child component to the `Scrollpane`. If there already was a child component, it is replaced by the new component.

addNotify

`public void addNotify()`

Overrides `Container.addNotify()`

Description Creates `ScrollPane`'s peer.

doLayout

`public void doLayout()`

Overrides `Container.doLayout()`

Description Lays out the `ScrollPane`. Resizes the child component to its preferred size.

getHAdjustable

`public Adjustable getHAdjustable()`

Returns The object implementing the `Adjustable` interface that is used to adjust the `ScrollPane` horizontally. Usually this is a `Scrollbar`.

getHScrollbarHeight

`public int getHScrollbarHeight()`

Returns The height a horizontal scrollbar would occupy, regardless of whether it's shown or not.

getScrollPosition

`public Point getScrollPosition()`

Returns Returns the position within the child component that is displayed at 0, 0 in the `ScrollPane`.

getScrollbarDisplayPolicy

`public int getScrollbarDisplayPolicy()`

Returns The display policy for the scrollbars (one of the `SCROLLBARS_` constants).

getVAdjustable

`public Adjustable getVAdjustable()`

Returns — The object implementing the `Adjustable` interface that is used to adjust the `ScrollPane` vertically. Usually this is a `Scrollbar`.

getVScrollbarWidth

`public int getVScrollbarWidth()`

Returns — The width a vertical scrollbar would occupy, regardless of whether it's shown or not.

getViewportSize

`public Dimension getViewportSize()`

Returns — The size of the `ScrollPane`'s port (the area of the child component that is shown).

layout

`public void layout()` ☆

Overrides — `Container.layout()`

Description — Lays out component. Replaced by `doLayout()`.

paramString

`public String paramString()`

Returns — String with current settings of `ScrollPane`.

Overrides — `Container.paramString()`

Description — Helper method for `toString()` to generate string of current settings.

printComponents

`public void printComponents (Graphics g)`

Parameters — *g* — Graphics context.

Overrides — `Container.printComponents(Graphics)`

Description — Prints the `ScrollPane`'s child component.

setLayout

`public void setLayout (LayoutManager manager)`

Parameters *manager* Ignored.
Overrides `Container.setLayout(LayoutManager)`
Description Does nothing. No layout manager is needed because there is only one child component.

`setScrollPosition`

`public void setScrollPosition (int x, int y)`

Parameters *x* New horizontal position.
y New vertical position.
Throws *IllegalArgumentException*
If the point given is not valid.
Description Scroll to the given position in the child component.

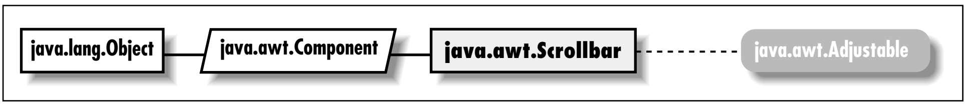
`public void setScrollPosition (Point p)`

Parameters *p* New position.
Throws *IllegalArgumentException*
If the point given is not valid.
Description Scroll to the given position in the child component.

See Also

`Adjustable`, `Container`, `Point`, `Scrollbar`

19.54 Scrollbar



Description

The `Scrollbar` is a `Component` that provides the means to get and set values within a predetermined range. For example, a scrollbar could be used for a volume control. Scrollbars are most frequently used to help users manipulate areas too large to be displayed on the screen (pre version 1.1) or to set a value within an integer range.

Class Definition

```
public class java.awt.Scrollbar
    extends java.awt.Component
    implements java.awt.Adjustable {

  // Constants
  public final static int HORIZONTAL;
  public final static int VERTICAL;

  // Constructors
  public Scrollbar();
  public Scrollbar (int orientation);
  public Scrollbar (int orientation, int value, int visible, int minimum,
    int maximum);

  // Instance Methods
  public void addAdjustmentListener (AdjustmentListener l); ★
  public void addNotify();
  public int getBlockIncrement(); ★
  public int getLineIncrement(); ☆
  public int getMaximum();
  public int getMinimum();
  public int getOrientation();
  public int getPageIncrement(); ☆
  public int getUnitIncrement(); ★
  public int getValue();
  public int getVisible(); ☆
  public int getVisibleAmount(); ★
  public void removeAdjustmentListener (AdjustmentListener l); ★
  public synchronized void setBlockIncrement (int v); ★
  public void setLineIncrement (int amount); ☆
  public synchronized void setMaximum (int newMaximum); ★
  public synchronized void setMinimum (int newMinimum); ★
  public synchronized void setOrientation (int orientation); ★
  public void setPageIncrement (int amount); ☆
  public synchronized void setUnitIncrement(int v); ★
  public synchronized void setValue (int value);
  public synchronized void setValues (int value, int visible,
    int minimum, int maximum);
  public synchronized void setVisibleAmount (int newAmount); ★

  // Protected Instance Methods
  protected String paramString();
  protected void processAdjustmentEvent (AdjustmentEvent e); ★
  protected void processEvent (AWTEvent e); ★
}
```

Constants

HORIZONTAL

`public final static int HORIZONTAL`

Constant used for a `Scrollbar` with a horizontal orientation.

VERTICAL

`public final static int VERTICAL`

Constant used for a `Scrollbar` with a vertical orientation.

Constructors

Scrollbar

`public Scrollbar()`

Description	Constructs a vertical `Scrollbar` object; slider size, minimum value, maximum value, and initial value are all zero.	

`public Scrollbar (int orientation)`

Parameters	*orientation*	`Scrollbar` constant designating direction.
Throws	*IllegalArgumentException*	If `orientation` is invalid.
Description	Constructs a `Scrollbar` object, in the designated direction; slider size, minimum value, maximum value, and initial value are all zero.	

```
public Scrollbar (int orientation, int value, int visible,
int minimum, int maximum)
```

Parameters	*orientation*	`Scrollbar` constant designating direction.
	value	Initial value of `Scrollbar`.
	visible	Initial slider size.
	minimum	Initial minimum value.
	maximum	Initial maximum value.
Throws	*IllegalArgumentException*	If `orientation` is invalid.
Description	Constructs a `Scrollbar` object with the given values.	

Instance Methods

addAdjustmentListener

`public void addAdjustmentListener (AdjustmentListener l)` ★

Parameters	*l*	An object that implements the `AdjustmentListener` interface.
Implements	`Adjustable.addAdjustmentListener()`	
Description	Add a listener for adjustment event.	

addNotify

`public void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `Scrollbar`'s peer.

getBlockIncrement

`public int getBlockIncrement()` ★

Implements	`Adjustable.getBlockIncrement()`
Returns	The amount to scroll when a paging area is selected.

getLineIncrement

`public int getLineIncrement()` ☆

Returns	The amount to scroll when one of the arrows at the ends of the scrollbar is selected. Replaced by `getUnitIncrement()`.

getMaximum

`public int getMaximum()`

Implements	`Adjustable.getMaximum()`
Returns	The maximum value that the `Scrollbar` can take.

getMinimum

`public int getMinimum()`

Implements	`Adjustable.getMinimum()`
Returns	The minimum value that the `Scrollbar` can take.

getOrientation

`public int getOrientation()`

Implements	`Adjustable.getOrientation()`
Returns	A constant representing the direction of the `Scrollbar`.

getPageIncrement

`public int getPageIncrement()` ☆

Returns — The amount to scroll when a paging area is selected. Replaced with `getBlockIncrement()`.

getUnitIncrement

`public int getUnitIncrement()` ★

Implements — `Adjustable.getUnitIncrement()`
Returns — The amount to scroll when one of the arrows at the ends of the scrollbar is selected.

getValue

`public int getValue()`

Implements — `Adjustable.getValue()`
Returns — The current setting for the `Scrollbar`.

getVisible

`public int getVisible()` ☆

Returns — The current visible setting (i.e., size) for the slider. Replaced by `getVisibleAmount()`.

getVisibleAmount

`public int getVisibleAmount()` ★

Implements — `Adjustable.getVisibleAmount()`
Returns — The current visible setting (i.e., size) for the slider.

removeAdjustmentListener

`public void removeAdjustmentListener (AdjustmentListener l)` ★

Parameters — *l* — One of this `Scrollbar`'s `AdjustmentListeners`.
Implements — `Adjustable.removeAdjustmentListener()`
Description — Remove an adjustment event listener.

setBlockIncrement

`public synchronized void setBlockIncrement (int amount)` ★

Parameters	*amount*	New paging increment amount.
Implements	`Adjustable.setBlockIncrement()`	
Description	Changes the block increment amount for the `Scrollbar`; the default block increment is 10.	

setLineIncrement

`public void setLineIncrement (int amount)` ☆

Parameters	*amount*	New line increment amount.
Description	Changes the line increment amount for the `Scrollbar`. The default line increment is 1. Replaced by `setUnitIncrement(int)`.	

setMaximum

`public synchronized void setMaximum (int newMaximum)` ★

Parameters	*newMaximum*	New maximum value.
Implements	`Adjustable.setMaximum()`	
Description	Changes the maximum value for the `Scrollbar`.	

setMinimum

`public synchronized void setMinimum (int newMinimum)` ★

Parameters	*newMinimum*	New minimum value.
Implements	`Adjustable.setMinimum()`	
Description	Changes the minimum value for the `Scrollbar`.	

setOrientation

`public synchronized void setOrientation (int orientation)`
★

Parameters	*orientation*	One of the orientation constants `HORIZONTAL` or `VERTICAL`.
Description	Changes the orientation of the `Scrollbar`.	

setPageIncrement

`public void setPageIncrement (int amount)` ☆

Parameters	*amount*	New paging increment amount.
Description	Changes the paging increment amount for the `Scrollbar`; the default page increment is 10. Replaced by `setBlockIncrement(int)`.	

setUnitIncrement

`public synchronized void setUnitIncrement (int amount)` ★

Parameters	*amount*	New line increment amount.
Implements	`Adjustable.setUnitIncrement()`	
Description	Changes the unit increment amount for the `Scrollbar`. The default unit increment is 1.	

setValue

`public synchronized void setValue (int value)`

Parameters	*value*	New `Scrollbar` value.
Implements	`Adjustable.setValue()`	
Description	Changes the current value of the `Scrollbar`.	

setValues

`public synchronized void setValues (int value, int visible, int minimum, int maximum)`

Parameters	*value*	New `Scrollbar` value.
	visible	New slider width.
	minimum	New minimum value for `Scrollbar`.
	maximum	New maximum value for `Scrollbar`.
Description	Changes the settings of the `Scrollbar` to the given amounts.	

setVisibleAmount

`public synchronized void setVisibleAmount (int newAmount)` ★

Parameters	*newAmount*	New amount visible.
Implements	`Adjustable.setVisibleAmount()`	
Description	Changes the current visible amount of the `Scrollbar`.	

Protected Instance Methods

paramString

`protected String paramString()`

Returns	String with current settings of `Scrollbar`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

processAdjustmentEvent

```
protected void processAdjustmentEvent (AdjustmentEvent e)
```
★

Parameters *e* The adjustment event to process.

Description Adjustment events are passed to this method for processing. Normally, this method is called by `processEvent()`.

processEvent

```
protected void processEvent (AWTEvent e) ★
```

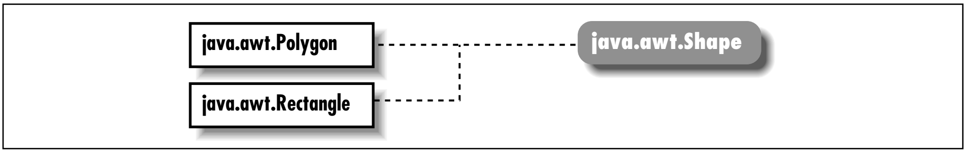
Parameters *e* The event to process.

Description Low level `AWTEvents` are passed to this method for processing.

See Also

`Adjustable`, `Component`, `String`

19.55 Shape ★



Description

`Shape` is an interface describing a two-dimensional geometric shape.

Interface Definition

```
public abstract interface java.awt.Shape {

  // Interface Methods
  public abstract Rectangle getBounds();
}
```

Interface Methods

getBounds

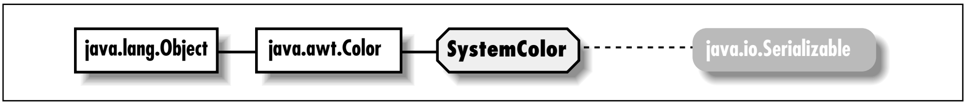
```
public abstract Rectangle getBounds()
```

Returns A `Rectangle` that completely encloses the shape.

See Also

Polygon, Rectangle

19.56 SystemColor ★



Description

`SystemColor` provides information on the colors that the windowing system uses to display windows and other graphic components. Most windowing systems allow the user to choose different color schemes; `SystemColor` enables programs to find out what colors are in use in order to paint themselves in a consistent manner.

Class Definition

```
public final class java.awt.SystemColor
    extends java.awt.Color
    implements java.io.Serializable {

  // Constants
  public final static int ACTIVE_CAPTION;
  public final static int ACTIVE_CAPTION_BORDER;
  public final static int ACTIVE_CAPTION_TEXT;
  public final static int CONTROL;
  public final static int CONTROL_DK_SHADOW;
  public final static int CONTROL_HIGHLIGHT;
  public final static int CONTROL_LT_HIGHLIGHT;
  public final static int CONTROL_SHADOW;
  public final static int CONTROL_TEXT;
  public final static int DESKTOP;
  public final static int INACTIVE_CAPTION;
  public final static int INACTIVE_CAPTION_BORDER;
  public final static int INACTIVE_CAPTION_TEXT;
  public final static int INFO;
  public final static int INFO_TEXT;
  public final static int MENU;
  public final static int MENU_TEXT;
  public final static int NUM_COLORS;
  public final static int SCROLLBAR;
  public final static int TEXT;
  public final static int TEXT_HIGHLIGHT;
  public final static int TEXT_HIGHLIGHT_TEXT;
  public final static int TEXT_INACTIVE_TEXT;
  public final static int TEXT_TEXT;
```

```
  public final static int WINDOW;
  public final static int WINDOW_BORDER;
  public final static int WINDOW_TEXT;
  public final static SystemColor activeCaption;
  public final static SystemColor activeCaptionBorder;
  public final static SystemColor activeCaptionText;
  public final static SystemColor control;
  public final static SystemColor controlDkShadow;
  public final static SystemColor controlHighlight;
  public final static SystemColor controlLtHighlight;
  public final static SystemColor controlShadow;
  public final static SystemColor controlText;
  public final static SystemColor desktop;
  public final static SystemColor inactiveCaption;
  public final static SystemColor inactiveCaptionBorder;
  public final static SystemColor inactiveCaptionText;
  public final static SystemColor info;
  public final static SystemColor infoText;
  public final static SystemColor menu;
  public final static SystemColor menuText;
  public final static SystemColor scrollbar;
  public final static SystemColor text;
  public final static SystemColor textHighlight;
  public final static SystemColor textHighlightText;
  public final static SystemColor textInactiveText;
  public final static SystemColor textText;
  public final static SystemColor window;
  public final static SystemColor windowBorder;
  public final static SystemColor windowText;

  // Public Instance Methods
  public int getRGB();
  public String toString();
}
```

Constants

ACTIVE_CAPTION

```
public static final int ACTIVE_CAPTION
```

ACTIVE_CAPTION_BORDER

```
public static final int ACTIVE_CAPTION_BORDER
```

ACTIVE_CAPTION_TEXT

```
public static final int ACTIVE_CAPTION_TEXT
```

CONTROL

```
public static final int CONTROL
```

CONTROL_DK_SHADOW

```
public static final int CONTROL_DK_SHADOW
```

CONTROL_HIGHLIGHT

```
public static final int CONTROL_HIGHLIGHT
```

CONTROL_LT_HIGHLIGHT

```
public static final int CONTROL_LT_HIGHLIGHT
```

CONTROL_SHADOW

```
public static final int CONTROL_SHADOW
```

CONTROL_TEXT

```
public static final int CONTROL_TEXT
```

DESKTOP

```
public static final int DESKTOP
```

INACTIVE_CAPTION

```
public static final int INACTIVE_CAPTION
```

INACTIVE_CAPTION_BORDER

```
public static final int INACTIVE_CAPTION_BORDER
```

INACTIVE_CAPTION_TEXT

```
public static final int INACTIVE_CAPTION_TEXT
```

INFO

```
public static final int INFO
```

INFO_TEXT

```
public static final int INFO_TEXT
```

MENU

```
public static final int MENU
```

MENU_TEXT

```
public static final int MENU_TEXT
```

NUM_COLORS

```
public static final int NUM_COLORS
```

SCROLLBAR

```
public static final int SCROLLBAR
```

TEXT

```
public static final int TEXT
```

TEXT_HIGHLIGHT

```
public static final int TEXT_HIGHLIGHT
```

TEXT_HIGHLIGHT_TEXT

```
public static final int TEXT_HIGHLIGHT_TEXT
```

TEXT_INACTIVE_TEXT

```
public static final int TEXT_INACTIVE_TEXT
```

TEXT_TEXT

```
public static final int TEXT_TEXT
```

WINDOW

`public static final int WINDOW`

WINDOW_BORDER

`public static final int WINDOW_BORDER`

WINDOW_TEXT

`public static final int WINDOW_TEXT`

activeCaption

`public static final SystemColor activeCaption`

Background color for captions in window borders.

activeCaptionBorder

`public static final SystemColor activeCaptionBorder`

Border color for captions in window borders.

activeCaptionText

`public static final SystemColor activeCaptionText`

Text color for captions in window borders.

control

`public static final SystemColor control`

Background color for controls.

controlDkShadow

`public static final SystemColor controlDkShadow`

Dark shadow color for controls.

controlHighlight

`public static final SystemColor controlHighlight`

Highlight color for controls.

controlLtHighlight

`public static final SystemColor controlLtHighlight`

Light highlight color for controls.

controlShadow

`public static final SystemColor controlShadow`

Shadow color for controls.

controlText

`public static final SystemColor controlText`

Text color for controls.

desktop

`public static final SystemColor desktop`

Desktop background color.

inactiveCaption

`public static final SystemColor inactiveCaption`

Background color for inactive captions in window borders.

inactiveCaptionBorder

`public static final SystemColor inactiveCaptionBorder`

Border color for inactive captions in window borders.

inactiveCaptionText

`public static final SystemColor inactiveCaptionText`

Text color for inactive captions in window borders.

info

`public static final SystemColor info`

Background color for informational text.

infoText

`public static final SystemColor infoText`

Text color for informational text.

menu

`public static final SystemColor menu`

Background color for menus.

menuText

```
public static final SystemColor menuText
```

Text color for menus.

scrollbar

```
public static final SystemColor scrollbar
```

Background color for scrollbars.

text

```
public static final SystemColor text
```

Background color for text components.

textHighlight

```
public static final SystemColor textHighlight
```

Background color for highlighted text.

textHighlightText

```
public static final SystemColor textHighlightText
```

Text color for highlighted text.

textInactiveText

```
public static final SystemColor textInactiveText
```

Text color for inactive text.

textText

```
public static final SystemColor textText
```

Text color for text components.

window

```
public static final SystemColor window
```

Background color for windows.

windowBorder

```
public static final SystemColor windowBorder
```

Border color for windows.

windowText

```
public static final SystemColor windowText
```

Text color for windows.

Instance Methods

getRGB

```
public int getRGB()
```

Returns	Current color as a composite value
Overrides	`Color.getRGB()`
Description	Gets integer value of current system color.

toString

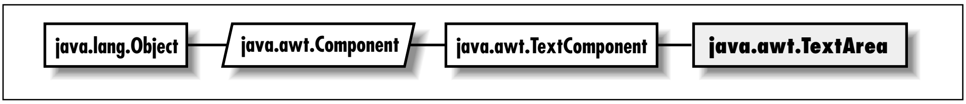
```
public String toString()
```

Returns	A string representation of the `SystemColor` object.
Overrides	`Color.toString()`

See Also

`Color`, `Serializable`, `String`

19.57 TextArea



Description

The `TextArea` class provides a multi-line `Component` for textual user input.

Class Definition

```
public class java.awt.TextArea
    extends java.awt.TextComponent {

  // Constants
  public final static int SCROLLBARS_BOTH; ★
  public final static int SCROLLBARS_HORIZONTAL_ONLY; ★
  public final static int SCROLLBARS_NONE; ★
  public final static int SCROLLBARS_VERTICAL_ONLY; ★

  // Constructors
  public TextArea();
  public TextArea (int rows, int columns);
```

```
  public TextArea (String text);
  public TextArea (String text, int rows, int columns);
  public TextArea (String text, int rows, int columns, int scrollbars); ★

  // Instance Methods
  public void addNotify();
  public synchronized void append (String string); ★
  public void appendText (String string); ☆
  public int getColumns();
  public Dimension getMinimumSize(); ★
  public Dimension getMinimumSize (int rows, int columns); ★
  public Dimension getPreferredSize(); ★
  public Dimension getPreferredSize (int rows, int columns); ★
  public int getRows();
  public int getScrollbarVisibility(); ★
  public synchronized void insert (String string, int position); ★
  public void insertText (String string, int position); ☆
  public Dimension minimumSize(); ☆
  public Dimension minimumSize (int rows, int columns); ☆
  public Dimension preferredSize(); ☆
  public Dimension preferredSize (int rows, int columns); ☆
  public synchronized void replaceRange (String str, int start, int end); ★
  public void replaceText (String string, int startPosition, int endPosition); ☆
  public void setColumns (int columns); ★
  public void setRows (int rows); ★

  // Protected Instance Methods
  protected String paramString();
}
```

Constants

SCROLLBARS_BOTH

`public final static int SCROLLBARS_BOTH` ★

Show both the horizontal and vertical scrollbars.

SCROLLBARS_HORIZONTAL_ONLY

`public final static int SCROLLBARS_HORIZONTAL_ONLY` ★

Show the horizontal scrollbar.

SCROLLBARS_NONE

`public final static int SCROLLBARS_NONE` ★

Show no scrollbars.

SCROLLBARS_VERTICAL_ONLY

`public final static int SCROLLBARS_VERTICAL_ONLY` ★

Show the vertical scrollbar.

Constructors

TextArea

`public TextArea()`

Description	Constructs a `TextArea` object with the default size and no initial content. The default size of a text area varies widely from platform to platform, so it's best to avoid this constructor.

`public TextArea (int rows, int columns)`

Parameters	*rows*	Requested number of displayed rows.
	columns	Requested number of displayed columns.
Description	Constructs a `TextArea` object of the given size and no initial content.	

`public TextArea (String text)`

Parameters	*text*	Initial text for `TextArea`.
Description	Constructs a `TextArea` object with the given initial content.	

`public TextArea (String text, int rows, int columns)`

Parameters	*text*	Initial text for `TextArea`.
	rows	Requested number of displayed rows.
	columns	Requested number of displayed columns.
Description	Constructs a `TextArea` object with the given content and size.	

`public TextArea (String text, int rows, int columns, int scrollbars)` ★

Parameters	*text*	Initial text for `TextArea`.
	rows	Requested number of displayed rows.
	columns	Requested number of displayed columns.
	scrollbars	Requested scrollbar visibility. Use one of the constants defined.
Description	Constructs a `TextArea` object with the given content, size, and scrollbar visibility.	

Instance Methods

addNotify

`public void addNotify()`

Overrides `Component.addNotify()`
Description Creates `TextArea`'s peer.

append

`public synchronized void append (String string)` ★

Parameters *string* Content to append to the end of the `TextArea`.
Description Appends the given text string to the text already displayed in the `TextArea`.

appendText

`public void appendText (String string)` ☆

Parameters *string* Content to append to end of `TextArea`.
Description Replaced by `append(String)`.

getColumns

`public int getColumns()`

Returns The width of the `TextArea` in columns.

getMinimumSize

`public Dimension getMinimumSize()` ★

Returns The minimum dimensions of the `TextArea`.

`public Dimension getMinimumSize (int rows, int columns)` ★

Parameters *rows* Number of rows within `TextArea` to size.
columns Number of columns within `TextArea` to size.
Returns The minimum dimensions of a `TextArea` of the given size.

getPreferredSize

`public Dimension getPreferredSize()` ★

Returns The preferred dimensions of the `TextArea`.

`public Dimension getPreferredSize (int rows, int columns)`
★

Parameters	*rows*	Number of rows within TextArea to size.
	columns	Number of columns within TextArea to size.
Returns	The preferred dimensions of a TextArea of the given size.	

getRows

```
public int getRows()
```

Returns	The height of the TextArea in rows.

getScrollbarVisibility

```
public int getScrollbarVisibility() ★
```

Returns	One of the SCROLLBAR_ constants indicating which scrollbars are visible.

insert

```
public synchronized void insert (String string, int
position) ★
```

Parameters	*string*	Content to place within TextArea content.
	position	Location to insert content.
Description	Places additional text within the TextArea at the given position.	

insertText

```
public void insertText (String string, int position) ☆
```

Parameters	*string*	Content to place within TextArea content.
	position	Location to insert content.
Description	Places additional text within the TextArea at the given position. Replaced by insert(String, int).	

minimumSize

```
public Dimension minimumSize() ☆
```

Returns	The minimum dimensions of the TextArea. Replaced by getMinimumSize().

```
public Dimension minimumSize (int rows, int columns) ☆
```

Parameters	*rows*	Number of rows within TextArea to size.
	columns	Number of columns within TextArea to size.
Returns	The minimum dimensions of a TextArea of the given size. Replaced by getMinimumSize(int, int).	

preferredSize

`public Dimension preferredSize()` ☆

Returns	The preferred dimensions of the `TextArea`. Replaced by `getPreferredSize()`.	

`public Dimension preferredSize (int rows, int columns)` ☆

Parameters	*rows*	Number of rows within `TextArea` to size.
	columns	Number of columns within `TextArea` to size.
Returns	The preferred dimensions of a `TextArea` of the given size. Replaced by `getPreferredSize(int, int)`.	

replaceRange

`public synchronized void replaceRange (String str, int start, int end)` ★

Parameters	*str*	New content to place in `TextArea`.
	start	Starting position of content to replace.
	end	Ending position of content to replace.
Description	Replaces a portion of the `TextArea`'s content with the given text.	

replaceText

`public void replaceText (String string, int startPosition, int endPosition)` ☆

Parameters	*string*	New content to place in `TextArea`.
	startPosition	Starting position of content to replace.
	endPosition	Ending position of content to replace.
Description	Replaces a portion of the `TextArea`'s content with the given text. Replaced by `replaceRange(String, int, int)`.	

setColumns

`public void setColumns (int columns)` ★

Parameters	*columns*	New number of columns.
Throws	*IllegalArgumentException*	If `columns` is less than zero.
Description	Changes the number of columns.	

setRows

```
public void setRows (int rows) ★
```

Parameters *rows* New number of columns.
Throws *IllegalArgumentException*
If `rows` is less than zero.
Description Changes the number of rows.

Protected Instance Methods

paramString

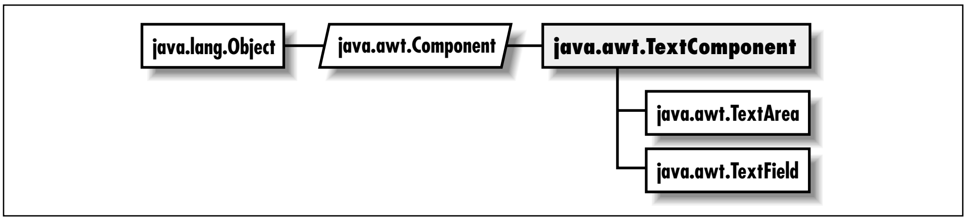
```
protected String paramString()
```

Returns String with current settings of `TextArea`.
Overrides `TextComponent.paramString()`
Description Helper method for `toString()` to generate string of current settings.

See Also

`Dimension`, `TextComponent`, `String`

19.58 TextComponent



Description

The abstract `TextComponent` class provides the base class for the text input components, `TextArea` and `TextField`.

Class Definition

```
public abstract class java.awt.TextComponent
    extends java.awt.Component {

  // Instance Methods
  public synchronized void addTextListener (TextListener l); ★
  public int getCaretPosition(); ★
  public synchronized String getSelectedText();
  public synchronized int getSelectionEnd();
```

```
    public synchronized int getSelectionStart();
    public synchronized String getText();
    public boolean isEditable();
    public void removeNotify();
    public void removeTextListener (TextListener l); ★
    public synchronized void select (int selectionStart, int selectionEnd);
    public synchronized void selectAll();
    public void setCaretPosition (int position); ★
    public synchronized void setEditable (boolean state);
    public synchronized void setSelectionEnd (int selectionEnd); ★
    public synchronized void setSelectionStart (int selectionStart); ★
    public synchronized void setText (String text);

    // Protected Instance Methods
    protected String paramString();
    protected void processEvent (AWTEvent e); ★
    protected void processTextEvent (TextEvent e); ★
}
```

Instance Methods

addTextListener

`public synchronized void addTextListener (TextListener l)` ★

Parameters	*l*	An object that implements the `TextListener` interface.
Description	Add a listener for the text events.	

getCaretPosition

`public int getCaretPosition()` ★

Returns — The position, in characters, of the caret (text cursor).

getSelectedText

`public synchronized String getSelectedText()`

Returns — The currently selected text of the `TextComponent`.

getSelectionEnd

`public synchronized int getSelectionEnd()`

Returns — The ending cursor position of any selected text.

getSelectionStart

`public synchronized int getSelectionStart()`

Returns   The initial position of any selected text.

getText

`public synchronized String getText()`

Returns   Current contents of the `TextComponent`.

isEditable

`public boolean isEditable()`

Returns   `true` if editable, `false` otherwise.

removeNotify

`public void removeNotify()`

Description   Destroys the peer of the `TextComponent`.

removeTextListener

`public void removeTextListener (TextListener l)` ★

Parameters   *l*   One of this `TextComponent`'s `TextListeners`.
Description   Remove a text event listener.

select

`public synchronized void select (int selectionStart, int selectionEnd)`

Parameters   *selectionStart*   Beginning position of text to select.
selectionEnd   Ending position of text to select.
Description   Selects text in the `TextComponent`.

selectAll

`public synchronized void selectAll()`

Description   Selects all the text in the `TextComponent`.

setCaretPosition

`public void setCaretPosition (int position)` ★

Parameters   *position*   The new character position for the caret.

Throws	*IllegalArgumentException*	
		If `position` is less than zero.
Description	Allows you to change the location of the caret.	

setEditable

```
public synchronized void setEditable (boolean state)
```

Parameters	*state*	`true` to allow the user to edit the text in the `TextComponent`; `false` to prevent editing.
Description	Allows you to make the `TextComponent` editable or read-only.	

setSelectionEnd

```
public synchronized void setSelectionEnd (int
selectionEnd) ★
```

Parameters	*selectionEnd*	The character position of the end of the selection.
Description	Allows you to change the location of the end of the selected text.	

setSelectionStart

```
public synchronized void setSelectionStart (int
selectionStart) ★
```

Parameters	*selectionStart*	The character position of the start of the selection.
Description	Allows you to change the location of the start of the selected text.	

setText

```
public synchronized void setText (String text)
```

Parameters	*text*	New text for `TextComponent`.
Description	Sets the content of the `TextComponent`.	

Protected Instance Methods

paramString

```
protected String paramString()
```

Returns	String with current settings of `TextComponent`.
Overrides	`Component.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

processEvent

```
protected void processEvent (AWTEvent e) ★
```

Parameters *e* The event to process.
Description Low-level `AWTEvents` are passed to this method for processing.

processTextEvent

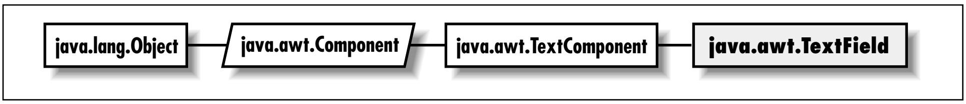
```
protected void processTextEvent (TextEvent e) ★
```

Parameters *e* The event to process.
Description Text events are passed to this method for processing. Normally, this method is called by `processEvent()`.

See Also

`Component`, `TextArea`, `TextField`, `String`

19.59 TextField



Description

The `TextField` class provides a single line `Component` for user input.

Class Definition

```
public class java.awt.TextField
    extends java.awt.TextComponent {

  // Constructors
  public TextField();
  public TextField (int columns);
  public TextField (String text);
  public TextField (String text, int columns);

  // Instance Methods
  public void addActionListener (ActionListener l); ★
  public void addNotify();
  public boolean echoCharIsSet();
  public int getColumns();
  public char getEchoChar();
  public Dimension getMinimumSize(); ★
  public Dimension getMinimumSize (int columns); ★
  public Dimension getPreferredSize(); ★
```

```
  public Dimension getPreferredSize (int columns); ★
  public Dimension minimumSize(); ☆
  public Dimension minimumSize (int columns); ☆
  public Dimension preferredSize(); ☆
  public Dimension preferredSize (int columns); ☆
  public void removeActionListener (ActionListener l); ★
  public void setColumns(int columns); ★
  public void setEchoChar(char c); ★
  public void setEchoCharacter (char c); ☆

  // Protected Instance Methods
  protected String paramString();
  protected void processActionEvent (ActionEvent e); ★
  protected void processEvent (AWTEvent e); ★
}
```

Constructors

TextField

`public TextField()`

Description Constructs a `TextField` object of the default size.

`public TextField (int columns)`

Parameters *columns* Requested number of displayed columns.
Description Constructs a `TextField` object of the given size.

`public TextField (String text)`

Parameters *text* Initial text for `TextField`.
Description Constructs a `TextField` object with the given content.

`public TextField (String text, int columns)`

Parameters *text* Initial text for `TextField`.
columns Requested number of displayed columns.
Description Constructs a `TextField` object with the given content and size.

Instance Methods

addActionListener

`public void addActionListener (ActionListener l) ★`

Parameters *l* An object that implements the `ActionListener` interface.
Description Add a listener for the action event.

addNotify

`public synchronized void addNotify()`

Overrides	`Component.addNotify()`
Description	Creates `TextField`'s peer.

echoCharIsSet

`public boolean echoCharIsSet()`

Returns	`true` if the `TextField` has an echo character used as a response to any input character; `false` otherwise. An echo character can be used to create a `TextField` for hidden input, like a password; the same character (e.g., "x") is used to echo all input.

getColumns

`public int getColumns()`

Returns	The width of the `TextField` in columns.

getEchoChar

`public char getEchoChar()`

Returns	The current echo character.

getMinimumSize

`public Dimension getMinimumSize()` ★

Returns	The minimum dimensions of the `TextField`.

`public Dimension getMinimumSize (int columns)` ★

Parameters	columns	Number of columns within `TextField` to size.
Returns	The minimum dimensions of a `TextField` of the given size.	

getPreferredSize

`public Dimension getPreferredSize()` ★

Returns	The preferred dimensions of the `TextField`.

`public Dimension getPreferredSize (int columns)` ★

Parameters	columns	Number of columns within `TextField` to size.
Returns	The preferred dimensions of a `TextField` of the given size.	

minimumSize

`public Dimension minimumSize()` ☆

Returns — The minimum dimensions of the `TextField`. Replaced by `getMinimumSize()`.

`public Dimension minimumSize (int columns)` ☆

Parameters — *columns* — Number of columns within `TextField` to size.
Returns — The minimum dimensions of a `TextField` of the given size. Replaced by `getMinimumSize(int)`.

preferredSize

`public Dimension preferredSize()` ☆

Returns — The preferred dimensions of the `TextField`. Replaced by `getPreferredSize()`.

`public Dimension preferredSize (int columns)` ☆

Parameters — *columns* — Number of columns within `TextField` to size.
Returns — The preferred dimensions of a `TextField` of the given size. Replaced by `getPreferredSize(int)`.

removeActionListener

`public void removeActionListener (ActionListener l)` ★

Parameters — *l* — One of this `TextField`'s `ActionListeners`.
Description — Remove an action event listener.

setColumns

`public void setColumns (int columns)` ★

Parameters — *columns* — New number of columns.
Throws — *IllegalArgumentException* — If `columns` is less than zero.
Description — Changes the number of columns.

setEchoChar

`public void setEchoChar (char c)` ★

Parameters — *c* — The character to echo for all input. To echo the characters that the user types (the default), set the echo character to 0 (zero).

Description Changes the character that is used to echo all user input in the `TextField`.

`setEchoCharacter`

`public void setEchoCharacter (char c)` ☆

Parameters *c* The character to echo for all input. To echo the characters that the user types (the default), set the echo character to 0 (zero).

Description Replaced by `setEchoChar(char)` for consistency with `getEchoChar()`.

Protected Instance Methods

`paramString`

`protected String paramString()`

Returns String with current settings of `TextField`.

Overrides `TextComponent.paramString()`

Description Helper method for `toString()` to generate string of current settings.

`processActionEvent`

`protected void processActionEvent (ActionEvent e)` ★

Parameters *e* The action event to process.

Description Action events are passed to this method for processing. Normally, this method is called by `processEvent()`.

`processEvent`

`protected void processEvent (AWTEvent e)` ★

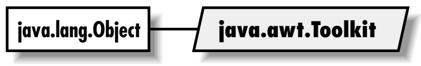
Parameters *e* The event to process.

Description Low-level `AWTEvents` are passed to this method for processing.

See Also

`Dimension`, `TextComponent`, `String`

19.60 Toolkit



Description

The abstract `Toolkit` class provides access to platform-specific details like window size and available fonts. It also deals with creating all the components' peer objects when you call `addNotify()`.

Class Definition

```
public abstract class java.awt.Toolkit
    extends java.lang.Object {

  // Class Methods
  public static synchronized Toolkit getDefaultToolkit();
  protected static Container getNativeContainer (Component c); ★
  public static String getProperty (String key, String defaultValue); ★

  // Instance Methods
  public abstract void beep(); ★
  public abstract int checkImage (Image image, int width, int height,
    ImageObserver observer);
  public abstract Image createImage (ImageProducer producer);
  public Image createImage (byte[] imagedata); ★
  public abstract Image createImage (byte[ ] imagedata, int imageoffset,
    int imagelength); ★
  public abstract ColorModel getColorModel();
  public abstract String[] getFontList();
  public abstract FontMetrics getFontMetrics (Font font);
  public abstract Image getImage (String filename);
  public abstract Image getImage (URL url);
  public int getMenuShortcutKeyMask(); ★
  public abstract PrintJob getPrintJob (Frame frame, String jobtitle,
    Properties props); ★
  public abstract int getScreenResolution();
  public abstract Dimension getScreenSize();
  public abstract Clipboard getSystemClipboard(); ★
  public final EventQueue getSystemEventQueue(); ★
  public abstract boolean prepareImage (Image image, int width, int height,
    ImageObserver observer);
  public abstract void sync();

  // Protected Instance Methods
  protected abstract ButtonPeer createButton (Button b);
```

```
  protected abstract CanvasPeer createCanvas (Canvas c);
  protected abstract CheckboxPeer createCheckbox (Checkbox cb);
  protected abstract CheckboxMenuItemPeer createCheckboxMenuItem
    (CheckboxMenuItem cmi);
  protected abstract ChoicePeer createChoice (Choice c);
  protected LightweightPeer createComponent(Component target); ★
  protected abstract DialogPeer createDialog (Dialog d);
  protected abstract FileDialogPeer createFileDialog (FileDialog fd);
  protected abstract FramePeer createFrame (Frame f);
  protected abstract LabelPeer createLabel (Label l);
  protected abstract ListPeer createList (List l);
  protected abstract MenuPeer createMenu (Menu m);
  protected abstract MenuBarPeer createMenuBar (MenuBar mb);
  protected abstract MenuItemPeer createMenuItem (MenuItem mi);
  protected abstract PanelPeer createPanel (Panel p);
  protected abstract PopupMenuPeer createPopupMenu (PopupMenu target); ★
  protected abstract ScrollPanePeer createScrollPane (ScrollPane target);  ★
  protected abstract ScrollbarPeer createScrollbar (Scrollbar sb);
  protected abstract TextAreaPeer createTextArea (TextArea ta);
  protected abstract TextFieldPeer createTextField (TextField tf);
  protected abstract WindowPeer createWindow (Window w);
  protected abstract FontPeer getFontPeer (String name, int style); ★
  protected abstract EventQueue getSystemEventQueueImpl(); ★
  protected void loadSystemColors (int[] systemColors);  ★
}
```

Class Methods

getDefaultToolkit

`public static synchronized Toolkit getDefaultToolkit()`

Throws	*AWTError*	If the toolkit for the current platform cannot be found.
Returns	The system's default `Toolkit`.	

getNativeContainer

`protected static Container getNativeContainer (Component c)` ★

Returns	The native container for the given component. The component's immediate parent may be a lightweight component.

getProperty

```
public static String getProperty (String key, String
defaultValue) ★
```

Parameters	*key*	The name of a property.
	defaultValue	A default value to return if the property is not found.
Returns	The value of the property described by `key`, or `defaultValue` if it is not found.	

Instance Methods

beep

```
public abstract void beep() ★
```

Description — Produces an audible beep.

checkImage

```
public abstract int checkImage (Image image, int width,
int height, ImageObserver observer)
```

Parameters	*image*	Image to check.
	width	Width of the scaled image; -1 if image will be rendered unscaled.
	height	Height of the scaled image; -1 if image will be rendered unscaled.
	observer	The `Component` that `image` will be rendered on.
Returns	The `ImageObserver` flags ORed together for the data that is now available.	
Description	Checks on the status of the construction of a screen representation of `image` on `observer`.	

createImage

```
public abstract Image createImage (ImageProducer producer)
```

Parameters	*producer*	An `ImageProducer` that generates data for the desired image.
Returns	Newly created `Image`.	
Description	Creates a new `Image` from an `ImageProducer`.	

```
public abstract Image createImage (byte[] imagedata) ★
```

Parameters	*imagedata*	Raw data representing an image.

Returns Newly created `Image`.
Description Creates a new `Image` from the `imagedata` provided.

`public abstract Image createImage (byte[] imagedata, int imageoffset, int imagelength)` ★

Parameters *imagedata* Raw data representing one or more images.
imageoffset An offset into the data given.
imagelength The length of data to use.
Returns Newly created `Image`.
Description Creates a new `Image` from the `imagedata` provided, starting at `imageoffset` bytes and reading `imagelength` bytes.

getColorModel

`public abstract ColorModel getColorModel()`

Returns The current `ColorModel` used by the system.

getFontList

`public abstract String[] getFontList()`

Returns A `String` array of the set of Java fonts available with this `Toolkit`.

getFontMetrics

`public abstract FontMetrics getFontMetrics (Font font)`

Parameters *font* A `Font` whose metrics are desired
Returns The current `FontMetrics` for the `font` on the user's system.

getImage

`public abstract Image getImage (String filename)`

Parameters *filename* Location of `Image` on local filesystem
Returns The `Image` that needs to be fetched.
Description Fetches an image from the local file system.

`public abstract Image getImage (URL url)`

Parameters *url* Location of `Image`.
Returns The `Image` that needs to be fetched.
Description Fetches an image from a `URL`.

getMenuShortcutKeyMask

`public int getMenuShortcutKeyMask()` ★

Returns The modifier key mask used for menu shortcuts. This will be one of the mask constants defined in `java.awt.Event`.

getPrintJob

`public abstract PrintJob getPrintJob (Frame frame, String jobtitle, Properties props)` ★

Parameters *frame* The `frame` to be used as the parent of a platform-specific printing dialog.
jobtitle The name of the job.
props Properties for this print job.

Returns A `PrintJob` object. If the user canceled the printing operation, `null` is returned.

getScreenResolution

`public abstract int getScreenResolution()`

Returns The current resolution of the user's screen, in dots-per-inch.

getScreenSize

`public abstract Dimension getScreenSize()`

Returns The size of the screen available to the `Toolkit`, in pixels, as a `Dimension` object.

getSystemClipboard

`public abstract Clipboard getSystemClipboard()` ★

Returns A `Clipboard` object that can be used for cut, copy, and paste operations.

getSystemEventQueue

`public final EventQueue getSystemEventQueue()` ★

Returns A reference to the system's event queue, allowing the program to post new events or inspect the queue.

prepareImage

```
public abstract boolean prepareImage (Image image, int
width, int height, ImageObserver observer)
```

Parameters	*image*	Image to check.
	width	Width of the scaled image; -1 if image will be rendered unscaled.
	height	Height of the scaled image; -1 if image will be rendered unscaled.
	observer	The `Component` that `image` will be rendered on.
Returns	`true` if image fully loaded, `false` otherwise.	
Description	Forces the system to start loading the `image`.	

sync

```
public abstract void sync()
```

Description	Flushes the display of the underlying graphics context.

Protected Instance Methods

createButton

```
protected abstract ButtonPeer createButton (Button b)
```

Parameters	*b*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Button`.	

createCanvas

```
protected abstract CanvasPeer createCanvas (Canvas c)
```

Parameters	*c*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Canvas`.	

createCheckbox

```
protected abstract CheckboxPeer createCheckbox (Checkbox
cb)
```

Parameters	*cb*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Checkbox`.	

createCheckboxMenuItem

`protected abstract CheckboxMenuItemPeer createCheckboxMenuItem (CheckboxMenuItem cmi)`

Parameters	*cmi*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `CheckboxMenuItem`.	

createChoice

`protected abstract ChoicePeer createChoice (Choice c)`

Parameters	*c*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Choice`.	

createComponent

`protected LightweightPeer createComponent (Component target)` ★

Parameters	*target*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Component`.	

createDialog

`protected abstract DialogPeer createDialog (Dialog d)`

Parameters	*d*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Dialog`.	

createFileDialog

`protected abstract FileDialogPeer createFileDialog (FileDialog fd)`

Parameters	*fd*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `FileDialog`.	

createFrame

`protected abstract FramePeer createFrame (Frame f)`

Parameters	*f*	`Component` whose peer needs to be created.

Returns	Newly created peer.	
Description	Creates a peer for the `Frame`.	

`createLabel`

`protected abstract LabelPeer createLabel (Label l)`

Parameters	*l*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Label`.	

`createList`

`protected abstract ListPeer createList (List l)`

Parameters	*l*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `List`.	

`createMenu`

`protected abstract MenuPeer createMenu (Menu m)`

Parameters	*m*	`Menu` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the given `Menu`.	

`createMenuBar`

`protected abstract MenuBarPeer createMenuBar (MenuBar mb)`

Parameters	*mb*	`MenuBar` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `MenuBar`.	

`createMenuItem`

```
protected abstract MenuItemPeer createMenuItem (MenuItem
mi)
```

Parameters	*mi*	`MenuItem` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `MenuItem`.	

`createPanel`

`protected abstract PanelPeer createPanel (Panel p)`

Parameters	*p*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Panel`.	

createPopupMenu

`protected abstract PopupMenuPeer createPopupMenu (PopupMenu target)` ★

Parameters	*target*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `PopupMenu`.	

createScrollPane

`protected abstract ScrollPanePeer createScrollPane (ScrollPane target)` ★

Parameters	*target*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `ScrollPane`.	

createScrollbar

`protected abstract ScrollbarPeer createScrollbar (Scrollbar sb)`

Parameters	*sb*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Scrollbar`.	

createTextArea

`protected abstract TextAreaPeer createTextArea (TextArea ta)`

Parameters	*ta*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `TextArea`.	

createTextField

`protected abstract TextFieldPeer createTextField (TextField tf)`

Parameters	*tf*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `TextField`.	

createWindow

```
protected abstract WindowPeer createWindow (Window w)
```

Parameters	*w*	`Component` whose peer needs to be created.
Returns	Newly created peer.	
Description	Creates a peer for the `Window`.	

getFontPeer

```
protected abstract FontPeer getFontPeer (String name, int
style) ★
```

Parameters	*name*	Name of the font to be created.
	style	Style of the font to be created.
Returns	Newly created peer.	
Description	Creates a `FontPeer`.	

getSystemEventQueueImpl

```
protected abstract getSystemEventQueueImpl()★
```

Returns	A toolkit-specific `EventQueue` object.

loadSystemColors

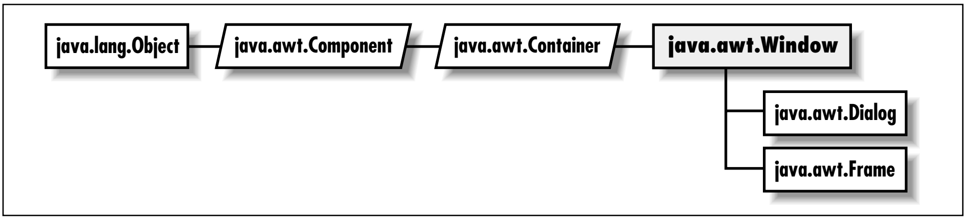
```
protected abstract void loadSystemColors
(int[] systemColors) ★
```

Description	Fills the given integer array with the current system colors.

See Also

`Button`, `ButtonPeer`, `Canvas`, `CanvasPeer`, `Checkbox`, `CheckboxMenuItem`, `CheckboxMenuItemPeer`, `CheckboxPeer`, `Choice`, `ChoicePeer`, `Clipboard`, `ColorModel`, `Component`, `Container`, `Dialog`, `DialogPeer`, `Dimension`, `FileDialog`, `FileDialogPeer`, `Font`, `FontMetrics`, `FontPeer`, `Frame`, `FramePeer`, `Image`, `ImageObserver`, `ImageProducer`, `Label`, `LabelPeer`, `LightweightPeer`, `List`, `ListPeer`, `Menu`, `MenuBar`, `MenuBarPeer`, `MenuItem`, `MenuItemPeer`, `MenuPeer`, `Panel`, `PanelPeer`, `PrintJob`, `Scrollbar`, `ScrollbarPeer`, `ScrollPane`, `ScrollPanePeer`, `String`, `TextArea`, `TextAreaPeer`, `TextField`, `TextFieldPeer`, `Window`, `WindowPeer`

19.61 Window



Description

The `Window` class serves as a top-level display area that exists outside the browser or applet area you may be working in. A window must have a parent `Frame`.

Class Definition

```
public class java.awt.Window
    extends java.awt.Container {

   // Constructors
   public Window (Frame parent);

   // Instance Methods
   public void addNotify();
   public synchronized void addWindowListener (WindowListener l); ★
   public void dispose();
   public Component getFocusOwner(); ★
   public Locale getLocale(); ★
   public Toolkit getToolkit();
   public final String getWarningString();
   public boolean isShowing(); ★
   public void pack();
   public boolean postEvent (Event e); ☆
   public synchronized void remove WindowListener (WindowListener l); ★
   public void show();
   public void toBack();
   public void toFront();
//Protected Instance Methods
   protected void processEvent (AWTEvent e); ★
   protected void processWindowEvent (WindowEvent e); ★
}
```

Constructors

Window

`public Window (Frame parent)`

Parameters	*parent*	`Frame` that is to act as the parent of `Window`.
Description	Constructs a `Window` object.	

Instance Methods

addNotify

`public void addNotify()`

Overrides	`Container.addNotify()`
Description	Creates `Window`'s peer and peers of contained components.

removeWindowListener

`public synchronized void`
`removeWindowListener(WindowListener l)` ★

Parameters	*l*	One of this `Frame`'s `WindowListeners`.
Description	Remove an event listener.	

addWindowListener

`public synchronized void addWindowListener (WindowListener`
`l)` ★

Parameters	*l*	An object that implements the `WindowListener` interface.
Description	Add a listener for windowing events.	

dispose

`public void dispose()`

Returns	Releases the resources of the `Window`.

getFocusOwner

`public Component getFocusOwner()` ★

Returns	The child component that currently has the input focus.

getLocale

`public Locale getLocale()` ★

Returns	The locale for this `Window`.
Overrides	`Window.getLocale()`

getToolkit

`public Toolkit getToolkit()`

Returns	`Toolkit` of `Window`.
Overrides	`Component.getToolkit()`

getWarningString

`public final String getWarningString()`

Returns	String that will be displayed on the bottom of insecure `Window` instances.

isShowing

`public boolean isShowing()`

Returns	`true` if the `Window` is showing on the screen, `false` otherwise.

pack

`public void pack()`

Description	Resizes `Window` to `getPreferredSize()` of contained components.

postEvent

`public boolean postEvent (Event e)` ☆

Parameters	*e*	`Event` instance to post to window.
Returns	If `Event` is handled, `true` is returned. Otherwise, `false` is returned.	
Description	Tells the `Window` to deal with `Event`.	

removeWindowListener

`public synchronized void removeWindowListener (WindowListener l)` ★

Parameters	*l*	One of this `Frame`'s `WindowListeners`.
Description	Remove an event listener.	

show

`public void show()`

Description Show the `Window` and validate its components.
Overrides `Component.show()`

toBack

`public void toBack()`

Description Puts the `Window` in the background of the display.

toFront

`public void toFront()`

Description Brings the `Window` to the foreground of the display.

Protected Instance Methods

processEvent

`protected void processEvent (AWTEvent e)` ★

Parameters *e* The event to process.
Description Low level `AWTEvents` are passed to this method for processing.

processWindowEvent

`protected void processWindowEvent (WindowEvent e)` ★

Parameters *e* The event to process.
Description Window events are passed to this method for processing. Normally, this method is called by `processEvent()`.

See Also

`Component`, `Container`, `Dialog`, `Frame`, `String`, `Toolkit`

20

java.awt.datatransfer Reference

20.1 Clipboard ★

Description

The `Clipboard` class is a repository for a `Transferable` object and can be used for cut, copy, and paste operations. The system clipboard can be accessed by calling `Toolkit.getDefaultToolkit().getSystemClipboard()`. You can use this technique if you are interested in exchanging data between your application and other applications (Java or non-Java) running on the system. In addition, `Clipboard` can be instantiated directly, if "private" clipboards are needed.

Class Definition

```
public class java.awt.datatransfer.Clipboard
    extends java.lang.Object {

    // Variables
    protected Transferable contents;
    protected ClipboardOwner owner;

    // Constructors
    public Clipboard (String name);

    // Instance Methods
    public synchronized Transferable getContents (Object requestor);
    public String getName();
    public synchronized void setContents (Transferable contents, ClipboardOwner owner);
}
```

Variables

contents

`protected Transferable contents`

The object that the `Clipboard` contains, i.e., the object that has been cut or copied.

owner

`protected ClipboardOwner owner`

The object that owns the `contents`. When something else is placed on the clipboard, owner is notified via lostOwnership().

Constructors

Clipboard

`public Clipboard (String name)`

Parameters	*name*	The name for this `Clipboard`.
Description	Constructs a `Clipboard` object with the given `name`.	

Instance Methods

getContents

```
public synchronized Transferable getContents (Object
requestor)
```

Parameters	*requestor*	The object asking for the contents.
Returns	An object that implements the `Transferable` interface.	
Description	Returns the current contents of the `Clipboard`. You could use this method to paste data from the clipboard into your application.	

getName

`public String getName()`

Returns	`Clipboard`'s name.
Description	Returns the name used when this clipboard was constructed. `Toolkit.getSystemClipboard()` returns a `Clipboard` named "System".

setContents

```
public synchronized void setContents (Transferable
contents, ClipboardOwner owner)
```

Parameters	*contents*	New contents.
	owner	Owner of the new contents.
Description	Changes the contents of the `Clipboard`. You could use this method to cut or copy data from your application to the clipboard.	

See Also

`ClipboardOwner`, `Toolkit`, `Transferable`

20.2 ClipboardOwner ★

Description

`ClipboardOwner` is implemented by classes that want to be notified when someone else sets the contents of a clipboard.

Interface Definition

```
public abstract interface java.awt.datatransfer.ClipboardOwner {

  // Interface Methods
  public abstract void lostOwnership (Clipboard clipboard, Transferable contents);
}
```

Interface Methods

`lostOwnership`

```
public abstract void lostOwnership (Clipboard clipboard,
Transferable contents)
```

Parameters	*clipboard*	The clipboard whose contents have changed.
	contents	The contents that this owner originally put on the clipboard.
Description	Tells the `ClipboardOwner` that the `contents` it placed on the given `clipboard` are no longer there.	

See Also

`Clipboard`, `StringSelection`, `Transferable`

20.3 DataFlavor ★

Description

The DataFlavor class encapsulates information about data formats.

Class Definition

```
public class java.awt.datatransfer.DataFlavor
    extends java.lang.Object {

  // Class Variables
  public static DataFlavor plainTextFlavor;
  public static DataFlavor stringFlavor;

  // Constructors
  public DataFlavor (Class representationClass,
    String humanPresentableName);
  public DataFlavor (String MIMEType, String humanPresentableName);

  // Instance Methods
  public boolean equals (DataFlavor dataFlavor);
  public String getHumanPresentableName();
  public String getMIMEType();
  public Class getRepresentationClass();
  public boolean isMIMETypeEqual (String MIMEType);
  public final boolean isMIMETypeEqual (DataFlavor dataFlavor);
  public void setHumanPresentableName (String humanPresentableName);

  // Protected Instance Methods
  protected String normalizeMIMEType (String MIMEType);
  protected String normalizeMIMETypeParameter (String parameterName,
    String parameterValue);
}
```

Class Variables

plainTextFlavor

```
public static DataFlavor plainTextFlavor
```

A preset DataFlavor object representing plain text.

stringFlavor

```
public static DataFlavor stringFlavor
```

A preset DataFlavor object representing a Java String.

Constructors

DataFlavor

`public DataFlavor (Class representationClass, String humanPresentableName)`

Parameters *representationClass*
The Java class that represents data in this flavor.
humanPresentableName
A name for this flavor that humans will recognize.

Description Constructs a `DataFlavor` object with the given characteristics. The MIME type for this `DataFlavor` is `application/x-java-serialized-object <Java ClassName>`.*

`public DataFlavor (String MIMEType, String humanPresentableName)`

Parameters *MIMEType* The MIME type string this `DataFlavor` represents.
humanPresentableName
A name for this flavor that humans will recognize.

Description Constructs a `DataFlavor` object with the given characteristics. The representation class used for this `DataFlavor` is `java.io.InputStream`.

Instance Methods

equals

`public boolean equals (DataFlavor dataFlavor)`

Parameters *dataFlavor* The flavor to compare.

Returns `true` if `dataFlavor` is equivalent to this `DataFlavor`, `false` otherwise.

Description Compares two different `DataFlavor` instances for equivalence.

getHumanPresentableName

`public String getHumanPresentableName()`

Returns The name of this flavor.

* The type name changed to `x-java-serialized-object` in the 1.1.1 release.

getMIMEType

`public String getMIMEType()`

Returns The MIME type string for this flavor.

getRepresentationClass

`public Class getRepresentationClass()`

Returns The Java class that will be used to represent data in this flavor.

isMIMETypeEqual

`public boolean isMIMETypeEqual (String MIMEType)`

Parameters *MIMEType* The type to compare.
Returns `true` if the given MIME type is the same as this `DataFlavor`'s MIME type; `false` otherwise.
Description Compares two different `DataFlavor` MIME types for equivalence.

```
public final boolean isMIMETypeEqual (DataFlavor
dataFlavor)
```

Parameters *dataFlavor* The flavor to compare.
Returns `true` if `DataFlavor`'s MIME type is the same as this `DataFlavor`'s MIME type; `false` otherwise.
Description Compares two different `DataFlavor` MIME types for equivalence.

setHumanPresentableName

```
public void setHumanPresentableName (String
humanPresentableName)
```

Parameters *humanPresentableName* A name for this flavor that humans will recognize.
Description Changes the name of the `DataFlavor`.

Protected Instance Methods

normalizeMIMEType

`protected String normalizeMIMEType (String MIMEType)`

Parameters *MIMEType* The MIME type string to normalize.
Returns Normalized MIME type string.

Description This method is called for each MIME type string. Subclasses can override this method to add default parameter/value pairs to MIME strings.

normalizeMIMETypeParameter

```
protected String normalizeMIMETypeParameter (String
parameterName, String parameterValue)
```

Parameters *parameterName*
The MIME type parameter to normalize.
parameterValue
The corresponding value.

Returns Normalized MIME type parameter string.

Description This method is called for each MIME type parameter string. Subclasses can override this method to handle special parameters, such as those that are case-insensitive.

See Also

Class, String

20.4 StringSelection ★

Description

StringSelection is a "convenience" class that can be used for copy and paste operations on Unicode text strings. For example, you could place a string on the system's clipboard with the following code:

```
Clipboard c =
  Toolkit.getDefaultToolkit().getSystemClipboard();
StringSelection s = new StringSelection(

  "Be safe when you cut and paste.");
c.setContents(s, s);
```

Class Definition

```
public class java.awt.datatransfer.StringSelection
    extends java.lang.Object
    implements java.awt.datatransfer.ClipboardOwner,
            java.awt.datatransfer.Transferable {

  // Constructor
  public StringSelection(String data);

  // Instance Methods
```

```
  public synchronized Object getTransferData (DataFlavor flavor)
    throws UnsupportedFlavorException, IOException;
  public synchronized DataFlavor[] getTransferDataFlavors();
  public boolean isDataFlavorSupported (DataFlavor flavor);
  public void lostOwnership (Clipboard clipboard, Transferable contents);
}
```

Constructors

StringSelection

`public StringSelection (String data)`

Parameters	*data*	The string to be placed in a clipboard.
Description	Constructs a `StringSelection` object from the given string.	

Instance Methods

getTransferData

`public synchronized Object getTransferData (DataFlavor flavor) throws UnsupportedFlavorException, IOException`

Parameters	*flavor*	The requested flavor for the returned data, which can be either `DataFlavor.stringFlavor` or `DataFlavor.plainTextFlavor`.
Returns	The string that the `StringSelection` was constructed with. This is returned either as a `String` object or a `Reader` object, depending on the flavor requested.	
Throws	*UnsupportedFlavorException*	If the requested flavor is not supported.
	IOException	If a `Reader` representing the string could not be created.
Implements	`Transferable.getTransferData(DataFlavor)`	
Description	Returns the string this `StringSelection` represents. This is returned either as a `String` object or a `Reader` object, depending on the flavor requested.	

getTransferDataFlavors

`public synchronized DataFlavor[] getTransferDataFlavors()`

Returns	An array of the data flavors the `StringSelection` supports.
Implements	`Transferable.getTransferDataFlavors()`
Description	`DataFlavor.stringFlavor` and `DataFlavor.plainTextFlavor` are returned.

isDataFlavorSupported

```
public boolean isDataFlavorSupported (DataFlavor flavor)
```

Parameters	*flavor*	The flavor in question.
Returns	`true` if `flavor` is supported; `false` otherwise.	
Implements	`Transferable.isDataFlavorSupported(DataFlavor)`	

lostOwnership

```
public void lostOwnership (Clipboard clipboard,
Transferable contents)
```

Parameters	*clipboard*	The clipboard whose contents are changing.
	contents	The contents that were on the clipboard.
Implements	`ClipboardOwner.lostOwnership(Clipboard, Transferable)`	
Description	Does nothing.	

See Also

`Clipboard`, `ClipboardOwner`, `DataFlavor`, `String`, `Transferable`

20.5 Transferable ★

Description

The `Transferable` interface is implemented by objects that can be placed on `Clipboards`.

Interface Definition

```
public abstract interface Transferable {

  // Instance Methods
  public abstract Object getTransferData (DataFlavor flavor)
    throws UnsupportedFlavorException, IOException;
  public abstract DataFlavor[] getTransferDataFlavors();
  public abstract boolean isDataFlavorSupported (DataFlavor flavor);
}
```

Interface Methods

getTransferData

```
public abstract Object getTransferData (DataFlavor flavor)
throws UnsupportedFlavorException, IOException
```

Parameters	*flavor*	The requested flavor for the returned data.
Returns	The data represented by this `Transferable` object, in the requested flavor.	
Throws	*UnsupportedFlavorException*	If the requested flavor is not supported.
	IOException	If a `Reader` representing the data could not be created.
Description	Returns the data this `Transferable` object represents. The class of object returned depends on the flavor requested.	

getTransferDataFlavors

```
public abstract DataFlavor[] getTransferDataFlavors()
```

Returns	An array of the supported data flavors.
Description	The data flavors should be returned in order, sorted from most to least descriptive.

isDataFlavorSupported

```
public abstract boolean isDataFlavorSupported (DataFlavor
flavor)
```

Parameters	*flavor*	The flavor in question.
Returns	`true` if `flavor` is supported; `false` otherwise.	

See Also

`Clipboard`, `DataFlavor`, `Reader`, `StringSelection`, `Transferable`

20.6 UnsupportedFlavorException ★

Description

This exception is thrown from `Transferable.getTransferData(DataFlavor)` to indicate that the `DataFlavor` requested is not available.

Class Definition

```
public class java.awt.datatransfer.UnsupportedFlavorException
   extends java.lang.Exception {

  // Constructor
  public UnsupportedFlavorException (DataFlavor flavor);
}
```

Constructors

UnsupportedFlavorException

```
public UnsupportedFlavorException (DataFlavor flavor)
```

Parameters	*flavor*	The flavor that caused the exception.

See Also

`DataFlavor`, `Exception`, `Transferable`

21

java.awt.event Reference

21.1 ActionEvent ★

Description

Action events are fired off when the user performs an action on a component, such as pushing a button, double-clicking on a list item, or selecting a menu item. There is only one action event type, ACTION_PERFORMED.

Class Definition

```
public class java.awt.event.ActionEvent
    extends java.awt.AWTEvent {

   // Constants
   public final static int ACTION_FIRST;
   public final static int ACTION_LAST;
   public final static int ACTION_PERFORMED;
   public final static int ALT_MASK;
   public final static int CTRL_MASK;
   public final static int META_MASK;
   public final static int SHIFT_MASK;

   // Constructors
   public ActionEvent (Object source, int id, String command);
   public ActionEvent (Object source, int id, String command, int modifiers);

   // Instance Methods
   public String getActionCommand();
   public int getModifiers();
```

```
  public String paramString();
}
```

Constants

ACTION_FIRST

`public final static int ACTION_FIRST`

Specifies the beginning range of action event ID values.

ACTION_LAST

`public final static int ACTION_LAST`

Specifies the ending range of action event ID values.

ACTION_PERFORMED

`public final static int ACTION_PERFORMED`

The only action event type; it indicates that the user has performed an action.

ALT_MASK

`public final static int ALT_MASK`

A constant representing the ALT key. ORed with other masks to form `modifiers` setting of an `AWTEvent`.

CTRL_MASK

`public final static int CTRL_MASK`

A constant representing the Control key. ORed with other masks to form `modifiers` setting of an `AWTEvent`.

META_MASK

`public final static int META_MASK`

A constant representing the META key. ORed with other masks to form `modifiers` setting of an `AWTEvent`.

SHIFT_MASK

`public final static int SHIFT_MASK`

A constant representing the Shift key. ORed with other masks to form `modifiers` setting of an `AWTEvent`.

Constructors

ActionEvent

`public ActionEvent (Object source, int id, String command)`

Parameters	*source*	The object that generated the event.
	id	The type ID of the event.
	command	The action command string.
Description	Constructs an `ActionEvent` with the given characteristics.	

`public ActionEvent (Object source, int id, String command, int modifiers)`

Parameters	*source*	The object that generated the event.
	id	The type ID of the event.
	command	The action command string.
	modifiers	A combination of the key mask constants.
Description	Constructs an `ActionEvent` with the given characteristics.	

Instance Methods

getActionCommand

`public String getActionCommand()`

Returns	The action command string for this `ActionEvent`.
Description	Generally the action command string is the label of the component that generated the event. Also, when localization is necessary, the action command string can provide a setting that does not get localized.

getModifiers

`public int getModifiers()`

Returns	A combination of the key mask constants.
Description	Returns the modifier keys that were held down when this action was performed. This enables you to perform special processing if, for example, the user holds down Shift while pushing a button.

paramString

```
public String paramString()
```

Returns	String with current settings of `ActionEvent`.
Overrides	`AWTEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`ActionListener`, `AWTEvent`, `String`

21.2 ActionListener ★

Description

Objects that implement the `ActionListener` interface can receive `ActionEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.ActionListener
   extends java.util.EventListener {

  // Interface Methods
  public abstract void actionPerformed (ActionEvent e);
}
```

Interface Methods

actionPerformed

```
public abstract void actionPerformed (ActionEvent e)
```

Parameters	*e*	The action event that occurred.
Description	Notifies the `ActionListener` that an event occurred.	

See Also

`ActionEvent`, `AWTEventMulticaster`, `EventListener`

21.3 AdjustmentEvent ★

Description

AdjustmentEvents are generated by objects that implement the Adjustable interface. Scrollbar is one example of such an object.

Class Definition

```
public class java.awt.event.AdjustmentEvent
   extends java.awt.AWTEvent {

  // Constants
  public final static int ADJUSTMENT_FIRST;
  public final static int ADJUSTMENT_LAST;
  public final static int ADJUSTMENT_VALUE_CHANGED;
  public final static int BLOCK_DECREMENT;
  public final static int BLOCK_INCREMENT;
  public final static int TRACK;
  public final static int UNIT_DECREMENT;
  public final static int UNIT_INCREMENT;

  // Constructors
  public AdjustmentEvent (Adjustable source, int id, int type, int value);

  // Instance Methods
  public Adjustable getAdjustable();
  public int getAdjustmentType();
  public int getValue();
  public String paramString();
}
```

Constants

ADJUSTMENT_FIRST

```
public final static int ADJUSTMENT_FIRST
```

Specifies the beginning range of adjustment event ID values.

ADJUSTMENT_LAST

```
public final static int ADJUSTMENT_LAST
```

Specifies the ending range of adjustment event ID values.

ADJUSTMENT_VALUE_CHANGED

`public final static int ADJUSTMENT_VALUE_CHANGED`

Event type ID for value changed.

BLOCK_DECREMENT

`public final static int BLOCK_DECREMENT`

Adjustment type for block decrement.

BLOCK_INCREMENT

`public final static int BLOCK_INCREMENT`

Adjustment type for block increment.

TRACK

`public final static int TRACK`

Adjustment type for tracking.

UNIT_DECREMENT

`public final static int UNIT_DECREMENT`

Adjustment type for unit decrement.

UNIT_INCREMENT

`public final static int UNIT_INCREMENT`

Adjustment type for unit increment.

Constructors

AdjustmentEvent

```
public AdjustmentEvent (Adjustable source, int id, int
type, int value)
```

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
	type	The type of adjustment event.
	value	The value of the `Adjustable` object.
Description	Constructs an `AdjustmentEvent` with the given characteristics.	

Instance Methods

getAdjustable

```
public Adjustable getAdjustable()
```

Returns — The source of this event.

getAdjustmentType

```
public int getAdjustmentType()
```

Returns — One of the adjustment type constants.

Description — The type will be BLOCK_DECREMENT, BLOCK_INCREMENT, TRACK, UNIT_DECREMENT, or UNIT_INCREMENT.

getValue

```
public int getValue()
```

Returns — The new value of the Adjustable object.

paramString

```
public String paramString()
```

Returns — String with current settings of the AdjustmentEvent.

Overrides — AWTEvent.paramString()

Description — Helper method for toString() to generate string of current settings.

See Also

Adjustable, AdjustmentListener, AWTEvent, Scrollbar

21.4 AdjustmentListener ★

Description

Objects that implement the AdjustmentListener interface can receive AdjustmentEvent objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.AdjustmentListener
    extends java.util.Eventlistener {

   // Interface Methods
   public abstract void adjustmentValueChanged (AdjustmentEvent e);
}
```

Interface Methods

adjustmentPerformed

```
public abstract void adjustmentValueChanged
(AdjustmentEvent e)
```

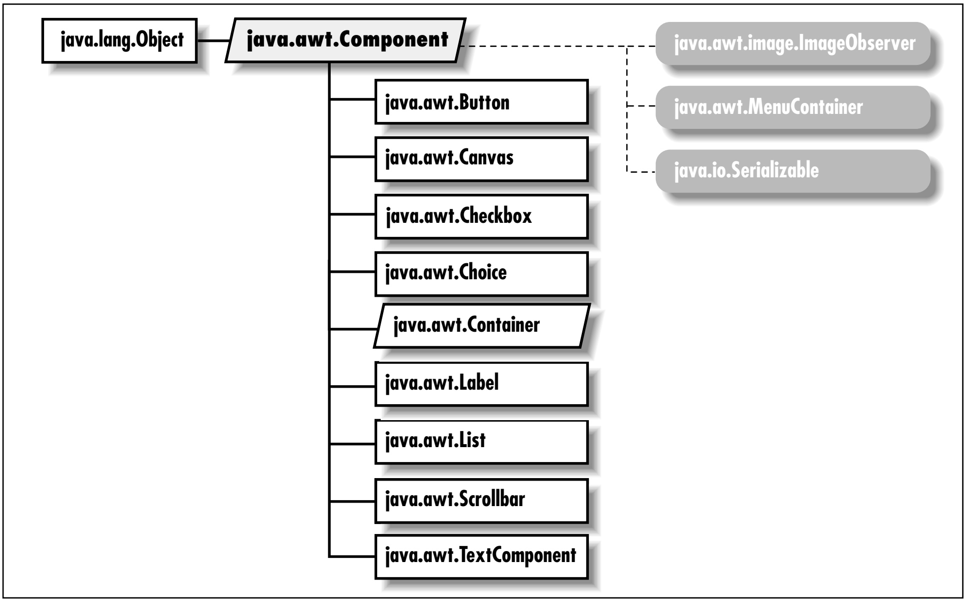
Parameters *e* The adjustment event that occurred.

Description Notifies the `AdjustmentListener` that an event occurred.

See Also

`AdjustmentEvent`, `AWTEventMulticaster`, `EventListener`

21.5 ComponentAdapter ★



Description

`ComponentAdapter` is a class that implements the methods of `ComponentListener` with empty functions. It may be easier for you to extend `ComponentAdapter`, overriding only those methods you are interested in, than to implement `ComponentListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.ComponentAdapter
    extends java.lang.Object
    implements java.awt.event.ComponentListener {

  // Instance Methods
  public void componentHidden (ComponentEvent e);
  public void componentMoved (ComponentEvent e);
  public void componentResized (ComponentEvent e);
  public void componentShown (ComponentEvent e);
}
```

Instance Methods

componentHidden

`public void componentHidden (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is hidden.	

componentMoved

`public void componentMoved (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is moved.	

componentResized

`public void componentResized (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is resized.	

componentShown

`public void componentShown (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is shown.	

See Also

`Component`, `ComponentEvent`, `ComponentListener`

21.6 ComponentEvent ★

Description

Component events are generated when a component is shown, hidden, moved, or resized. AWT automatically deals with component moves and resizing; these events are provided only for notification. Subclasses of `ComponentEvent` deal with other specific component-level events.

Class Definition

```
public class java.awt.event.ComponentEvent
   extends java.awt.AWTEvent {

  // Constants
  public final static int COMPONENT_FIRST;
  public final static int COMPONENT_HIDDEN;
  public final static int COMPONENT_LAST;
  public final static int COMPONENT_MOVED;
  public final static int COMPONENT_RESIZED;
  public final static int COMPONENT_SHOWN;

  // Constructors
  public ComponentEvent (Component source, int id);

  // Instance Methods
  public Component getComponent();
  public String paramString();
}
```

Constants

COMPONENT_FIRST

```
public final static int COMPONENT_FIRST
```

Specifies the beginning range of component event ID values.

COMPONENT_HIDDEN

```
public final static int COMPONENT_HIDDEN
```

Event type ID indicating that the component was hidden.

`COMPONENT_LAST`

`public final static int COMPONENT_LAST`

Specifies the ending range of component event ID values.

`COMPONENT_MOVED`

`public final static int COMPONENT_MOVED`

Event type ID indicating that the component was moved.

`COMPONENT_RESIZED`

`public final static int COMPONENT_RESIZED`

Event type ID indicating that the component was resized.

`COMPONENT_SHOWN`

`public final static int COMPONENT_SHOWN`

Event type ID indicating that the component was shown.

Constructors

`ComponentEvent`

`public ComponentEvent (Component source, int id)`

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
Description	Constructs a `ComponentEvent` with the given characteristics.	

Instance Methods

`getComponent`

`public Component getComponent()`

Returns	The source of this event.

`paramString`

`public String paramString()`

Returns	String with current settings of the `ComponentEvent`.
Overrides	`AWTEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`AWTEvent`, `Component`, `ComponentAdapter`, `ComponentListener`, `ContainerEvent`, `FocusEvent`, `InputEvent`, `PaintEvent`, `WindowEvent`

21.7 ComponentListener ★

Description

Objects that implement the `ComponentListener` interface can receive `ComponentEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.ComponentListener
   extends java.util.EventListener {

  // Instance Methods
  public abstract void componentHidden (ComponentEvent e);
  public abstract void componentMoved (ComponentEvent e);
  public abstract void componentResized (ComponentEvent e);
  public abstract void componentShown (ComponentEvent e);
}
```

Interface Methods

componentHidden

`public abstract void componentHidden (ComponentEvent e)`

Parameters	*e*	The component event that occurred.
Description	Notifies the `ComponentListener` that a component was hidden.	

componentMoved

`public abstract void componentMoved (ComponentEvent e)`

Parameters	*e*	The component event that occurred.
Description	Notifies the `ComponentListener` that a component was moved.	

componentResized

`public abstract void componentResized (ComponentEvent e)`

Parameters	*e*	The component event that occurred.
Description	Notifies the `ComponentListener` that a component was resized.	

componentShown

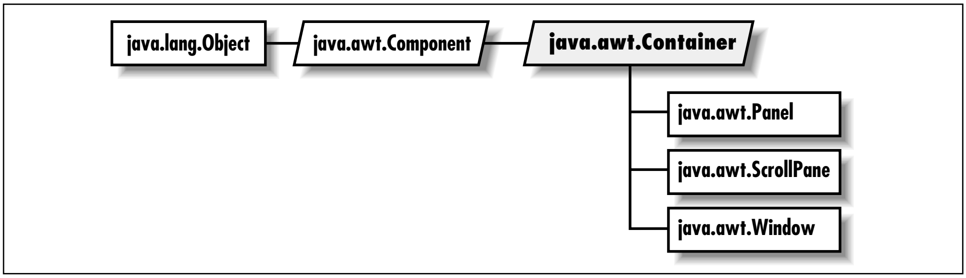
`public abstract void componentShown (ComponentEvent e)`

Parameters	*e*	The component event that occurred.
Description	Notifies the `ComponentListener` that a component was shown.	

See Also

`AWTEventMulticaster`, `ComponentAdapter`, `ComponentEvent`, `EventListener`

21.8 ContainerAdapter ★



Description

The `ContainerAdapter` class implements the methods of `ContainerListener` with empty functions. It may be easier for you to extend `ContainerAdapter`, overriding only those methods you are interested in, than to implement `ContainerListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.ContainerAdapter
    extends java.lang.Object
    implements java.awt.event.ContainerListener {

  // Instance Methods
```

```
    public void componentAdded (ContainerEvent e);
    public void componentRemoved (ContainerEvent e);
  }
```

Instance Methods

componentAdded

`public void componentAdded (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is added to a container.	

componentRemoved

`public void componentRemoved (ComponentEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component is removed from a container.	

See Also

`ContainerEvent`, `ContainerListener`

21.9 ContainerEvent ★

Description

Container events are fired off when a component is added to or removed from a container. The AWT automatically deals with adding components to containers; these events are provided only for notification.

Class Definition

```
public class java.awt.event.ContainerEvent
    extends java.awt.event.ComponentEvent {

  // Constants
  public final static int COMPONENT_ADDED;
  public final static int COMPONENT_REMOVED;
  public final static int CONTAINER_FIRST;
  public final static int CONTAINER_LAST;

  // Constructors
  public ContainerEvent (Component source, int id, Component child);

  // Instance Methods
```

```
    public Component getChild();
    public Container getContainer();
    public String paramString();
  }
```

Constants

COMPONENT_ADDED

`public final static int COMPONENT_ADDED`

Event type ID indicating that a component was added to a container.

CONTAINER_FIRST

`public final static int CONTAINER_FIRST`

Specifies the beginning range of container event ID values.

CONTAINER_LAST

`public final static int CONTAINER_LAST`

Specifies the ending range of container event ID values.

COMPONENT_REMOVED

`public final static int COMPONENT_REMOVED`

Event type ID indicating that a component was removed from a container.

Constructors

ContainerEvent

`public ContainerEvent (Component source, int id, Component child)`

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
	child	The component that was added or removed.

Description: Constructs a `ContainerEvent` with the given characteristics.

Instance Methods

getChild

`public Component getChild()`

Returns: The component that is being added or removed.

getContainer

```
public Container getContainer()
```

Returns	The container for this event.

paramString

```
public String paramString()
```

Returns	String with current settings of the `ContainerEvent`.
Overrides	`ComponentEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`Component`, `ComponentEvent`, `Container`, `ContainerAdapter`, `ContainerListener`

21.10 ContainerListener ★

Description

Objects that implement the `ContainerListener` interface can receive `ContainerEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.ContainerListener
    extends java.util.EventListener {

  // Instance Methods
  public abstract void componentAdded (ContainerEvent e);
  public abstract void componentRemoved (ContainerEvent e);
}
```

Interface Methods

componentAdded

```
public abstract void componentAdded (ContainerEvent e)
```

Parameters	*e*	The event that occurred.

Description	Notifies the `ContainerListener` that a component has been added to the container.

componentRemoved

`public abstract void componentRemoved (ContainerEvent e)`

Parameters	*e*	The event that occurred.
Description	Notifies the `ContainerListener` that a component has been removed from the container.	

See Also

`ContainerAdapter`, `ContainerEvent`, `EventListener`

21.11 FocusAdapter ★

Description

The `FocusAdapter` class implements the methods of `FocusListener` with empty functions. It may be easier for you to extend `FocusAdapter`, overriding only those methods you are interested in, than to implement `FocusListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.FocusAdapter
    extends java.lang.Object
    implements java.awt.event.FocusListener {

  // Instance Methods
  public void focusGained (FocusEvent e);
  public void focusLost (FocusEvent e);
}
```

Instance Methods

focusGained

`public void focusGained (FocusEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a component gains focus.	

focusLost

```
public void focusLost (FocusEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a component loses focus.

See Also

`FocusEvent`, `FocusListener`

21.12 FocusEvent ★

Description

Focus events are generated when a component gets or loses input focus. Focus events come in two flavors, permanent and temporary. Permanent focus events occur with explicit focus changes. For example, when the user tabs through components, this causes permanent focus events. An example of a temporary focus event is when a component loses focus as its containing window is deactivated.

Class Definition

```
public class java.awt.event.FocusEvent
   extends java.awt.event.ComponentEvent {

  // Constants
  public final static int FOCUS_FIRST;
  public final static int FOCUS_GAINED;
  public final static int FOCUS_LAST;
  public final static int FOCUS_LOST;

  // Constructors
  public FocusEvent (Component source, int id);
  public FocusEvent (Component source, int id, boolean temporary);

  // Instance Methods
  public boolean isTemporary();
  public String paramString();
}
```

Constants

FOCUS_FIRST

`public final static int FOCUS_FIRST`

Specifies the beginning range of focus event ID values.

FOCUS_GAINED

`public final static int FOCUS_GAINED`

Event type ID indicating that the component gained the input focus.

FOCUS_LAST

`public final static int FOCUS_LAST`

Specifies the ending range of focus event ID values.

FOCUS_LOST

`public final static int FOCUS_LOST`

Event type ID indicating that the component lost the input focus.

Constructors

FocusEvent

`public FocusEvent (Component source, int id)`

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
Description	Constructs a non-temporary `FocusEvent` with the given characteristics.	

```
public FocusEvent (Component source, int id, boolean
temporary)
```

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
	temporary	A flag indicating whether this is a temporary focus event.
Description	Constructs a `FocusEvent` with the given characteristics.	

Instance Methods

isTemporary

```
public boolean isTemporary()
```

Returns   `true` if this is a temporary focus event; `false` otherwise.

paramString

```
public String paramString()
```

Returns   String with current settings of the `FocusEvent`.
Overrides   `ComponentEvent.paramString()`
Description   Helper method for `toString()` to generate string of current settings.

See Also

`Component`, `ComponentEvent`, `FocusAdapter`, `FocusListener`

21.13 FocusListener ★

Description

Objects that implement the `FocusListener` interface can receive `FocusEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.FocusListener
   extends java.util.EventListener {

  // Instance Methods
  public abstract void focusGained (FocusEvent e);
  public abstract void focusLost (FocusEvent e);
}
```

Interface Methods

focusGained

```
public abstract void focusGained (FocusEvent e)
```

Parameters   *e*   The component event that occurred.
Description   Notifies the `FocusListener` that a component gained the input focus.

focusLost

`public abstract void focusLost (FocusEvent e)`

Parameters *e* The component event that occurred.

Description Notifies the `FocusListener` that a component lost the input focus.

See Also

`AWTEventMulticaster`, `EventListener`, `FocusAdapter`, `FocusEvent`

21.14 InputEvent ★

Description

`InputEvent` is the root class for representing user input events. Input events are passed to listeners before the event source processes them. If one of the listeners consumes an event by using `consume()`, the event will not be processed by the event source peer.

Class Definition

```
public abstract class java.awt.event.InputEvent
   extends java.awt.event.ComponentEvent {

  // Constants
  public final static int ALT_MASK;
  public final static int BUTTON1_MASK;
  public final static int BUTTON2_MASK;
  public final static int BUTTON3_MASK;
  public final static int CTRL_MASK;
  public final static int META_MASK;
  public final static int SHIFT_MASK;

  // Instance Methods
  public void consume();
  public int getModifiers();
  public long getWhen();
  public boolean isAltDown();
  public boolean isConsumed();
  public boolean isControlDown();
  public boolean isMetaDown();
  public boolean isShiftDown();
}
```

Constants

ALT_MASK

`public final static int ALT_MASK`

The ALT key mask. ORed with other masks to form modifiers setting of event.

BUTTON1_MASK

`public final static int BUTTON1_MASK`

The mouse button 1 key mask. ORed with other masks to form modifiers setting of event.

BUTTON2_MASK

`public final static int BUTTON2_MASK`

The mouse button 2 key mask. ORed with other masks to form modifiers setting of event. This constant is identical to `ALT_MASK`.

BUTTON3_MASK

`public final static int BUTTON3_MASK`

The mouse button 3 key mask. ORed with other masks to form modifiers setting of event. This constant is identical to `ALT_MASK`.

CTRL_MASK

`public final static int CTRL_MASK`

The Control key mask. ORed with other masks to form modifiers setting of event.

META_MASK

`public final static int META_MASK`

The Meta key mask. ORed with other masks to form modifiers setting of event.

SHIFT_MASK

`public final static int SHIFT_MASK`

The Shift key mask. ORed with other masks to form modifiers setting of event.

Instance Methods

consume

`public void consume()`

Description — A consumed event will not be delivered to its source for default processing.

getModifiers

`public int getModifiers()`

Returns — The modifier flags, a combination of the `_MASK` constants.
Description — Use this method to find out what modifier keys were pressed when an input event occurred.

getWhen

`public long getWhen()`

Returns — The time at which this event occurred.
Description — The time of the event is returned as the number of milliseconds since the epoch (00:00:00 UTC, January 1, 1970). Conveniently, `java.util.Date` has a constructor that accepts such values.

isAltDown

`public boolean isAltDown()`

Returns — `true` if the Alt key was pressed; `false` otherwise.

isConsumed

`public boolean isConsumed()`

Returns — `true` if the event has been consumed; `false` otherwise.

isControlDown

`public boolean isControlDown()`

Returns — `true` if the Control key was pressed; `false` otherwise.

isMetaDown

`public boolean isMetaDown()`

Returns — `true` if the Meta key was pressed; `false` otherwise.

isShiftDown

```
public boolean isShiftDown()
```

Returns `true` if the Shift key was pressed; `false` otherwise.

See Also

`ComponentEvent`, `KeyEvent`, `MouseEvent`

21.15 ItemEvent ★

Description

`ItemEvents` are generated by objects that implement the `ItemSelectable` interface. `Choice` is one example of such an object.

Class Definition

```
public class java.awt.event.ItemEvent
   extends java.awt.AWTEvent {

  // Constants
  public final static int DESELECTED;
  public final static int ITEM_FIRST;
  public final static int ITEM_LAST;
  public final static int ITEM_STATE_CHANGED;
  public final static int SELECTED;

  // Constructors
  public ItemEvent (ItemSelectable source, int id, Object item, int stateChange);

// Instance Methods
  public Object getItem();
  public ItemSelectable getItemSelectable();
  public int getStateChange();
  public String paramString();
}
```

Constants

DESELECTED

```
public final static int DESELECTED
```

Indicates that an item was deselected.

ITEM_FIRST

`public final static int ITEM_FIRST`

Specifies the beginning range of item event ID values.

ITEM_LAST

`public final static int ITEM_LAST`

Specifies the ending range of item event ID values.

ITEM_STATE_CHANGED

`public final static int ITEM_STATE_CHANGED`

An event type indicating that an item was selected or deselected.

SELECTED

`public final static int SELECTED`

Indicates that an item was selected.

Constructors

ItemEvent

```
public ItemEvent (ItemSelectable source, int id, Object
item, int stateChange)
```

Parameters	*source*	The object that generated the event.
	id	The type ID of the event.
	item	The item whose state is changing.
	stateChange	Either `SELECTED` or `DESELECTED`.
Description	Constructs an `ItemEvent` with the given characteristics.	

Instance Methods

getItem

`public Object getItem()`

Returns	The item pertaining to this event.
Description	Returns the item whose changed state triggered this event.

getItemSelectable

`public ItemSelectable getItemSelectable()`

Returns	The source of this event.

Description	Returns an object that implements the `ItemSelectable` interface.

`getStateChange`

`public int getStateChange()`

Returns	The change in state that triggered this event. The new state is returned.
Description	This method will return `SELECTED` or `DESELECTED`.

`paramString`

`public String paramString()`

Returns	String with current settings of `ItemEvent`.
Overrides	`AWTEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`AWTEvent`, `ItemSelectable`, `ItemListener`

21.16 ItemListener ★

Description

Objects that implement the `ItemListener` interface can receive `ItemEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.ItemListener
   extends java.util.EventListener {

  // Interface Methods
  public abstract void itemStateChanged (ItemEvent e);
}
```

Interface Methods

itemStateChanged

`public abstract void itemStateChanged (ItemEvent e)`

Parameters	*e*	The item event that occurred.
Description	Notifies the `ItemListener` that an event occurred.	

See Also

`AWTEventMulticaster`, `EventListener`, `ItemEvent`

21.17 KeyAdapter ★

Description

The `KeyAdapter` class implements the methods of `KeyListener` with empty functions. It may be easier for you to extend `KeyAdapter`, overriding only those methods you are interested in, than to implement `KeyListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.KeyAdapter
    extends java.lang.Object
    implements java.awt.event.KeyListener {

  // Instance Methods
  public void keyPressed (KeyEvent e);
  public void keyReleased (KeyEvent e);
  public void keyTyped (KeyEvent e);
}
```

Instance Methods

keyPressed

`public void keyPressed (KeyEvent e)`

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a key is pressed.	

keyReleased

`public void keyReleased (KeyEvent e)`

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a pressed key is released.

keyTyped

`public void keyTyped (KeyEvent e)`

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a key has been pressed and released.

See Also

KeyEvent, KeyListener

21.18 KeyEvent ★

Description

Key events are generated when the user types on the keyboard.

Class Definition

```
public class java.awt.event.KeyEvent
   extends java.awt.event.InputEvent {

  // Constants
  public final static int CHAR_UNDEFINED;
  public final static int KEY_FIRST;
  public final static int KEY_LAST;
  public final static int KEY_PRESSED;
  public final static int KEY_RELEASED;
  public final static int KEY_TYPED;
  public final static int VK_0;
  public final static int VK_1;
  public final static int VK_2;
  public final static int VK_3;
  public final static int VK_4;
  public final static int VK_5;
  public final static int VK_6;
  public final static int VK_7;
  public final static int VK_8;
  public final static int VK_9;
  public final static int VK_A;
  public final static int VK_ACCEPT;
  public final static int VK_ADD;
```

```
public final static int VK_ALT;
public final static int VK_B;
public final static int VK_BACK_QUOTE;
public final static int VK_BACK_SLASH;
public final static int VK_BACK_SPACE;
public final static int VK_C;
public final static int VK_CANCEL;
public final static int VK_CAPS_LOCK;
public final static int VK_CLEAR;
public final static int VK_CLOSE_BRACKET;
public final static int VK_COMMA;
public final static int VK_CONTROL;
public final static int VK_CONVERT;
public final static int VK_D;
public final static int VK_DECIMAL;
public final static int VK_DELETE;
public final static int VK_DIVIDE;
public final static int VK_DOWN;
public final static int VK_E;
public final static int VK_END;
public final static int VK_ENTER;
public final static int VK_EQUALS;
public final static int VK_ESCAPE;
public final static int VK_F;
public final static int VK_F1;
public final static int VK_F2;
public final static int VK_F3;
public final static int VK_F4;
public final static int VK_F5;
public final static int VK_F6;
public final static int VK_F7;
public final static int VK_F8;
public final static int VK_F9;
public final static int VK_F10;
public final static int VK_F11;
public final static int VK_F12;
public final static int VK_FINAL;
public final static int VK_G;
public final static int VK_H;
public final static int VK_HELP;
public final static int VK_HOME;
public final static int VK_I;
public final static int VK_INSERT;
public final static int VK_J;
public final static int VK_K;
public final static int VK_KANA;
public final static int VK_KANJI;
public final static int VK_L;
public final static int VK_LEFT;
```

```
public final static int VK_M;
public final static int VK_META;
public final static int VK_MODECHANGE;
public final static int VK_MULTIPLY;
public final static int VK_N;
public final static int VK_NONCONVERT;
public final static int VK_NUM_LOCK;
public final static int VK_NUMPAD0;
public final static int VK_NUMPAD1;
public final static int VK_NUMPAD2;
public final static int VK_NUMPAD3;
public final static int VK_NUMPAD4;
public final static int VK_NUMPAD5;
public final static int VK_NUMPAD6;
public final static int VK_NUMPAD7;
public final static int VK_NUMPAD8;
public final static int VK_NUMPAD9;
public final static int VK_O;
public final static int VK_OPEN_BRACKET;
public final static int VK_P;
public final static int VK_PAGE_DOWN;
public final static int VK_PAGE_UP;
public final static int VK_PAUSE;
public final static int VK_PERIOD;
public final static int VK_PRINTSCREEN;
public final static int VK_Q;
public final static int VK_QUOTE;
public final static int VK_R;
public final static int VK_RIGHT;
public final static int VK_S;
public final static int VK_SCROLL_LOCK;
public final static int VK_SEMICOLON;
public final static int VK_SEPARATER;
public final static int VK_SHIFT;
public final static int VK_SLASH;
public final static int VK_SPACE;
public final static int VK_SUBTRACT;
public final static int VK_T;
public final static int VK_TAB;
public final static int VK_U;
public final static int VK_UNDEFINED;
public final static int VK_UP;
public final static int VK_V;
public final static int VK_W;
public final static int VK_X;
public final static int VK_Y;
public final static int VK_Z;

// Constructors
```

```
  public KeyEvent (Component source, int id, long when, int modifiers,
    int keyCode, char keyChar);

  // Class Methods
  public static String getKeyModifiersText(int modifiers);
  public static String getKeyText(int keyCode);

  // Instance Methods
  public char getKeyChar();
  public int getKeyCode();
  public boolean isActionKey();
  public String paramString();
  public void setKeyChar (char keyChar);
  public void setKeyCode (int keyCode);
  public void setModifiers (int modifiers);
}
```

Constants

CHAR_UNDEFINED

`public final static int CHAR_UNDEFINED`

This constant is used for key presses have that no associated character.

KEY_FIRST

`public final static int KEY_FIRST`

Specifies the beginning range of key event ID values.

KEY_LAST

`public final static int KEY_LAST`

Specifies the ending range of key event ID values.

KEY_PRESSED

`public final static int KEY_PRESSED`

An event ID type for a key press.

KEY_RELEASED

`public final static int KEY_RELEASED`

An event ID type for a key release.

KEY_TYPED

```
public final static int KEY_TYPED
```

An event ID type for a typed key (a press and a release).

VK_0

```
public final static int VK_0
```

The 0 key.

VK_1

```
public final static int VK_1
```

The 1 key.

VK_2

```
public final static int VK_2
```

The 2 key.

VK_3

```
public final static int VK_3
```

The 3 key.

VK_4

```
public final static int VK_4
```

The 4 key.

VK_5

```
public final static int VK_5
```

The 5 key.

VK_6

```
public final static int VK_6
```

The 6 key.

VK_7

```
public final static int VK_7
```

The 7 key.

VK_8

`public final static int VK_8`

The 8 key.

VK_9

`public final static int VK_9`

The 9 key.

VK_A

`public final static int VK_A`

The ‘a’ key.

VK_ACCEPT

`public final static int VK_ACCEPT`

This constant is used for Asian keyboards.

VK_ADD

`public final static int VK_ADD`

The plus (+) key on the numeric keypad.

VK_ALT

`public final static int VK_ALT`

The Alt key.

VK_B

`public final static int VK_B`

The ‘b’ key.

VK_BACK_QUOTE

`public final static int VK_BACK_QUOTE`

The backquote (‘) key.

VK_BACK_SLASH

`public final static int VK_BACK_SLASH`

The backslash key.

VK_BACK_SPACE

`public final static int VK_BACK_SPACE`

The Backspace key.

VK_C

`public final static int VK_C`

The ‘c’ key.

VK_CANCEL

`public final static int VK_CANCEL`

The Cancel key.

VK_CAPS_LOCK

`public final static int VK_CAPS_LOCK`

The Caps Lock key.

VK_CLEAR

`public final static int VK_CLEAR`

The Clear key.

VK_CLOSE_BRACKET

`public final static int VK_CLOSE_BRACKET`

The close bracket ‘]’ key.

VK_COMMA

`public final static int VK_COMMA`

The comma (,) key.

VK_CONTROL

`public final static int VK_CONTROL`

The Control key.

VK_CONVERT

`public final static int VK_CONVERT`

This constant is used for Asian keyboards.

VK_D

`public final static int VK_D`

The ‘d’ key.

VK_DECIMAL

`public final static int VK_DECIMAL`

The decimal (.) key on the numeric keypad.

VK_DELETE

`public final static int VK_DELETE`

The Delete key.

VK_DIVIDE

`public final static int VK_DIVIDE`

The divide (/) key on the numeric keypad.

VK_DOWN

`public final static int VK_DOWN`

The Down arrow key.

VK_E

`public final static int VK_E`

The ‘e’ key.

VK_END

`public final static int VK_END`

The End key.

VK_ENTER

`public final static int VK_ENTER`

The Enter key.

VK_EQUALS

`public final static int VK_ EQUALS`

The equals (=) key.

VK_ESCAPE

```
public final static int VK_ESCAPE
```

The Escape key.

VK_F

```
public final static int VK_F
```

The ‘f’ key.

VK_F1

```
public final static int VK_F1
```

The F1 key.

VK_F2

```
public final static int VK_F2
```

The F2 key.

VK_F3

```
public final static int VK_F3
```

The F3 key.

VK_F4

```
public final static int VK_F4
```

The F4 key.

VK_F5

```
public final static int VK_F5
```

The F5 key.

VK_F6

```
public final static int VK_F6
```

The F6 key.

VK_F7

```
public final static int VK_F7
```

The F7 key.

VK_F8

```
public final static int VK_F8
```

The F8 key.

VK_F9

```
public final static int VK_F9
```

The F9 key.

VK_F10

```
public final static int VK_F10
```

The F10 key.

VK_F11

```
public final static int VK_F11
```

The F11 key.

VK_F12

```
public final static int VK_F12
```

The F12 key.

VK_FINAL

```
public final static int VK_FINAL
```

This constant is used for Asian keyboards.

VK_G

```
public final static int VK_G
```

The 'g' key.

VK_H

```
public final static int VK_H
```

The 'h' key.

VK_HELP

```
public final static int VK_HELP
```

The Help key.

VK_HOME

`public final static int VK_HOME`

The Home key.

VK_I

`public final static int VK_I`

The ‘i’ key.

VK_INSERT

`public final static int VK_INSERT`

The Insert key.

VK_J

`public final static int VK_J`

The ‘j’ key.

VK_K

`public final static int VK_K`

The ‘k’ key.

VK_KANA

`public final static int VK_KANA`

This constant is used for Asian keyboards.

VK_KANJI

`public final static int VK_KANJI`

This constant is used for Asian keyboards.

VK_L

`public final static int VK_L`

The ‘l’ key.

VK_LEFT

`public final static int VK_LEFT`

The Left arrow key.

VK_M

`public final static int VK_M`

The ‘m’ key.

VK_MODECHANGE

`public final static int VK_MODECHANGE`

This constant is used for Asian keyboards.

VK_META

`public final static int VK_META`

The Meta key.

VK_MULTIPLY

`public final static int VK_MULTIPLY`

The * key on the numeric keypad.

VK_N

`public final static int VK_N`

The ‘n’ key.

VK_NONCONVERT

`public final static int VK_NONCONVERT`

This constant is used for Asian keyboards.

VK_NUM_LOCK

`public final static int VK_NUM_LOCK`

The Num Lock key.

VK_NUMPAD0

`public final static int VK_NUMPAD0`

The 0 key on the numeric keypad.

VK_NUMPAD1

`public final static int VK_NUMPAD1`

The 1 key on the numeric keypad.

VK_NUMPAD2

```
public final static int VK_NUMPAD2
```

The 2 key on the numeric keypad.

VK_NUMPAD3

```
public final static int VK_NUMPAD3
```

The 3 key on the numeric keypad.

VK_NUMPAD4

```
public final static int VK_NUMPAD4
```

The 4 key on the numeric keypad.

VK_NUMPAD5

```
public final static int VK_NUMPAD5
```

The 5 key on the numeric keypad.

VK_NUMPAD6

```
public final static int VK_NUMPAD6
```

The 6 key on the numeric keypad.

VK_NUMPAD7

```
public final static int VK_NUMPAD7
```

The 7 key on the numeric keypad.

VK_NUMPAD8

```
public final static int VK_NUMPAD8
```

The 8 key on the numeric keypad.

VK_NUMPAD9

```
public final static int VK_NUMPAD9
```

The 9 key on the numeric keypad.

VK_O

```
public final static int VK_O
```

The ‘o’ key.

VK_OPEN_BRACKET

```
public final static int VK_OPEN_BRACKET
```

The open bracket '[' key.

VK_P

```
public final static int VK_P
```

The 'p' key.

VK_PAGE_DOWN

```
public final static int VK_PAGE_DOWN
```

The Page Down key.

VK_PAGE_UP

```
public final static int VK_PAGE_UP
```

The Page Up key.

VK_PAUSE

```
public final static int VK_PAUSE
```

The Pause key.

VK_PERIOD

```
public final static int VK_PERIOD
```

The period (.) key.

VK_PRINTSCREEN

```
public final static int VK_PRINTSCREEN
```

The Print Screen key.

VK_Q

```
public final static int VK_Q
```

The 'q' key.

VK_QUOTE

```
public final static int VK_QUOTE
```

The quotation mark (") key.

VK_R

`public final static int VK_R`

The 'r' key.

VK_RIGHT

`public final static int VK_RIGHT`

The Right arrow key.

VK_S

`public final static int VK_S`

The 's' key.

VK_SCROLL_LOCK

`public final static int VK_SCROLL_LOCK`

The Scroll Lock key.

VK_SEMICOLON

`public final static int VK_SEMICOLON`

The semicolon (;) key.

VK_SEPARATER

`public final static int VK_SEPARATER`

The numeric separator key on the numeric keypad (i.e., the locale-dependent key used to separate groups of digits). A misspelling of VK_SEPARATOR.

VK_SHIFT

`public final static int VK_SHIFT`

The Shift key.

VK_SLASH

`public final static int VK_SLASH`

The slash (/) key.

VK_SPACE

`public final static int VK_SPACE`

The space key.

VK_SUBTRACT

`public final static int VK_SUBTRACT`

The subtract (–) key on the numeric keypad.

VK_T

`public final static int VK_T`

The ‘t’ key.

VK_TAB

`public final static int VK_TAB`

The Tab key.

VK_U

`public final static int VK_U`

The ‘u’ key.

VK_UNDEFINED

`public final static int VK_UNDEFINED`

An undefined key.

VK_UP

`public final static int VK_UP`

The Up arrow key.

VK_V

`public final static int VK_V`

The ‘v’ key.

VK_W

`public final static int VK_W`

The ‘w’ key.

VK_X

`public final static int VK_X`

The 'x' key.

VK_Y

`public final static int VK_Y`

The 'y' key.

VK_Z

`public final static int VK_Z`

The 'z' key.

Constructors

KeyEvent

```
public KeyEvent (Component source, int id, long when, int
modifiers, int keyCode, char keyChar)
```

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
	when	When the event occurred, in milliseconds from the epoch.
	modifiers	What modifier keys were pressed with this key.
	keyCode	The code of the key.
	keyChar	The character for this key.

Description Constructs a `KeyEvent` with the given characteristics.

Class Methods

getKeyModifiersText

`public static String getKeyModifiersText(int modifiers)`

Parameters	*modifiers*	One or more modifier keys.

Returns A string describing the modifiers.

getKeyText

`public static String getKeyText(int keyCode)`

Parameters	*keyCode*	One of the key codes.

Returns A string describing the given key.

Instance Methods

getKeyChar

`public char getKeyChar()`

Returns The character corresponding to this event. KEY_TYPED events have characters.

getKeyCode

`public int getKeyCode()`

Returns The integer key code corresponding to this event. This will be one of the constants defined above. KEY_PRESSED and KEY_RELEASED events have codes. Key codes are virtual keys, not actual. Pressing the 'a' key is identical to 'A', but has different modifiers. Same for '/' and '?' on a standard keyboard.

isActionKey

`public boolean isActionKey()`

Returns `true` if this event is for one of the action keys; `false` otherwise.

Description In general, an action key is a key that causes an action but has no printing equivalent. The action keys are the function keys, the arrow keys, Caps Lock, End, Home, Insert, Num Lock, Pause, Page Down, Page Up, Print Screen, and Scroll Lock. They do not generate a KEY_TYPED event, only KEY_PRESSED and KEY_RELEASED.

paramString

`public String paramString()`

Returns A string with current settings of the `KeyEvent`.

Overrides `ComponentEvent.paramString()`

Description Helper method for `toString()` to generate string of current settings.

setKeyChar

`public void setKeyChar(char keyChar)`

Parameters *keyChar* The new key character.

Description Sets the character code of this `KeyEvent`.

setKeyCode

```
public void setKeyCode (int keyCode)
```

Parameters *keyCode* The new key code.

Description Sets the key code of this `KeyEvent`.

setModifiers

```
public void setModifiers (int modifiers)
```

Parameters *modifiers* The new modifiers.

Description This is a combination of the mask constants defined in `java.awt.event.InputEvent`.

See Also

`Component`, `ComponentEvent`, `InputEvent`, `KeyAdapter`, `KeyListener`

21.19 KeyListener ★

Description

Objects that implement the `KeyListener` interface can receive `KeyEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.KeyListener
   extends java.util.EventListener {

  // Instance Methods
  public abstract void keyPressed (KeyEvent e);
  public abstract void keyReleased (KeyEvent e);
  public abstract void keyTyped (KeyEvent e);
}
```

Interface Methods

keyPressed

`public abstract void keyPressed (KeyEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `KeyListener` that a key was pressed.

keyReleased

`public abstract void keyReleased (KeyEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `KeyListener` that a key was released.

keyTyped

`public abstract void keyTyped (KeyEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `KeyListener` that a key was typed (pressed and released).

See Also

`AWTEventMulticaster`, `EventListener`, `KeyEvent`, `KeyListener`

21.20 MouseAdapter ★

Description

The `MouseAdapter` class implements the methods of `MouseListener` with empty functions. It may be easier for you to extend `MouseAdapter`, overriding only those methods you are interested in, than to implement `MouseListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.MouseAdapter
   extends java.lang.Object
   implements java.awt.event.MouseListener {

  // Instance Methods
  public void mouseClicked (MouseEvent e);
  public void mouseEntered (MouseEvent e);
  public void mouseExited (MouseEvent e);
  public void mousePressed (MouseEvent e);
  public void mouseReleased (MouseEvent e);
}
```

Instance Methods

mouseClicked

```
public void mouseClicked (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the mouse button is clicked (pressed and released).	

mouseEntered

```
public void mouseEntered (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the user moves the mouse cursor into a component.	

mouseExited

```
public void mouseExited (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the moves the mouse cursor out of a component.	

mousePressed

```
public void mousePressed (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the mouse button is pressed.	

mouseReleased

```
public void mouseReleased (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the mouse button is released.	

See Also

`MouseEvent`, `MouseListener`

21.21 MouseEvent ★

Description

Mouse events are generated when the user moves and clicks the mouse.

Class Definition

```
public class java.awt.event.MouseEvent
    extends java.awt.event.InputEvent {

  // Constants
  public final static int MOUSE_CLICKED;
  public final static int MOUSE_DRAGGED;
  public final static int MOUSE_ENTERED;
  public final static int MOUSE_EXITED;
  public final static int MOUSE_FIRST;
  public final static int MOUSE_LAST;
  public final static int MOUSE_MOVED;
  public final static int MOUSE_PRESSED;
  public final static int MOUSE_RELEASED;

  // Constructors
  public MouseEvent (Component source, int id, long when, int modifiers, int x,
    int y, int clickCount, boolean popupTrigger);

  // Instance Methods
  public int getClickCount();
  public synchronized Point getPoint();
  public int getX();
  public int getY();
  public boolean isPopupTrigger();
  public String paramString();
  public synchronized void translatePoint (int x, int y);
}
```

Constants

MOUSE_CLICKED

```
public final static int MOUSE_CLICKED
```

An event type ID indicating a mouse click.

MOUSE_DRAGGED

`public final static int MOUSE_DRAGGED`

An event type ID indicating a mouse move with the button held down.

MOUSE_ENTERED

`public final static int MOUSE_ENTERED`

An event type ID indicating that a mouse entered a component.

MOUSE_EXITED

`public final static int MOUSE_EXITED`

An event type ID indicating that a mouse left a component.

MOUSE_FIRST

`public final static int MOUSE_FIRST`

Specifies the beginning range of mouse event ID values.

MOUSE_LAST

`public final static int MOUSE_LAST`

Specifies the ending range of mouse event ID values.

MOUSE_MOVED

`public final static int MOUSE_MOVED`

An event type ID indicating a mouse move.

MOUSE_PRESSED

`public final static int MOUSE_PRESSED`

An event type ID indicating a mouse button press.

MOUSE_RELEASED

`public final static int MOUSE_RELEASED`

An event type ID indicating a mouse button release.

Constructors

MouseEvent

```
public MouseEvent (Component source, int id, long when,
int modifiers, int x, int y, int clickCount, boolean
popupTrigger)
```

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
	when	When the event occurred, in milliseconds from the epoch.
	modifiers	What modifier keys were pressed with this key.
	x	The horizontal location of the event.
	y	The vertical location of the event.
	clickCount	The number of times the mouse button has been clicked.
	popupTrigger	A flag indicating if this event is a popup trigger event.

Description Constructs a `MouseEvent` with the given characteristics.

Instance Methods

getClickCount

```
public int getClickCount()
```

Returns The number of consecutive mouse button clicks for this event.

getPoint

```
public synchronized Point getPoint()
```

Returns The location where the event happened.

getX

```
public int getX()
```

Returns The horizontal location where the event happened.

getY

```
public int getY()
```

Returns The vertical location where the event happened.

isPopupTrigger

```
public boolean isPopupTrigger()
```

Returns Returns `true` if this event is the popup menu event for the run-time system.

paramString

```
public String paramString()
```

Returns — String with current settings of the `MouseEvent`.

Overrides — `ComponentEvent.paramString()`

Description — Helper method for `toString()` to generate string of current settings.

translatePoint

```
public synchronized void translatePoint (int x, int y)
```

Parameters — *x* — The horizontal amount of translation.

y — The vertical amount of translation.

Description — Translates the location of the event by the given amounts.

See Also

`Component`, `ComponentEvent`, `InputEvent`, `MouseAdapter`, `MouseListener`, `Point`

21.22 MouseListener ★

Description

Objects that implement the `MouseListener` interface can receive non-motion oriented `MouseEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.MouseListener
   extends java.util.EventListener {

  // Instance Methods
  public abstract void mouseClicked (MouseEvent e);
  public abstract void mouseEntered (MouseEvent e);
  public abstract void mouseExited (MouseEvent e);
  public abstract void mousePressed (MouseEvent e);
  public abstract void mouseReleased (MouseEvent e);
}
```

Interface Methods

mouseClicked

`public abstract void mouseClicked (MouseEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `MouseListener` that the mouse button was clicked (pressed and released).

mouseEntered

`public abstract void mouseEntered (MouseEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `MouseListener` that the mouse cursor has been moved into a component's coordinate space.

mouseExited

`public abstract void mouseExited (MouseEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `MouseListener` that the mouse cursor has been moved out of a component's coordinate space.

mousePressed

`public abstract void mousePressed (MouseEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `MouseListener` that the mouse button was pressed.

mouseReleased

`public abstract void mouseReleased (MouseEvent e)`

Parameters *e* The key event that occurred.

Description Notifies the `MouseListener` that the mouse button was released.

See Also

`EventListener`, `MouseAdapter`, `MouseEvent`

21.23 MouseMotionAdapter ★

Description

The `MouseMotionAdapter` class implements the methods of `MouseMotionListener` with empty functions. It may be easier for you to extend `MouseMotionAdapter`, overriding only those methods you are interested in, than to implement `MouseMotionListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.MouseMotionAdapter
   extends java.lang.Object
   implements java.awt.event.MouseMotionListener {

  // Instance Methods
  public void mouseDragged (MouseEvent e);
  public void mouseMoved (MouseEvent e);
}
```

Instance Methods

mouseDragged

```
public void mouseDragged (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the mouse is dragged.	

mouseMoved

```
public void mouseEntered (MouseEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when the mouse moves.	

See Also

`MouseEvent`, `MouseMotionListener`

21.24 MouseMotionListener ★

Description

Objects that implement the `MouseMotionListener` interface can receive motion-oriented `MouseEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.MouseMotionListener
   extends java.util.EventListener {

  // Instance Methods
  public abstract void mouseDragged (MouseEvent e);
  public abstract void mouseMoved (MouseEvent e);
}
```

Interface Methods

mouseDragged

```
public abstract void mouseDragged (MouseEvent e)
```

Parameters	*e*	The key event that occurred.
Description	Notifies the `MouseMotionListener` that the mouse has been dragged.	

mouseMoved

```
public abstract void mouseMoved (MouseEvent e)
```

Parameters	*e*	The key event that occurred.
Description	Notifies the `MouseMotionListener` that the mouse has been moved.	

See Also

`AWTEventMulticaster`, `EventListener`, `MouseEvent`, `MouseMotionAdapter`

21.25 PaintEvent ★

Description

The `PaintEvent` class represents the paint and update operations that the AWT performs on components. There is no `PaintListener` interface, so the only way to catch these events is to override `paint(Graphics)` and `update(Graphics)` in `Component`. This class exists so that paint events will get serialized properly.

Class Definition

```
public class java.awt.event.PaintEvent
   extends java.awt.event.ComponentEvent {

  // Constants
  public final static int PAINT;
  public final static int PAINT_FIRST;
  public final static int PAINT_LAST;
  public final static int UPDATE;

  // Constructor
  public PaintEvent (Component source, int id, Rectangle updateRect);

  // Instance Methods
  public Rectangle getUpdateRect();
  public String paramString();
  public void setUpdateRect (Rectangle updateRect);
}
```


Class Definition

```
public class java.awt.event.PaintEvent
        extends java.awt.event.ComponentEvent {

  // Constants
  public final static int PAINT;
  public final static int PAINT_FIRST;
  public final static int PAINT_LAST;
  public final static int UPDATE;

  //Constructor
  public PaintEvent (Component source, int id, Rectangle updateRect);

  // Instance Methods
  public Rectangle getUpdateRect();
  public String paramString();
  public void setUpdateRect (Rectangle updateRect);
}
```

Constants

PAINT

```
public final static int PAINT
```

The paint event type.

PAINT_FIRST

```
public final static int PAINT_FIRST
```

Specifies the beginning range of paint event ID values.

PAINT_LAST

```
public final static int PAINT_LAST
```

Specifies the ending range of paint event ID values.

UPDATE

```
public final static int UPDATE
```

The update event type.

Constructor

PaintEvent

```
public PaintEvent (Component source, ind id, Rectangle
updateRect)
```

Parameters	*source*	The source of the event.
	id	The event type ID.
	g	The rectangular area to paint.

Description Constructs a `PaintEvent` with the given characteristics.

Instance Methods

getUpdateRect

```
public Rectangle getUpdateRect()
```

Returns The rectangular area that needs painting.

paramString

```
public String paramString()
```

Returns String with current settings of the `PaintEvent`.
Overrides `ComponentEvent.paramString()`

Description Helper method for `toString()` to generate string of current settings.

setUpdateRect

```
public void setUpdateRect (Rectangle updateRect)
```

Parameters *updateRect* The rectangular area to paint.

Description Changes the rectangular area that this `PaintEvent` will paint.

See Also

`Component`, `ComponentEvent`, `Graphics`

21.26 TextEvent ★

Description

Text events are generated by text components when their contents change, either programmatically or by a user typing.

Class Definition

```
public class java.awt.event.TextEvent
    extends java.awt.AWTEvent {

  // Constants
  public final static int TEXT_FIRST;
  public final static int TEXT_LAST;
  public final static int TEXT_VALUE_CHANGED;

  // Constructors
  public TextEvent (Object source, int id);

  // Instance Methods
  public String paramString();
}
```

Constants

TEXT_FIRST

```
public final static int TEXT_FIRST
```

Specifies the beginning range of text event ID values.

TEXT_LAST

`public final static int TEXT_LAST`

Specifies the ending range of text event ID values.

TEXT_VALUE_CHANGED

`public final static int TEXT_VALUE_CHANGED`

The only text event type; it indicates that the contents of something have changed.

Constructors

TextEvent

`public TextEvent (Object source, int id)`

Parameters	*source*	The object that generated the event.
	id	The type ID of the event.
Description	Constructs a `TextEvent` with the given characteristics.	

Instance Methods

paramString

`public String paramString()`

Returns	String with current settings of the `TextEvent`.
Overrides	`AWTEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`AWTEvent`, `TextListener`

21.27 TextListener ★

Description

Objects that implement the `TextListener` interface can receive `TextEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.TextListener
    extends java.util.EventListener {

  // Interface Methods
  public abstract void textValueChanged (TextEvent e);
}
```

Interface Methods

textValueChanged

```
public abstract void textValueChanged (TextEvent e)
```

Parameters	*e*	The text event that occurred.
Description	Notifies the `TextListener` that an event occurred.	

See Also

`AWTEventMulticaster`, `EventListener`, `TextEvent`

21.28 WindowAdapter ★

Description

The `WindowAdapter` class implements the methods of `WindowListener` with empty functions. It may be easier for you to extend `WindowAdapter`, overriding only those methods you are interested in, than to implement `WindowListener` and provide the empty functions yourself.

Class Definition

```
public abstract class java.awt.event.WindowAdapter
    extends java.lang.Object
    implements java.awt.event.WindowListener {

  // Instance Methods
  public void windowActivated (WindowEvent e);
  public void windowClosed (WindowEvent e);
  public void windowClosing (WindowEvent e);
  public void windowDeactivated (WindowEvent e);
  public void windowDeiconified (WindowEvent e);
  public void windowIconified (WindowEvent e);
  public void windowOpened (WindowEvent e);
}
```

Instance Methods

windowActivated

```
public void windowActivated (WindowEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a window is activated.

windowClosed

```
public void windowClosed (WindowEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a window is closed.

windowClosing

```
public void windowClosing (WindowEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a window is in the process of closing.

windowDeactivated

```
public void windowDeactivated (WindowEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when a window is deactivated.

windowDeiconified

```
public void windowDeiconified (WindowEvent e)
```

Parameters *e* The event that has occurred.

Description Does nothing. Override this function to be notified when an iconified window is restored.

windowIconified

```
public void windowIconified (WindowEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a window is iconified (minimized).	

windowOpened

```
public void windowOpened (WindowEvent e)
```

Parameters	*e*	The event that has occurred.
Description	Does nothing. Override this function to be notified when a window is opened.	

See Also

WindowEvent, WindowListener

21.29 WindowEvent ★

Description

Window events are generated when a window is opened, closed, iconified, or deiconified.

Class Definition

```
public class java.awt.event.WindowEvent
   extends java.awt.event.ComponentEvent {

  // Constants
  public final static int WINDOW_ACTIVATED;
  public final static int WINDOW_CLOSED;
  public final static int WINDOW_CLOSING;
  public final static int WINDOW_DEACTIVATED;
  public final static int WINDOW_DEICONIFIED;
  public final static int WINDOW_FIRST;
  public final static int WINDOW_ICONIFIED;
  public final static int WINDOW_LAST;
  public final static int WINDOW_OPENED;

  // Constructors
  public WindowEvent (Window source, int id);

  // Instance Methods
  public Window getWindow();
  public String paramString();
```

```
}
```

Constants

WINDOW_ACTIVATED

`public final static int WINDOW_ACTIVATED`

Event type ID indicating the window has been activated, brought to the foreground.

WINDOW_CLOSED

`public final static int WINDOW_CLOSED`

Event type ID indicating the window has closed.

WINDOW_CLOSING

`public final static int WINDOW_CLOSING`

Event type ID indicating the window is closing.

WINDOW_DEACTIVATED

`public final static int WINDOW_DEACTIVATED`

Event type ID indicating the window has been deactivated, placed in the background.

WINDOW_DEICONIFIED

`public final static int WINDOW_DEICONIFIED`

Event type ID indicating the window has been restored from an iconified state.

WINDOW_FIRST

`public final static int WINDOW_FIRST`

Specifies the beginning range of window event ID values.

WINDOW_ICONIFIED

`public final static int WINDOW_ICONIFIED`

Event type ID indicating the window has been iconified (minimized).

WINDOW_LAST

`public final static int WINDOW_LAST`

Specifies the ending range of window event ID values.

WINDOW_OPENED

`public final static int WINDOW_OPENED`

Event type ID indicating the window has opened.

Constructors

WindowEvent

`public WindowEvent (Window source, int id)`

Parameters	*source*	The object that generated the event.
	id	The event type ID of the event.
Description	Constructs a `WindowEvent` with the given characteristics.	

Instance Methods

getWindow

`public Window getWindow()`

Returns	The window that generated this event.

paramString

`public String paramString()`

Returns	String with current settings of the `WindowEvent`.
Overrides	`ComponentEvent.paramString()`
Description	Helper method for `toString()` to generate string of current settings.

See Also

`ComponentEvent`, `Window`, `WindowAdapter`, `WindowListener`

21.30 WindowListener ★

Description

Objects that implement the `WindowListener` interface can receive `WindowEvent` objects. Listeners must first register themselves with objects that produce events. When events occur, they are then automatically propagated to all registered listeners.

Interface Definition

```
public abstract interface java.awt.event.WindowListener
    extends java.util.EventListener {

   // Instance Methods
```

```
  public abstract void windowActivated (WindowEvent e);
  public abstract void windowClosed (WindowEvent e);
  public abstract void windowClosing (WindowEvent e);
  public abstract void windowDeactivated (WindowEvent e);
  public abstract void windowDeiconified (WindowEvent e);
  public abstract void windowIconified (WindowEvent e);
  public abstract void windowOpened (WindowEvent e);
}
```

Interface Methods

windowActivated

`public abstract void windowActivated (WindowEvent e)`

Parameters	*e*	The event that occurred.
Description	Notifies the `WindowListener` that a window has been activated.	

windowClosed

`public abstract void windowClosed (WindowEvent e)`

Parameters	*e*	The event that occurred.
Description	Notifies the `WindowListener` that a window has closed.	

windowClosing

`public abstract void windowClosing (WindowEvent e)`

Parameters	*e*	The event that occurred.
Description	Notifies the `WindowListener` that a window is closing.	

windowDeactivated

`public abstract void windowDeactivated (WindowEvent e)`

Parameters	*e*	The event that occurred.
Description	Notifies the `WindowListener` that a window has been deactivated.	

windowDeiconified

`public abstract void windowDeiconified (WindowEvent e)`

Parameters	*e*	The event that occurred.

Description Notifies the `WindowListener` that a window has been restored from an iconified state.

windowIconified

`public abstract void windowIconified (WindowEvent e)`

Parameters *e* The event that occurred.

Description Notifies the `WindowListener` that a window has iconified (minimized).

windowOpened

`public abstract void windowOpened (WindowEvent e)`

Parameters *e* The event that occurred.

Description Notifies the `WindowListener` that a window has opened.

See Also

`AWTEventMulticaster`, `EventListener`, `Window`, `WindowAdapter`, `WindowEvent`

22

java.awt.image Reference

22.1 AreaAveragingScaleFilter ★

Description

The `AreaAveragingScaleFilter` class scales an image using a simple smoothing algorithm.

Class Definition

```
public class java.awt.image.AreaAveragingScaleFilter
    extends java.awt.image.ReplicateScaleFilter {

  // Constructor
  public AreaAveragingScaleFilter (int width, int height);

  // Instance Methods
  public void setHints (int hints);
  public void setPixels (int x, int y, int w, int h, ColorModel model,
    byte[] pixels, int off, int scansize);

  public void setPixels (int x, int y, int w, int h, ColorModel model,
    int[] pixels, int off, int scansize);
}
```

Constructor

AreaAveragingScaleFilter

`public AreaAveragingScaleFilter (int width, int height)`

Parameters	*width*	Width of scaled image.
	height	Height of scaled image.
Description	Constructs an `AverageScaleFilter` that scales the original image to the specified size.	

Instance Methods

setHints

`public void setHints (int hints)`

Parameters	*hints*	Flags indicating how data will be delivered.
Overrides	`ImageFilter.setHints(int)`	
Description	Gives this filter hints about how data will be delivered.	

setPixels

```
public void setPixels (int x, int y, int w, int h,
ColorModel model, byte[] pixels, int off, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	w	Width of the rectangle of pixel data delivered with this method call.
	h	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	off	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ReplicateScaleFilter.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	
Description	Receives a rectangle of image data from the `ImageProducer`; scales these pixels and delivers them to any `ImageConsumers`.	

```
public void setPixels (int x, int y, int w, int h,
ColorModel model, int[] pixels, int off, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	w	Width of the rectangle of pixel data delivered with this method call.
	h	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	off	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.

Overrides `ReplicateScaleFilter.setPixels(int, int, int, int, ColorModel, int[], int, int)`

Description Receives a rectangle of image data from the `ImageProducer`; scales these pixels and delivers them to any `ImageConsumers`.

See Also

ColorModel, ReplicateScaleFilter

22.2 ColorModel

Description

The abstract `ColorModel` class defines the way a Java program represents colors. It provides methods for extracting different color components from a pixel.

Class Definition

```
public class java.awt.image.ColorModel
    extends java.lang.Object {

  // Variables
  protected int pixel_bits;

  // Constructors
  public ColorModel (int bits);

  // Class Methods
  public static ColorModel getRGBdefault();

  // Instance Methods
  public void finalize(); ★
  public abstract int getAlpha (int pixel);
  public abstract int getBlue (int pixel);
```

```
    public abstract int getGreen (int pixel);
    public int getPixelSize();
    public abstract int getRed (int pixel);
    public int getRGB (int pixel);
  }
```

ProtectedVariables

pixel_bits

`protected int pixel_bits`

The `pixel_bits` variable saves the ColorModel's `bits` setting (the total number of bits per pixel).

Constructors

ColorModel

`public ColorModel (int bits)`

Parameters	*bits*	The number of bits required per pixel using this model.
Description	Constructs a `ColorModel` object.	

Class Methods

getRGBdefault

`public static ColorModel getRGBdefault()`

Returns	The default `ColorModel` format, which uses 8 bits for each of a pixel's color components: alpha (transparency), red, green, and blue.

Instance Methods

finalize

`public void finalize()` ★

Overrides	`Object.finalize()`
Description	Cleans up when this object is garbage collected.

getAlpha

`public abstract int getAlpha (int pixel)`

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current alpha setting of the pixel.	

getBlue

`public abstract int getBlue (int pixel)`

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current blue setting of the pixel.

getGreen

`public abstract int getGreen (int pixel)`

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current green setting of the pixel.

getPixelSize

`public int getPixelSize()`

Returns The current pixel size for the color model.

getRed

`public abstract int getRed (int pixel)`

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current red setting of the pixel.

getRGB

`public int getRGB (int pixel)`

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current combined red, green, and blue settings of the pixel.
Description Gets the color of `pixel` in the default RGB color model.

See Also

`DirectColorModel`, `IndexColorModel`, `Object`

22.3 CropImageFilter

Description

The `CropImageFilter` class creates a smaller image by cropping (i.e., extracting a rectangular region from) a larger image.

Class Definition

```
public class java.awt.image.CropImageFilter
    extends java.awt.image.ImageFilter {

  // Constructors
  public CropImageFilter (int x, int y, int width, int height);

  // Instance Methods
  public void setDimensions (int width, int height);
  public void setPixels (int x, int y, int width, int height, ColorModel model,
    byte[] pixels, int offset, int scansize);
  public void setPixels (int x, int y, int width, int height, ColorModel model,
    int[] pixels, int offset, int scansize);
  public void setProperties (Hashtable properties);
}
```

Constructors

CropImageFilter

```
public CropImageFilter (int x, int y, int width, int
height)
```

Parameters	*x*	x-coordinate of top-left corner of piece to crop.
	y	y-coordinate of top-left corner of piece to crop.
	width	Width of image to crop.
	height	Height of image to crop.
Description	Constructs a `CropImageFilter` that crops the specified region from the original image.	

Instance Methods

setDimensions

```
public void setDimensions (int width, int height)
```

Parameters	*width*	Ignored parameter.
	height	Ignored parameter.
Overrides	`ImageFilter.setDimensions(int, int)`	
Description	Called with the original image's dimensions; these dimensions are ignored. The method in turn calls the `ImageConsumer` with the dimensions of the cropped image.	

setPixels

`public void setPixels (int x, int y, int width, int height, ColorModel model, byte[] pixels, int offset, int scansize)`

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	
Description	Receives a rectangle of image data from the `ImageProducer`; crops these pixels and delivers them to any `ImageConsumers`.	

`public void setPixels (int x, int y, int width, int height, ColorModel model, int[] pixels, int offset, int scansize)`

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, int[], int, int)`	
Description	Receives a rectangle of image data from the `ImageProducer`; crops these pixels and delivers them to any `ImageConsumers`.	

setProperties

```
public void setProperties (Hashtable properties)
```

Parameters	*properties*	The properties for the image.
Overrides	`ImageFilter.setProperties(Hashtable)`	
Description	Adds the "croprect" image property to the properties list.	

See Also

`ColorModel`, `Hashtable`, `ImageFilter`

22.4 DirectColorModel

Description

The `DirectColorModel` class provides a `ColorModel` that specifies a translation between pixels and alpha, red, green, and blue component values, where the color values are embedded directly within the pixel.

Class Definition

```
public class java.awt.image.DirectColorModel
    extends java.awt.image.ColorModel {

  // Constructors
  public DirectColorModel (int bits, int redMask, int greenMask,
    int blueMask);
  public DirectColorModel (int bits, int redMask, int greenMask,
    int blueMask,
    int alphaMask);

  // Instance Methods
  public final int getAlpha (int pixel);
  public final int getAlphaMask();
  public final int getBlue (int pixel);
  public final int getBlueMask();
  public final int getGreen (int pixel);
  public final int getGreenMask()
  public final int getRed (int pixel);
  public final int getRedMask();
  public final int getRGB (int pixel);
}
```

Constructors

DirectColorModel

`public DirectColorModel (int bits, int redMask, int greenMask, int blueMask)`

Parameters	*bits*	The number of bits required per pixel of an image using this model.
	redMask	The location of the red component of a pixel.
	greenMask	The location of the green component of a pixel.
	blueMask	The location of the blue component of a pixel.
Throws	`IllegalArgumentException`	If the mask bits are not contiguous or overlap.
Description	Constructs a `DirectColorModel` object with the given size and color masks; the alpha (transparency) component is not used.	

`public DirectColorModel (int bits, int redMask, int greenMask, int blueMask, int alphaMask)`

Parameters	*bits*	The number of bits required per pixel of an image using this model.
	redMask	The location of the red component of a pixel.
	greenMask	The location of the green component of a pixel.
	blueMask	The location of the blue component of a pixel.
	alphaMask	The location of the alpha component of a pixel.
Throws	`IllegalArgumentException`	If the mask bits are not contiguous or overlap.
Description	Constructs a `DirectColorModel` object with the given size and color masks.	

Instance Methods

getAlpha

`public final int getAlpha (int pixel)`

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current alpha setting of the pixel.	
Overrides	`ColorModel.getAlpha(int)`	

getAlphaMask

```
public final int getAlphaMask()
```

Returns The current alpha mask setting of the color model.

getBlue

```
public final int getBlue (int pixel)
```

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current blue setting of the pixel.
Overrides `ColorModel.getBlue(int)`

getBlueMask

```
public final int getBlueMask()
```

Returns The current blue mask setting of the color model.

getGreen

```
public final int getGreen (int pixel)
```

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current green setting of the pixel.
Overrides `ColorModel.getGreen(int)`

getGreenMask

```
public final int getGreenMask()
```

Returns The current green mask setting of the color model.

getRed

```
public final int getRed (int pixel)
```

Parameters *pixel* A pixel encoded with this `ColorModel`.
Returns The current red setting of the pixel.
Overrides `ColorModel.getRed(int)`

getRedMask

```
public final int getRedMask()
```

Returns The current red mask setting of the color model.

getRGB

```
public final int getRGB (int pixel)
```

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current combined red, green, and blue settings of the pixel.	
Overrides	`ColorModel.getRGB(int)`	
Description	Gets the color of `pixel` in the default RGB color model.	

See Also

`ColorModel`

22.5 FilteredImageSource

Description

The `FilteredImageSource` class acts as glue to put an original `ImageProducer` and `ImageFilter` together to create a new image. As the `ImageProducer` for the new image, `FilteredImageSource` is responsible for registering image consumers for the new image.

Class Definition

```
public class java.awt.image.FilteredImageSource
    extends java.lang.Object
    implements java.awt.image.ImageProducer {

  // Constructors
  public FilteredImageSource (ImageProducer original,
      ImageFilter filter);

  // Instance Methods
  public synchronized void addConsumer (ImageConsumer ic);
  public synchronized boolean isConsumer (ImageConsumer ic);
  public synchronized void removeConsumer (ImageConsumer ic);
  public void requestTopDownLeftRightResend (ImageConsumer ic);
  public void startProduction (ImageConsumer ic);
}
```

Constructors

`FilteredImageSource`

```
public FilteredImageSource (ImageProducer original,
ImageFilter filter)
```

Parameters	*original*	An `ImageProducer` that generates the image to be filtered.
	filter	The `ImageFilter` to use to process image data delivered by `original`.
Description	Constructs a `FilteredImageSource` object to filter an image generated by an `ImageProducer`.	

Class Methods

addConsumer

```
public synchronized void addConsumer (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` interested in receiving the new image.
Implements	`ImageProducer.addConsumer(ImageConsumer)`	
Description	Registers an `ImageConsumer` as interested in `Image` information.	

isConsumer

```
public synchronized boolean isConsumer (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` to check.
Returns	`true` if `ImageConsumer` is registered with this `ImageProducer`, `false` otherwise.	
Implements	`ImageProducer.isConsumer(ImageConsumer)`	

removeConsumer

```
public synchronized void removeConsumer (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` to remove.
Implements	`ImageProducer.removeConsumer(ImageConsumer)`	
Description	Removes an `ImageConsumer` from the registered consumers for this `ImageProducer`.	

requestTopDownLeftRightResend

```
public void requestTopDownLeftRightResend (ImageConsumer
ic)
```

Parameters	*ic*	`ImageConsumer` to communicate with.
Implements	`ImageProducer.requestTopDownLeftRightResend()`	
Description	Requests the retransmission of the `Image` data in top-down, left-to-right order.	

startProduction

```
public void startProduction (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` to communicate with.
Implements	`ImageProducer.startProduction(ImageConsumer)`	
Description	Registers `ImageConsumer` as interested in `Image` information and tells `ImageProducer` to start creating the filtered `Image` data immediately.	

See Also

`ImageFilter`, `ImageConsumer`, `ImageProducer`, `Object`

22.6 ImageConsumer

Description

`ImageConsumer` is an interface that provides the means to consume pixel data and render it for display.

Interface Definition

```
public abstract interface java.awt.image.ImageConsumer {

  // Constants
  public final static int COMPLETESCANLINES;
  public final static int IMAGEABORTED;
  public final static int IMAGEERROR;
  public final static int RANDOMPIXELORDER;
  public final static int SINGLEFRAME;
  public final static int SINGLEFRAMEDONE;
  public final static int SINGLEPASS;
  public final static int STATICIMAGEDONE;
  public final static int TOPDOWNLEFTRIGHT;

  // Interface Methods
  public abstract void imageComplete (int status);
  public abstract void setColorModel (ColorModel model);
  public abstract void setDimensions (int width, int height);
  public abstract void setHints (int hints);
  public abstract void setPixels (int x, int y, int width, int height,
      ColorModel model, byte[] pixels, int offset, int scansize);
  public abstract void setPixels (int x, int y, int width, int height,
      ColorModel model, int[] pixels, int offset, int scansize);
  public abstract void setProperties (Hashtable properties);
}
```

Constants

COMPLETESCANLINES

```
public final static int COMPLETESCANLINES
```

Hint flag for the `setHints(int)` method; indicates that the image will be delivered one or more scanlines at a time.

IMAGEABORTED

```
public final static int IMAGEABORTED
```

Status flag for the `imageComplete(int)` method indicating that the loading process for the image aborted.

IMAGEERROR

```
public final static int IMAGEERROR
```

Status flag for the `imageComplete(int)` method indicating that an error happened during image loading.

RANDOMPIXELORDER

```
public final static int RANDOMPIXELORDER
```

Hint flag for the `setHints(int)` method; indicates that the pixels will be delivered in no particular order.

SINGLEFRAME

```
public final static int SINGLEFRAME
```

Hint flag for the `setHints(int)` method; indicates that the image consists of a single frame.

SINGLEFRAMEDONE

```
public final static int SINGLEFRAMEDONE
```

Status flag for the `imageComplete(int)` method indicating a single frame of the image has loaded.

SINGLEPASS

```
public final static int SINGLEPASS
```

Hint flag for the `setHints(int)` method; indicates that each pixel will be delivered once (i.e., the producer will not make multiple passes over the image).

STATICIMAGEDONE

```
public final static int STATICIMAGEDONE
```

Status flag for the `imageComplete(int)` method indicating that the image has fully and successfully loaded, and that there are no additional frames.

TOPDOWNLEFTRIGHT

```
public final static int TOPDOWNLEFTRIGHT
```

Hint flag for the `setHints(int)` method; indicates that pixels will be delivered in a top to bottom, left to right order.

Interface Methods

imageComplete

```
public abstract void imageComplete (int status)
```

Parameters	*status*	Image loading status flags.
Description	Called when the image, or a frame of an image sequence, is complete to report the completion status.	

setColorModel

```
public abstract void setColorModel (ColorModel model)
```

Parameters	*model*	The color model for the image.
Description	Tells the `ImageConsumer` the color model used for most of the pixels in the image.	

setDimensions

```
public abstract void setDimensions (int width, int height)
```

Parameters	*width*	Width for image.
	height	Height for image.
Description	Tells the consumer the image's dimensions.	

setHints

```
public abstract void setHints (int hints)
```

Parameters	*hints*	Image consumption hints.
Description	Gives the consumer information about how pixels will be delivered.	

setPixels

```
public abstract void setPixels (int x, int y, int width,
int height, ColorModel model, byte[] pixels, int offset,
int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Description	Delivers a rectangular block of pixels to the image consumer.	

```
public abstract void setPixels (int x, int y, int width,
int height, ColorModel model, int[] pixels, int offset,
int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Description	Delivers a rectangular block of pixels to the image consumer.	

setProperties

```
public abstract void setProperties (Hashtable properties)
```

Parameters	*properties*	The properties for the image.

Description Delivers a Hashtable that contains the image's properties.

See Also

`ColorModel`, `Hashtable`, `ImageFilter`, `PixelGrabber`, `Object`

22.7 ImageFilter

Description

The `ImageFilter` class sits between the `ImageProducer` and `ImageConsumer` as an image is being created to provide a filtered version of that image. Image filters are always used in conjunction with a `FilteredImageSource`. As an implementer of the `ImageConsumer` interface, an image filter receives pixel data from the original image's source and delivers it to another image consumer. The `ImageFilter` class implements a null filter (i.e., the new image is the same as the original); to produce a filter that modifies an image, create a subclass of `ImageFilter`.

Class Definition

```
public class java.awt.image.ImageFilter
    extends java.lang.Object
    implements java.awt.image.ImageConsumer, java.lang.Cloneable {

  // Variables
  protected ImageConsumer consumer;

  // Constructors
  public ImageFilter();

  // Instance Methods
  public Object clone();
  public ImageFilter getFilterInstance (ImageConsumer ic);
  public void imageComplete (int status);
  public void resendTopDownLeftRight (ImageProducer ip);
  public void setColorModel (ColorModel model);
  public void setDimensions (int width, int height);
  public void setHints (int hints);
  public void setPixels (int x, int y, int width, int height,
      ColorModel model, byte[] pixels, int offset, int scansize);
  public void setPixels (int x, int y, int width, int height,
      ColorModel model, int[] pixels, int offset, int scansize);
  public void setProperties (Hashtable properties);
}
```

Protected Variables

consumer

`protected ImageConsumer consumer`

The consumer variable is a reference to the actual `ImageConsumer` for the `Image`.

Constructors

ImageFilter

`public ImageFilter()`

Description	Constructs an empty `ImageFilter` instance.

Instance Methods

clone

`public Object clone()`

Overrides	`Object.clone()`
Returns	A copy of the `ImageFilter` instance.

getFilterInstance

`public ImageFilter getFilterInstance (ImageConsumer ic)`

Parameters	*ic*	The consumer in question.
Returns	A copy of the `ImageFilter` instance.	
Description	Returns the filter that will do the filtering for `ic`.	

imageComplete

`void imageComplete (int status)`

Parameters	*status*	Image loading completion status flags.
Implements	`ImageConsumer.imageComplete(int)`	
Description	Called by the `ImageProducer` to indicate an image's completion status. `ImageFilter` passes these flags to the consumer unchanged.	

resendTopDownLeftRight

`public void resendTopDownLeftRight (ImageProducer ip)`

Parameters	*ip*	The `ImageProducer` generating the original image.
Description	Called by the `ImageConsumer` to ask the filter to resend the image data in the top-down, left-to-right order. In `ImageFilter`, this method calls the same method in the `ImageProducer`, thus relaying the request.	

setColorModel

`void setColorModel (ColorModel model)`

Parameters	*model*	The color model for the image.
Implements	`ImageConsumer.setColorModel(ColorModel)`	
Description	Sets the image's color model.	

setDimensions

`void setDimensions (int width, int height)`

Parameters	*width*	Width for image.
	height	Height for image.
Implements	`ImageConsumer.setDimensions(int, int)`	
Description	Sets the image's dimensions.	

setHints

`void setHints (int hints)`

Parameters	*hints*	Image consumption hints.
Implements	`ImageConsumer.setHints(int)`	
Description	Called by the `ImageProducer` to deliver hints about how the image data will be delivered. `ImageFilter` passes these hints on to the `ImageConsumer`.	

setPixels

```
void setPixels (int x, int y, int width, int height,
ColorModel model, byte[] pixels, int offset, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Implements	`ImageConsumer.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	

Description	Delivers a rectangular block of pixels to the `ImageFilter`. `ImageFilter` passes these pixels on to the consumer unchanged.	

```
void setPixels (int x, int y, int width, int height,
ColorModel model, int[] pixels, int offset, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Implements	`ImageConsumer.setPixels(int, int, int, int, ColorModel, int[], int, int)`	
Description	Delivers a rectangular block of pixels to the `ImageFilter`. `ImageFilter` passes these pixels on to the consumer unchanged.	

`setProperties`

```
void setProperties (Hashtable properties)
```

Parameters	*properties*	The properties for the image.
Implements	`ImageConsumer.setProperties(Hashtable)`	
Description	Initializes the image's properties. `ImageFilter` adds the property "filter" to the `Hashtable`, and passes the result on to the image consumer; the value of the property is the string returned by the filter's `toString()` method. If the property "filter" is already in the `Hashtable`, `ImageFilter` adds the string returned by its `toString()` method to the value already associated with that property.	

See Also

`Cloneable`, `ColorModel`, `CropImageFilter`, `Hashtable`, `ImageConsumer`, `ImageProducer`, `Object`, `ReplicateImageFilter`, `RGBImageFilter`

22.8 ImageObserver

Description

`ImageObserver` is an interface that provides constants and the callback mechanism to receive asynchronous information about the status of an image as it loads.

Interface Definition

```
public abstract interface java.awt.image.ImageObserver {

   // Constants
   public static final int ABORT;
   public static final int ALLBITS;
   public static final int ERROR;
   public static final int FRAMEBITS;
   public static final int HEIGHT;
   public static final int PROPERTIES;
   public static final int SOMEBITS;
   public static final int WIDTH;

   // Interface Methods
   public abstract boolean imageUpdate (Image image, int infoflags,
      int x, int y, int width, int height);
}
```

Constants

ABORT

```
public static final int ABORT
```

The `ABORT` flag indicates that the image aborted during loading. An attempt to reload the image may succeed, unless `ERROR` is also set.

ALLBITS

```
public static final int ALLBITS
```

The `ALLBITS` flag indicates that the image has completely loaded successfully. The `x`, `y`, `width`, and `height` arguments to `imageUpdate()` should be ignored.

ERROR

```
public static final int ERROR
```

The `ERROR` flag indicates that an error happened during the image loading process. An attempt to reload the image will fail.

FRAMEBITS

`public static final int FRAMEBITS`

The `FRAMEBITS` flag indicates that a complete frame of a multi-frame image has loaded. The `x`, `y`, `width`, and `height` arguments to `imageUpdate()` should be ignored.

HEIGHT

`public static final int HEIGHT`

The `HEIGHT` flag indicates that the height information is available for an image; the image's height is in the `height` argument to `imageUpdate()`.

PROPERTIES

`public static final int PROPERTIES`

The `PROPERTIES` flag indicates that the properties information is available for an image.

SOMEBITS

`public static final int SOMEBITS`

The `SOMEBITS` flag indicates that the image has started loading and some pixels are available. The bounding rectangle for the pixels that have been delivered so far is indicated by the `x`, `y`, `width`, and `height` arguments to `imageUpdate()`.

WIDTH

`public static final int WIDTH`

The `WIDTH` flag indicates that the width information is available for an image; the image's width is in the `width` argument to `imageUpdate()`.

Interface Methods

imageUpdate

```
public abstract boolean imageUpdate (Image image, int
infoflags, int x, int y, int width, int height)
```

Parameters	*image*	Image that is being loaded.
	infoflags	The `ImageObserver` flags for the information that is currently available.
	x	Meaning depends on `infoflags` that are set.
	y	Meaning depends on `infoflags` that are set.

	width	Meaning depends on `infoflags` that are set.
	height	Meaning depends on `infoflags` that are set.
Returns	`true` if image has completed loading (successfully or unsuccessfully), `false` if additional information needs to be loaded.	
Description	Provides the callback mechanism for the asynchronous loading of images.	

See Also

`Component`, `Image`, `Object`

22.9 ImageProducer

Description

`ImageProducer` is an interface that provides the methods necessary for the production of images and the communication with classes that implement the `ImageConsumer` interface.

Interface Definition

```
public abstract interface java.awt.image.ImageProducer {

  // Interface Methods
  public abstract void addConsumer (ImageConsumer ic);
  public abstract boolean isConsumer (ImageConsumer ic);
  public abstract void removeConsumer (ImageConsumer ic);
  public abstract void requestTopDownLeftRightResend (ImageConsumer ic);
  public abstract void startProduction (ImageConsumer ic);
}
```

Interface Methods

`addConsumer`

```
public abstract void addConsumer (ImageConsumer ic)
```

Parameters	*ic*	An `ImageConsumer` that wants to receive image data.
Description	Registers an `ImageConsumer` as interested in image information.	

`isConsumer`

`public abstract boolean isConsumer (ImageConsumer ic)`

Parameters	*ic*	`ImageConsumer` to check.
Returns	`true` if `ImageConsumer` has registered with the `ImageProducer`, `false` otherwise.	

`removeConsumer`

`public abstract void removeConsumer (ImageConsumer ic)`

Parameters	*ic*	`ImageConsumer` to remove.
Description	Removes an `ImageConsumer` from registered consumers for this `ImageProducer`.	

`requestTopDownLeftRightResend`

`public abstract void requestTopDownLeftRightResend (ImageConsumer ic)`

Parameters	*ic*	`ImageConsumer` to communicate with.
Description	Requests the retransmission of the image data in top-down, left-to-right order.	

`startProduction`

`public abstract void startProduction (ImageConsumer ic)`

Parameters	*ic*	ImageConsumer to communicate with.
Description	Registers `ImageConsumer` as interested in image information and tells `ImageProducer` to start sending the image data immediately.	

See Also

`FilteredImageSource`, `Image`, `ImageConsumer`, `ImageFilter`, `MemoryImageSource`, `Object`

22.10 IndexColorModel

Description

The `IndexColorModel` class is a `ColorModel` that uses a color map lookup table (with a maximum size of 256) to convert pixel values into their alpha, red, green, and blue component parts.

Class Definition

```
public class java.awt.image.IndexColorModel
    extends java.awt.image.ColorModel {

  // Constructors
  public IndexColorModel (int bits, int size,
      byte[] colorMap, int start, boolean hasalpha);
  public IndexColorModel (int bits, int size,
      byte[] colorMap, int start, boolean hasalpha, int transparent);
  public IndexColorModel (int bits, int size,
      byte[] red, byte[] green, byte[] blue);
  public IndexColorModel (int bits, int size,
      byte[] red, byte[] green, byte[] blue, byte[] alpha);
  public IndexColorModel (int bits, int size,
      byte[] red, byte[] green, byte[] blue, int transparent);

  // Instance Methods
  public final int getAlpha (int pixel);
  public final void getAlphas (byte[] alphas);
  public final int getBlue (int pixel);
  public final void getBlues (byte[] blues);
  public final int getGreen (int pixel);
  public final void getGreens (byte[] greens);
  public final int getMapSize();
  public final int getRed (int pixel);
  public final void getReds (byte[] reds);
  public final int getRGB (int pixel);
  public final int getTransparentPixel();
}
```

Constructors

IndexColorModel

```
public IndexColorModel (int bits, int size, byte[]
colorMap, int start, boolean hasalpha)
```

Parameters	*bits*	The number of bits in a pixel.
	size	The number of entries in the color map. Note: this is not the size of the `colorMap` parameter.
	colorMap	Color component values in red, green, blue, alpha order; the alpha component is optional, and may not be present.
	start	The starting position in `colorMap` array.
	hasalpha	If `hasalpha` is `true`, alpha components are present in `colorMap` array.

Throws ArrayIndexOutOfBoundsException

If `size` is invalid.

Description Constructs an `IndexColorModel` object with the given component settings. The size of `colorMap` must be at least `3*size+start`, if `hasalpha` is `false`; if `hasalpha` is `true`, `colorMap.length` must be at least `4*size+start`.

```
public IndexColorModel (int bits, int size, byte[]
colorMap, int start, boolean hasalpha, int transparent)
```

Parameters
- *bits* The number of bits in a pixel.
- *size* The number of entries in the color map. Note: this is not the size of the `colorMap` parameter.
- *colorMap* Color component values in red, green, blue, alpha order; the alpha component is optional, and may not be present.
- *start* The starting position in `colorMap` array.
- *hasalpha* If `hasalpha` is `true`, alpha components are present in `colorMap` array.
- *transparent* Position of `colorMap` entry for transparent pixel entry.

Throws ArrayIndexOutOfBoundsException

If `size` invalid.

Description Constructs an `IndexColorModel` object with the given component settings. The size of `colorMap` must be at least `3*size+start`, if `hasalpha` is `false`; if `hasalpha` is `true`, `colorMap.length` must be at least `4*size+start`. The color map has a transparent pixel; its location is given by `transparent`.

```
public IndexColorModel (int bits, int size, byte[] red,
byte[] green, byte[] blue)
```

Parameters
- *bits* The number of bits in a pixel.
- *size* The number of entries in the color map.
- *red* Red color component values.
- *green* Green color component values.
- *blue* Blue color component values.

Throws ArrayIndexOutOfBoundsException

If `size` invalid.

Description Constructs an `IndexColorModel` object with the given component settings. There is no alpha component. The length of the `red`, `green`, and `blue` arrays must be greater than `size`.

```
public IndexColorModel (int bits, int size, byte[] red,
byte[] green, byte[] blue, byte[] alpha)
```

Parameters	*bits*	The number of bits in a pixel.
	size	The number of entries in the color map.
	red	Red color component values.
	green	Green color component values.
	blue	Blue color component values.
	alpha	Alpha component values.
Throws	`ArrayIndexOutOfBoundsException`	
		If `size` is invalid.
	`NullPointerException`	
		If `size` is positive and `alpha` array is `null`.
Description	Constructs an `IndexColorModel` object with the given component settings. The length of the `red`, `green`, `blue`, and `alpha` arrays must be greater than `size`.	

```
public IndexColorModel (int bits, int size, byte[] red,
byte[] green, byte[] blue, int transparent)
```

Parameters	*bits*	The number of bits in a pixel.
	size	The number of entries in the color map.
	red	Red color component values.
	green	Green color component values.
	blue	Blue color component values.
	transparent	Position of transparent pixel entry.
Throws	`ArrayIndexOutOfBoundsException`	
		If `size` is invalid.
Description	Constructs an `IndexColorModel` object with the given component settings. The length of the `red`, `green`, `blue`, and `alpha` arrays must be greater than `size`. The color map has a transparent pixel; its location is given by `transparent`.	

Instance Methods

getAlpha

```
public final int getAlpha (int pixel)
```

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current alpha setting of the pixel.	
Overrides	`ColorModel.getAlpha(int)`	

getAlphas

```
public final void getAlphas (byte[] alphas)
```

Parameters	*alphas*	The alpha values of the pixels in the color model.
Description	Copies the alpha values from the color map into the array `alphas[]`.	

getBlue

```
public final int getBlue (int pixel)
```

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current blue setting of the pixel.	
Overrides	`ColorModel.getBlue(int)`	

getBlues

```
public final void getBlues (byte[] blues)
```

Parameters	*blues*	The blue values of the pixels in the color model.
Description	Copies the blue values from the color map into the array `blues[]`.	

getGreen

```
public final int getGreen (int pixel)
```

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current green setting of the pixel.	
Overrides	`ColorModel.getGreen(int)`	

getGreens

```
public final void getGreens (byte[] greens)
```

Parameters	*greens*	The green values of the pixels in the color model.
Description	Copies the green values from the color map into the array `greens[]`.	

getMapSize

```
public final int getMapSize()
```

Returns	The current size of the color map table.

getRed

`public final int getRed (int pixel)`

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current red setting of the pixel.	
Overrides	`ColorModel.getRed(int)`	

getReds

`public final void getReds (byte[] reds)`

Parameters	*reds*	The red values of the pixels in the color model.
Description	Copies the red values from the color map into the array `reds[]`.	

getRGB

`public final int getRGB (int pixel)`

Parameters	*pixel*	A pixel encoded with this `ColorModel`.
Returns	The current combined red, green, and blue settings of the pixel.	
Overrides	`ColorModel.getRGB(int)`	
Description	Gets the color of `pixel` in the default RGB color model.	

getTransparentPixel

`public final int getTransparentPixel()`

Returns	The array index for the transparent pixel in the color model.

See Also

`ColorModel`

22.11 MemoryImageSource

Description

The `MemoryImageSource` class allows you to create images completely in memory. You provide an array of data; it serves as an image producer for that data. In the 1.1 release, new methods support using this class for animation (notably `setAnimated()` and the various overrides of `newPixels()`).

Class Definition

```
public class java.awt.image.MemoryImageSource
    extends java.lang.Object
    implements java.awt.image.ImageProducer {

  // Constructors
  public MemoryImageSource (int w, int h, ColorModel cm,
      byte[] pix, int off, int scan);
  public MemoryImageSource (int w, int h, ColorModel cm,
      byte[] pix, int off, int scan, Hashtable props);
  public MemoryImageSource (int w, int h, ColorModel cm,
      int[] pix, int off, int scan);
  public MemoryImageSource (int w, int h, ColorModel cm,
      int[] pix, int off, int scan, Hashtable props);
  public MemoryImageSource (int w, int h, int[] pix,
      int off, int scan);
  public MemoryImageSource (int w, int h, int[] pix,
      int off, int scan, Hashtable props);

  // Instance Methods
  public synchronized void addConsumer (ImageConsumer ic);
  public synchronized boolean isConsumer (ImageConsumer ic);
  public void newPixels(); ★
  public synchronized void newPixels (int x, int y,
      int w, int h); ★
  public synchronized void newPixels (int x, int y,
      int w, int h, boolean framenotify); ★
  public synchronized void newPixels (byte[] newpix,
      ColorModel newmodel, int offset, int scansize); ★
  public synchronized void newPixels (int[] newpix,
      ColorModel newmodel, int offset, int scansize); ★
  public synchronized void removeConsumer (ImageConsumer ic);
  public void requestTopDownLeftRightResend (ImageConsumer ic);
  public synchronized void setAnimated (boolean animated); ★
  public synchronized void setFullBufferUpdates
      (boolean fullbuffers); ★
  public void startProduction (ImageConsumer ic);
}
```

Constructors

MemoryImageSource

```
public MemoryImageSource (int w, int h, ColorModel cm,
byte[] pix, int off, int scan)
```

Parameters *w* Width of the image being created.

	h	Height of the image being created.
	cm	`ColorModel` of the image being created.
	pix	Array of pixel information.
	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

```
public MemoryImageSource (int w, int h, ColorModel cm,
byte[] pix, int off, int scan, Hashtable props)
```

Parameters	*w*	Width of the image being created.
	h	Height of the image being created.
	cm	`ColorModel` of the image being created.
	pix	Array of pixel information.
	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
	props	`Hashtable` of properties associated with image.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

```
public MemoryImageSource (int w, int h, ColorModel cm,
int[] pix, int off, int scan)
```

Parameters	*w*	Width of the image being created.
	h	Height of the image being created.
	cm	`ColorModel` of the image being created.
	pix	Array of pixel information.
	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

```
public MemoryImageSource (int w, int h, ColorModel cm,
int[] pix, int off, int scan, Hashtable props)
```

Parameters	*w*	Width of the image being created.
	h	Height of the image being created.
	cm	`ColorModel` of the image being created.
	pix	Array of pixel information.

	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
	props	`Hashtable` of properties associated with image.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

```
public MemoryImageSource (int w, int h, int[] pix, int
off, int scan)
```

Parameters	*w*	Width of the image being created.
	h	Height of the image being created.
	pix	Array of pixel information.
	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

```
public MemoryImageSource (int w, int h, int[] pix, int
off, int scan, Hashtable props)
```

Parameters	*w*	Width of the image being created.
	h	Height of the image being created.
	pix	Array of pixel information.
	off	The offset of the first pixel in the array; elements prior to this pixel are ignored.
	scan	The number of pixels per scan line in the array.
	props	`Hashtable` of properties associated with image.
Description	Constructs a `MemoryImageSource` object with the given parameters to serve as an `ImageProducer` for a new image.	

Class Methods

addConsumer

```
public synchronized void addConsumer (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` requesting image data.
Implements	`ImageProducer.addConsumer(ImageConsumer)`	
Description	Registers an `ImageConsumer` as interested in `Image` information.	

isConsumer

`public synchronized boolean isConsumer (ImageConsumer ic)`

Parameters *ic* `ImageConsumer` to check.

Returns `true` if `ImageConsumer` is registered with this `ImageProducer`, `false` otherwise.

Implements `ImageProducer.isConsumer(ImageConsumer)`

newPixels

`public synchronized void newPixels()` ★

Description Notifies the `MemoryImageSource` that there is new data available. The `MemoryImageSource` notifies all `ImageConsumers` that there is new data, sending the full rectangle and notifying the consumers that the frame is complete.

`public synchronized void newPixels (int x, int y, int w, int h, boolean framenotify)` ★

Parameters
x x coordinate of the top left corner of the new image data.
y y coordinate of the top left corner of the new image data.
w Width of the new image data.
h Height of the new image data.

Description Notifies the `MemoryImageSource` that there is new data available. The `MemoryImageSource` notifies all `ImageConsumers` that there is new data in the rectangle described by `x`, `y`, `w`, and `h`. The consumers are notified that the frame is complete.

`public synchronized void newPixels (int x, int y, int w, int h, boolean framenotify)` ★

Parameters
x x coordinate of the top left corner of the new image data.
y y coordinate of the top left corner of the new image data.
w Width of the new image data.
h Height of the new image data.
framenotify Determines whether this is a complete frame or not.

Description Notifies the `MemoryImageSource` that there is new data available. The `MemoryImageSource` notifies all `ImageConsumers` that there is new data in the rectangle described by `x`, `y`, `w`, and `h`. If `framenotify` is `true`, the consumers will also be notified that a frame is complete.

```
public synchronized void newPixels (byte[] newpix,
ColorModel newmodel, int offset, int scansize) ★
```

Parameters	*newpix*	New array of image data.
	newmodel	The color model to use for the new data.
	offset	Offset into the data array
	scansize	Size of each line.
Description	Changes the image data for this `MemoryImageSource` and notifies its `ImageConsumers` that new data is available.	

```
public synchronized void newPixels (int[] newpix,
ColorModel newmodel, int offset, int scansize) ★
```

Parameters	*newpix*	New array of image data.
	newmodel	The color model to use for the new data.
	offset	Offset into the data array
	scansize	Size of each line.
Description	Changes the image data for this `MemoryImageSource` and notifies its `ImageConsumers` that new data is available.	

removeConsumer

```
public void removeConsumer (ImageConsumer ic)
```

Parameters	*ic*	`ImageConsumer` to remove.
Implements	`ImageProducer.removeConsumer(ImageConsumer)`	
Description	Removes an `ImageConsumer` from registered consumers for this `ImageProducer`.	

requestTopDownLeftRightResend

```
public void requestTopDownLeftRightResend (ImageConsumer
ic)
```

Parameters	*ic*	`ImageConsumer` requesting image data.
Implements	`ImageProducer.requestTopDownLeftRightResend(ImageConsumer)`	
Description	Requests the retransmission of the `Image` data in top-down, left-to-right order.	

setAnimated

```
public void setAnimated (boolean animated) ★
```

Parameters	*animated*	Flag indicating whether this image is animated.
Description	To use this MemoryImageSource for animation, call `setAnimated(true)`. The `newPixels()` methods will not work otherwise.	

setFullBufferUpdates

`public void setFullBufferUpdates (boolean fullbuffers) ★`

Parameters *fullbuffers* `true` to send full buffers; `false` otherwise.

Description This method is only important for animations; i.e., you should call `setAnimated(true)` before using this function. If you do request to send full buffers, then any rectangle parameters passed to `newPixels()` will be ignored and the entire image will be sent to the consumers.

startProduction

`public void startProduction (ImageConsumer ic)`

Parameters *ic* `ImageConsumer` requesting image data.

Implements `ImageProducer.startProduction(ImageConsumer)`

Description Registers `ImageConsumer` as interested in Image information and tells `ImageProducer` to start sending the image data immediately.

See Also

`ColorModel`, `Hashtable`, `ImageConsumer`, `ImageProducer`, `Object`

22.12 PixelGrabber

Description

The `PixelGrabber` class is an `ImageConsumer` that captures the pixels from an image and saves them in an array.

Class Definition

```
public class java.awt.image.PixelGrabber
    extends java.lang.Object
    implements java.awt.image.ImageConsumer {

  // Constructors
  public PixelGrabber (Image img, int x, int y, int w, int h,
      boolean forceRGB); ★
  public PixelGrabber (Image image, int x, int y, int width,
      int height, int[] pixels, int offset, int scansize);
  public PixelGrabber (ImageProducer ip, int x, int y, int width,
      int height, int[] pixels, int offset, int scansize);

  // Instance Methods
  public synchronized void abortGrabbing(); ★
  public synchronized ColorModel getColorModel(); ★
```

```
  public synchronized int getHeight(); ★
  public synchronized Object getPixels(); ★
  public synchronized int getStatus(); ★
  public synchronized int getWidth(); ★
  public boolean grabPixels() throws InterruptedException;
  public synchronized boolean grabPixels (long ms)
      throws InterruptedException;
  public synchronized void imageComplete (int status);
  public void setColorModel (ColorModel model);
  public void setDimensions (int width, int height);
  public void setHints (int hints);
  public void setPixels (int x, int y, int width, int height,
      ColorModel model, byte[] pixels, int offset, int scansize);
  public void setPixels (int x, int y, int width, int height,
      ColorModel model, int[] pixels, int offset, int scansize);
  public void setProperties (Hashtable properties);
  public synchronized void startGrabbing(); ★
  public synchronized int status(); ☆
}
```

Constructors

PixelGrabber

`public PixelGrabber (Image img, int x, int y, int w, int h, boolean forceRGB)` ★

Parameters	*img*	`Image` to use as source of pixel data.
	x	x-coordinate of top-left corner of pixel data.
	y	y-coordinate of top-left corner of pixel data.
	w	Width of pixel data.
	h	Height of pixel data.
	forceRGB	`true` to force the use of the RGB color model; `false` otherwise.
Description	Constructs a `PixelGrabber` instance to grab the specified area of the image.	

`public PixelGrabber (Image image, int x, int y, int width, int height, int[] pixels, int offset, int scansize)`

Parameters	*image*	`Image` to use as source of pixel data.
	x	x-coordinate of top-left corner of pixel data.
	y	y-coordinate of top-left corner of pixel data.
	width	Width of pixel data.
	height	Height of pixel data.
	pixels	Where to store pixel data when `grabPixels()` called.

	offset	Offset from beginning of each line in pixels array.
	scansize	Size of each line of data in pixels array.
Description	Constructs a `PixelGrabber` instance to grab the specified area of the image and store the pixel data from this area in the array `pixels[]`.	

```
public PixelGrabber (ImageProducer ip, int x, int y, int
width, int height, int[] pixels, int offset, int scansize)
```

Parameters	*ip*	`ImageProducer` to use as source of pixel data.
	x	x-coordinate of top-left corner of pixel data.
	y	y-coordinate of top-left corner of pixel data.
	width	Width of pixel data.
	height	Height of pixel data.
	pixels	Where to store pixel data when `grabPixels()` called.
	offset	Offset from beginning of each line in pixels array.
	scansize	Size of each line of data in pixels array.
Description	Constructs a `PixelGrabber` instance to grab data from the specified area of the image generated by an `ImageProducer` and store the pixel data from this area in the array `pixels[]`.	

Instance Methods

abortGrabbing

`public synchronized void abortGrabbing()` ★

Description: Stops the `PixelGrabber`'s image-grabbing process.

getColorModel

`public synchronized ColorModel getColorModel()` ★

Returns: The color model the `PixelGrabber` is using for its array.

getHeight

`public synchronized int getHeight()` ★

Returns: The height of the grabbed image, or -1 if the height is not known.

getPixels

`public synchronized Object getPixels()` ★

Returns The array of pixels.

Description Either a byte array or an integer array is returned, or `null` if the size and format of the image are not yet known. Because the `PixelGrabber` may change its mind about what `ColorModel` it's using, different calls to this method may return different arrays until the image acquisition is complete.

getStatus

`public synchronized int getStatus()` ★

Returns A combination of `ImageObserver` flags indicating what data is available.

getWidth

`public synchronized int getWidth()` ★

Returns The width of the grabbed image, or -1 if the width is not known.

grabPixels

`public boolean grabPixels() throws InterruptedException`

Throws `InterruptedException`
If image grabbing is interrupted before completion.

Returns `true` if the image has completed loading, `false` if the loading process aborted or an error occurred.

Description Starts the process of grabbing the pixel data from the source and storing it in the array `pixels[]` from constructor. Returns when the image is complete, loading aborts, or an error occurs.

`public synchronized boolean grabPixels (long ms) throws InterruptedException`

Parameters *ms* Milliseconds to wait for completion.

Returns `true` if image has completed loading, `false` if the loading process aborted, or an error or a timeout occurred.

Throws `InterruptedException`
If image grabbing is interrupted before completion.

Description Starts the process of grabbing the pixel data from the source and storing it in the array `pixels[]` from constructor. Returns when the image is complete, loading aborts, an error occurs, or a timeout occurs.

imageComplete

`public synchronized void imageComplete (int status)`

Parameters *status* Image loading completion status flags.
Implements `ImageConsumer.imageComplete(int)`
Description Called by the `ImageProducer` to indicate that the image has been delivered.

setColorModel

`void setColorModel (ColorModel model)`

Parameters *model* The color model for the image.
Implements `ImageConsumer.setColorModel(ColorModel)`
Description Does nothing.

setDimensions

`void setDimensions (int width, int height)`

Parameters *width* Width for image.
height Height for image.
Implements `ImageConsumer.setDimensions(int, int)`
Description Does nothing.

setHints

`void setHints (int hints)`

Parameters *hints* Image consumption hints.
Implements `ImageConsumer.setHints(int)`
Description Does nothing.

setPixels

`void setPixels (int x, int y, int width, int height,`
`ColorModel model, byte[] pixels, int offset, int scansize)`

Parameters *x* x-coordinate of top-left corner of pixel data delivered with this method call.
y y-coordinate of top-left corner of pixel data delivered with this method call.

	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Implements	`ImageConsumer.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	
Description	Called by the `ImageProducer` to deliver pixel data from the image.	

```
void setPixels (int x, int y, int width, int height,
ColorModel model, int[] pixels, int offset, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Implements	`ImageConsumer.setPixels(int, int, int, int, ColorModel, int[], int, int)`	
Description	Called by the `ImageProducer` to deliver pixel data from the image.	

setProperties

```
void setProperties (Hashtable properties)
```

Parameters	*properties*	The properties for the image.
Implements	`ImageConsumer.setProperties(Hashtable)`	
Description	Does nothing.	

startGrabbing

`public synchronized void startGrabbing()` ★

Description Starts the `PixelGrabber`'s image-grabbing process.

status

`public synchronized int status ()` ☆

Returns The `ImageObserver` flags OR'ed together representing the available information about the image. Replaced by `getStatus()`.

See Also

`ColorModel`, `Hashtable`, `Image`, `ImageConsumer`, `ImageProducer`, `InterruptedException`, `MemoryImageSource`, `Object`

22.13 ReplicateScaleFilter ★

Description

The `ReplicateScaleFilter` class uses a simple-minded algorithm to scale an image. If the image is to be reduced, rows and columns of pixels are removed. If the image is to be expanded, rows and columns are duplicated (replicated).

Class Definition

```
public class ReplicateScaleFilter
    extends java.awt.image.ImageFilter {

  // Variables
  protected int destHeight;
  protected int destWidth;
  protected Object outpixbuf;
  protected int srcHeight;
  protected int srcWidth;
  protected int[] srccols;
  protected int[] srcrows;

  // Constructor
  public ReplicateScaleFilter(int width, int height);

  // Instance Methods
  public void setDimensions (int w, int h);
  public void setPixels(int x, int y, int w, int h, ColorModel model,
      byte[] pixels, int off, int scansize);
  public void setPixels(int x, int y, int w, int h, ColorModel model,
      int[] pixels, int off, int scansize);
```

```
    public void setProperties(Hashtable props);
  }
```

Variables

destHeight

`protected int destHeight`

Height of the scaled image.

destWidth

`protected int destWidth`

Width of the scaled image.

outpixbuf

`protected Object outpixbuf`

An internal buffer.

srcHeight

`protected int srcHeight`

Height of the original image.

srcWidth

`protected int srcWidth`

Width of the original image.

srccols

`protected int[] srccols`

Internal array used to map incoming columns to outgoing columns.

srcrows

`protected int[] srcrows`

Internal array used to map incoming rows to outgoing rows.

Constructor

ReplicateScaleFilter

`public ReplicateScaleFilter (int width, int height)`

Parameters	*width*	Width of scaled image.

	height	Height of scaled image.
Description	Constructs a `ReplicateScaleFilter` that scales the original image to the specified size. If both `width` and `height` are -1, the destination image size will be set to the source image size. If either one of the parameters is -1, it will be set to preserve the aspect ratio of the original image.	

Instance Methods

`setDimensions`

```
public void setDimensions (int w, int h)
```

Parameters	*w*	Width of the source image.
	h	Height of the source image.
Overrides	`ImageFilter.setDimensions(int, int)`	
Description	Sets the size of the source image.	

`setPixels`

```
void setPixels (int x, int y, int w, int h, ColorModel
model, byte[] pixels, int off, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	w	Width of the rectangle of pixel data delivered with this method call.
	h	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	off	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	
Description	Receives a rectangle of image data from the `ImageProducer`; scales these pixels and delivers them to any `ImageConsumers`.	

```
void setPixels (int x, int y, int w, int h, ColorModel
model, int[] pixels, int off, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.

	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	w	Width of the rectangle of pixel data delivered with this method call.
	h	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	off	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, int[], int, int)`	
Description	Receives a rectangle of image data from the `ImageProducer`; scales these pixels and delivers them to any `ImageConsumers`.	

`setProperties`

```
public void setProperties (Hashtable props)
```

Parameters	*props*	The properties for the image.
Overrides	`ImageFilter.setProperties(Hashtable)`	
Description	Adds the "rescale" image property to the properties list.	

See Also

`ColorModel`, `Hashtable`, `ImageConsumer`, `ImageFilter`, `ImageProducer`

22.14 RGBImageFilter

Description

`RGBImageFilter` is an abstract class that helps you filter images based on each pixel's color and position. In most cases, the only method you need to implement in subclasses is `filterRGB()`, which returns a new pixel value based on the old pixel's color and position. `RGBImageFilter` cannot be used to implement filters that depend on the value of neighboring pixels, or other factors aside from color and position.

Class Definition

```
public abstract class java.awt.image.RGBImageFilter
    extends java.awt.image.ImageFilter {

  // Variables
  protected boolean canFilterIndexColorModel;
```

```
    protected ColorModel newmodel;
    protected ColorModel oldmodel;

    // Instance Methods
    public IndexColorModel filterIndexColorModel (IndexColorModel icm);
    public abstract int filterRGB (int x, int y, int rgb);
    public void filterRGBPixels (int x, int y, int width,
        int height, int[] pixels, int off, int scansize);
    public void setColorModel (ColorModel model);
    public void setPixels (int x, int y, int width, int height,
        ColorModel model, byte[] pixels, int offset, int scansize);
    public void setPixels (int x, int y, int width, int height,
        ColorModel model, int[] pixels, int offset, int scansize);
    public void substituteColorModel (ColorModel oldModel,
        ColorModel newModel);
}
```

Variables

canFilterIndexColorModel

`protected boolean canFilterIndexColorModel`

Setting the `canFilterIndexColorModel` variable to `true` indicates the filter can filter `IndexColorModel` images. To filter an `IndexColorModel`, the filter must depend only on color, not on position.

newmodel

`protected ColorModel newmodel`

A place to store a new `ColorModel`.

origmodel

`protected ColorModel origmodel`

A place to store an old `ColorModel`.

Instance Methods

filterIndexColorModel

`public IndexColorModel filterIndexColorModel (IndexColorModel icm)`

Parameters	*icm*	Color model to filter.
Returns	Filtered color model.	
Description	Helper method for `setColorModel()` that runs the entire color table of `icm` through the `filterRGB()` method of the subclass. Used only if `canFilterIndexColorModel` is `true`, and the image uses an `IndexColorModel`.	

filterRGB

```
public abstract int filterRGB (int x, int y, int rgb)
```

Parameters	*x*	x-coordinate of pixel data.
	y	y-coordinate of pixel data.
	rgb	Color value of pixel to filter.
Returns	New color value of pixel.	
Description	Subclasses implement this method to provide a filtering function that generates new pixels.	

filterRGBPixels

```
public void filterRGBPixels (int x, int y, int width, int
height, int[] pixels, int off, int scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data within entire image.
	y	y-coordinate of top-left corner of pixel data within entire image.
	width	Width of pixel data within entire image.
	height	Height of pixel data within entire image.
	pixels	Image data.
	off	Offset from beginning of each line in pixels array.
	scansize	Size of each line of data in pixels array.
Description	Helper method for `setPixels()` that filters each element of the `pixels` buffer through the subclass's `filterRGB()` method.	

setColorModel

```
public void setColorModel (ColorModel model)
```

Parameters	*model*	The color model for the image.
Overrides	`ImageFilter.setColorModel(ColorModel)`	
Description	Sets the image's color model.	

setPixels

```
public void setPixels (int x, int y, int width, int
height, ColorModel model, byte[] pixels, int offset, int
scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.

	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, byte[], int, int)`	
Description	Called by the `ImageProducer` to deliver a rectangular block of pixels for filtering.	

```
public void setPixels (int x, int y, int width, int
height, ColorModel model, int[] pixels, int offset, int
scansize)
```

Parameters	*x*	x-coordinate of top-left corner of pixel data delivered with this method call.
	y	y-coordinate of top-left corner of pixel data delivered with this method call.
	width	Width of the rectangle of pixel data delivered with this method call.
	height	Height of the rectangle of pixel data delivered with this method call.
	model	Color model of image data.
	pixels	Image data.
	offset	Offset from beginning of the pixels array.
	scansize	Size of each line of data in pixels array.
Overrides	`ImageFilter.setPixels(int, int, int, int, ColorModel, int[], int, int)`	
Description	Called by the `ImageProducer` to deliver a rectangular block of pixels for filtering.	

substituteColorModel

```
public void substituteColorModel (ColorModel oldModel,
ColorModel newModel)
```

Parameters	*oldModel*	New value for `origmodel` variable.

	newModel	New value for `newmodel` variable.
Description	Helper method for `setColorModel()` to initialize the protected variables `newmodel` and `origmodel`.	

See Also

`ColorModel`, `ImageFilter`

23

java.awt.peer Reference

23.1 ButtonPeer

Description

`ButtonPeer` is an interface that defines the basis for buttons.

Interface Definition

```
public abstract interface java.awt.peer.ButtonPeer
extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void setLabel (String label);
}
```

Interface Methods

`setLabel`

`public abstract void setLabel (String label)`

Parameters	*label*	New text for label of button's peer.
Description	Changes the text of the label of button's peer.	

See Also

`ComponentPeer`, `String`

23.2 CanvasPeer

Description

`CanvasPeer` is an interface that defines the basis for canvases.

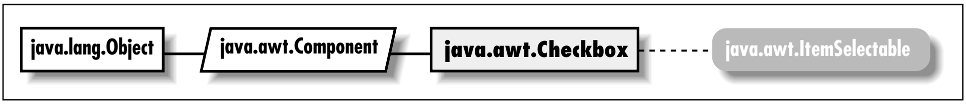
Interface Definition

```
public abstract interface java.awt.peer.CanvasPeer
   extends java.awt.peer.ComponentPeer {
}
```

See Also

`ComponentPeer`

23.3 CheckboxMenuItemPeer



Description

`CheckboxMenuItemPeer` is an interface that defines the basis for checkbox menu items.

Interface Definition

```
public abstract interface java.awt.peer.CheckboxMenuItemPeer
   extends java.awt.peer.MenuItemPeer {

  // Interface Methods
  public abstract void setState (boolean condition);
}
```

Interface Methods

setState

```
public abstract void setState (boolean condition)
```

Parameters *condition* New state for checkbox menu item's peer.
Description Changes the state of checkbox menu item's peer.

See Also

`MenuComponentPeer`, `MenuItemPeer`

23.4 CheckboxPeer

Description

`CheckboxPeer` is an interface that defines the basis for checkbox components.

Interface Definition

```
public abstract interface java.awt.peer.CheckboxPeer
    extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void setCheckboxGroup (CheckboxGroup group);
  public abstract void setLabel (String label);
  public abstract void setState (boolean state);
}
```

Interface Methods

setCheckboxGroup

```
public abstract void setCheckboxGroup (CheckboxGroup
group)
```

Parameters	*group*	New group to put the checkbox peer in.
Description	Changes the checkbox group to which the checkbox peer belongs; implicitly removes the peer from its old group, if any.	

setLabel

```
public abstract void setLabel (String label)
```

Parameters	*label*	New text for label of checkbox's peer.
Description	Changes the text of the label of the checkbox's peer.	

setState

```
public abstract void setState (boolean state)
```

Parameters	*state*	New state for the checkbox's peer.
Description	Changes the state of the checkbox's peer.	

See Also

`CheckboxGroup`, `ComponentPeer`, `String`

23.5 ChoicePeer

Description

`ChoicePeer` is an interface that defines the basis for choice components.

Interface Definition

```
public abstract interface java.awt.peer.ChoicePeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void add (String item, int index); ★
  public abstract void addItem (String item, int position); ☆

  public abstract void remove (int index); ★
  public abstract void select (int position);
}
```

Interface Methods

add

```
public abstract void add (String item, int index) ★
```

Parameters	*item*	Text of the entry to add.
	index	Position in which to add the entry; position 0 is the first entry in the list.
Description	Adds a new entry to the available choices at the designated position.	

addItem

```
public abstract void addItem (String item, int position)
☆
```

Parameters	*item*	Text of the entry to add.
	position	Position in which to add the entry; position 0 is the first entry in the list.

Description Adds a new entry to the available choices at the designated position.

remove

```
public abstract void remove (int index) ★
```

Parameters *index* Position of the item to remove.
Description Removes an entry at the given position.

select

```
public abstract void select (int position)
```

Parameters *position* Position to make selected entry.
Description Makes the given entry the selected one for the choice's peer.

See Also

ComponentPeer, String

23.6 ComponentPeer

Description

ComponentPeer is an interface that defines the basis for all non-menu GUI peer interfaces.

Interface Definition

```
public abstract interface java.awt.peer.ComponentPeer {
  // Interface Methods
  public abstract int checkImage (Image image, int width, int height,
    ImageObserver observer);
  public abstract Image createImage (ImageProducer producer);
  public abstract Image createImage (int width, int height);
  public abstract void disable(); ☆
  public abstract void dispose();
  public abstract void enable(); ☆
  public abstract ColorModel getColorModel();
  public abstract FontMetrics getFontMetrics (Font f);
  public abstract Graphics getGraphics();
  public abstract Point getLocationOnScreen(); ★
  public abstract Dimension getMinimumSize(); ★
  public abstract Dimension getPreferredSize(); ★
  public abstract Toolkit getToolkit();
  public abstract boolean handleEvent (Event e);
  public abstract void hide(); ☆
  public abstract boolean isFocusTraversable(); ★
  public abstract Dimension minimumSize(); ☆
```

```
  public abstract void paint (Graphics g);
  public abstract Dimension preferredSize (); ☆
  public abstract boolean prepareImage (Image image, int width, int height,
    ImageObserver observer);
  public abstract void print (Graphics g);
  public abstract void repaint (long tm, int x, int y, int width, int height);
  public abstract void requestFocus();
  public abstract void reshape (int x, int y, int width, int height); ☆
  public abstract void setBackground (Color c);
  public abstract void setBounds (int x, int y, int width, int height); ★
  public abstract void setCursor (Cursor cursor); ★
  public abstract void setEnabled (boolean b); ★
  public abstract void setFont (Font f);
  public abstract void setForeground (Color c);
  public abstract void setVisible (boolean b); ★
  public abstract void show(); ☆
}
```

Interface Methods

checkImage

`public abstract int checkImage (Image image, int width, int height, ImageObserver observer)`

Parameters	*image*	`Image` to check.
	width	Horizontal size to which the image will be scaled.
	height	Vertical size to which the image will be scaled.
	observer	An `ImageObserver` to monitor image loading; normally, the object on which the image will be rendered.
Returns	`ImageObserver` flags ORed together indicating status.	
Description	Checks status of image construction.	

createImage

`public abstract Image createImage (ImageProducer producer)`

Parameters	*producer*	An object that implements the `ImageProducer` interface to create a new image.
Returns	Newly created image instance.	
Description	Creates an `Image` based upon an `ImageProducer`.	

`public abstract Image createImage (int width, int height)`

Parameters	*width*	Horizontal size for in-memory `Image`.
	height	Vertical size for in-memory `Image`.
Returns	Newly created image instance.	
Description	Creates an in-memory `Image` for double buffering.	

disable

`public abstract void disable()` ☆

Description — Disables component so that it is unresponsive to user interactions. Replaced by `setEnabled(false)`.

dispose

`public abstract void dispose()`

Description — Releases resources used by peer.

enable

`public abstract void enable()` ☆

Description — Enables component so that it is responsive to user interactions. Replaced by `setEnabled(true)`.

getColorModel

`public abstract ColorModel getColorModel()`

Returns — `ColorModel` used to display the current component.

getFontMetrics

`public abstract FontMetrics getFontMetrics (Font f)`

Parameters	*f*	A font whose metrics are desired.
Returns	Font sizing information for the desired font.	

getGraphics

`public abstract Graphics getGraphics()`

Throws	*InternalException*	
		If acquiring a graphics context is unsupported
Returns	Component's graphics context.	

getLocationOnScreen

`public abstract Point getLocationOnScreen()` ★

Returns — The location of the component in the screen's coordinate space.

getMinimumSize

`public abstract Dimension getMinimumSize()` ★

Returns — The minimum dimensions of the component.

getPreferredSize

`public abstract Dimension getPreferredSize()` ★

Returns — The preferred dimensions of the component.

getToolkit

`public abstract Toolkit getToolkit()`

Returns — `Toolkit` of `Component`.

handleEvent

`public abstract boolean handleEvent (Event e)`

Parameters — *e* — `Event` instance identifying what caused the method to be called.

Returns — `true` if the peer handled the event, `false` to propagate the event to the parent container.

Description — High-level event handling routine.

hide

`public abstract void hide()` ☆

Description — Hides the component. Replaced by `setVisible(false)`.

isFocusTraversable

`public abstract boolean isFocusTraversable()` ★

Returns — `true` if the peer can be tabbed onto, `false` otherwise.

Description — Determines if this peer is navigable using the keyboard.

minimumSize

```
public abstract Dimension minimumSize() ☆
```

Returns — The minimum dimensions of the component. Replaced by `getMinimumSize()`.

paint

```
public abstract void paint (Graphics g)
```

Parameters — *g* — Graphics context of the component.

Description — Draws something in graphics context.

preferredSize

```
public abstract Dimension preferredSize() ☆
```

Returns — The preferred dimensions of the component. Replaced by `getPreferredSize()`.

prepareImage

```
public abstract boolean prepareImage (Image image, int
width,
int height, ImageObserver observer)
```

Parameters
- *image* — `Image` to load.
- *width* — Horizontal size to which the image will be scaled.
- *height* — Vertical size to which the image will be scaled.
- *observer* — An `ImageObserver` to monitor image loading; normally, the object on which the image will be rendered.

Returns — `true` if the image has already loaded, `false` otherwise.

Description — Forces the image to start loading.

print

```
public abstract void print (Graphics g)
```

Parameters — *g* — Graphics context of component.

Description — Print something from the graphics context.

repaint

`public abstract void repaint (long tm, int x, int y, int width, int height)`

Parameters	*tm*	Millisecond delay allowed before repaint.
	x	Horizontal origin of bounding box to redraw.
	y	Vertical origin of bounding box to redraw.
	width	Width of bounding box to redraw.
	height	Height of bounding box to redraw.
Description	Requests scheduler to redraw portion of component within a time period.	

requestFocus

`public abstract void requestFocus()`

Description Requests this `Component` gets the input focus.

reshape

`public abstract void reshape (int x, int y, int width, int height)` ☆

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.
	width	New width for component.
	height	New height for component.
Description	Relocates and resizes the component's peer. Replaced by `setBounds(int, int, int, int)`.	

setBackground

`public abstract void setBackground (Color c)`

Parameters	*c*	New color for the background.
Description	Changes the background color of the component.	

setBounds

`public abstract void setBounds (int x, int y, int width, int height)` ★

Parameters	*x*	New horizontal position for component.
	y	New vertical position for component.
	width	New width for component.
	height	New height for component.

Description	Relocates and resizes the component's peer.	

setCursor

`public abstract void setCursor (Cursor cursor)` ★

Parameters	*cursor*	New cursor.
Description	Changes the cursor of the component.	

setEnabled

`public abstract void setEnabled (boolean b)` ★

Parameters	*b*	`true` to enable the peer; `false` to disable it.
Description	Enables or disables the peer.	

setFont

`public abstract void setFont (Font f)`

Parameters	*f*	New font for the component.
Description	Changes the font used to display text in the component.	

setForeground

`public abstract void setForeground (Color c)`

Parameters	*c*	New foreground color for the component.
Description	Changes the foreground color of the component.	

setVisible

`public abstract void setVisible (boolean b)` ★

Parameters	*b*	`true` to show the peer; `false` to hide it.
Description	Shows or hides the peer.	

show

`public abstract void show()` ☆

Description	Makes the peer visible. Replaced by `setVisible(true)`.

See Also

`ButtonPeer`, `CanvasPeer`, `CheckboxPeer`, `ChoicePeer`, `Color`, `ColorModel`, `ContainerPeer`, Cursor, `Dimension`, `Event`, `Font`, `FontMetrics`, `Graphics`, `Image`, `ImageObserver`, `ImageProducer`, `LabelPeer`, `ListPeer`, `ScrollbarPeer`, `TextComponentPeer`, `Toolkit`

23.7 ContainerPeer

Description

`ContainerPeer` is an interface that defines the basis for containers.

Interface Definition

```
public abstract interface java.awt.peer.ContainerPeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void beginValidate(); ★
  public abstract void endValidate(); ★
  public abstract Insets getInsets(); ★
  public abstract Insets insets(); ☆
}
```

Interface Methods

beginValidate

`public abstract void beginValidate()` ★

Description Notifies the peer that the `Container` is going to validate its contents.

endValidate

`public abstract void endValidate()` ★

Description Notifies the peer that the `Container` is finished validating its contents.

getInsets

`public Insets getInsets()` ★

Returns Current `Insets` of container's peer.

insets

`public Insets insets()` ☆

Returns Current `Insets` of container's peer. Replaced by `getInsets()`.

See Also

`ComponentPeer`, `Insets`, `PanelPeer`, ScrollPanePeer, `WindowPeer`

23.8 DialogPeer

Description

DialogPeer is an interface that defines the basis for a dialog box.

Interface Definition

```
public abstract interface java.awt.peer.DialogPeer
   extends java.awt.peer.WindowPeer {

  // Interface Methods
  public abstract void setResizable (boolean resizable);
  public abstract void setTitle (String title);
}
```

Interface Methods

setResizable

```
public abstract void setResizable (boolean resizable)
```

Parameters	*resizable*	true if the dialog's peer should allow resizing; false to prevent resizing.
Description	Changes the resize state of the dialog's peer.	

setTitle

```
public abstract void setTitle (String title)
```

Parameters	*title*	New title for the dialog's peer.
Description	Changes the title of the dialog's peer.	

See Also

FileDialogPeer, String, WindowPeer

23.9 FileDialogPeer

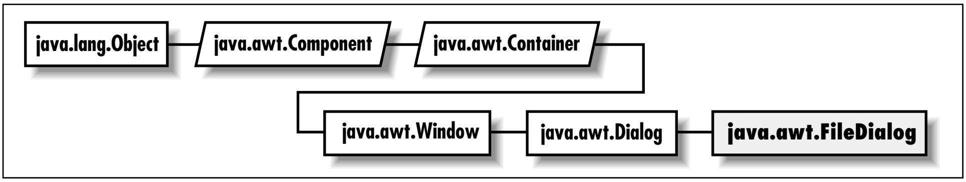
Description

FileDialogPeer is an interface that defines the basis for a file dialog box.

Interface Definition

```
public abstract interface java.awt.peer.FileDialogPeer
   extends java.awt.peer.DialogPeer {

  // Interface Methods
  public abstract void setDirectory (String directory);
  public abstract void setFile (String file);
  public abstract void setFilenameFilter (FilenameFilter filter);
```




```
}
```

Interface Methods

setDirectory

```
public abstract void setDirectory (String directory)
```

Parameters *directory* Initial directory for file dialog's peer.
Description Changes the directory displayed in the file dialog's peer.

setFile

```
public abstract void setFile (String file)
```

Parameters *file* Initial filename for the file dialog's peer.
Description Changes the default file selection for the file dialog's peer.

setFilenameFilter

```
public abstract void setFilenameFilter (FilenameFilter
filter)
```

Parameters *filter* Initial filter for file dialog's peer.
Description Changes the current filename filter of the file dialog's peer.

See Also

DialogPeer, FilenameFilter, String

23.10 FontPeer ★

Description

FontPeer is an interface that defines the basis for fonts.

Interface Definition

```
public abstract interface java.awt.peer.FontPeer {
}
```

See Also

`ComponentPeer`

23.11 FramePeer

Description

`FramePeer` is an interface that defines the basis for a frame.

Interface Definition

```
public abstract interface java.awt.peer.FramePeer
   extends java.awt.peer.WindowPeer {

  // Interface Methods
  public abstract void setIconImage (Image image);
  public abstract void setMenuBar (MenuBar bar);
  public abstract void setResizable (boolean resizable);
  public abstract void setTitle (String title);
}
```

Interface Methods

setIconImage

`public abstract void setIconImage (Image image)`

Parameters	*image*	New image to use for frame peer's icon.
Description	Changes the icon associated with the frame's peer.	

setMenuBar

`public abstract void setMenuBar (MenuBar bar)`

Parameters	*bar*	New `MenuBar` to use for the frame's peer.
Description	Changes the menu bar of the frame.	

setResizable

`public abstract void setResizable (boolean resizable)`

Parameters	*resizable*	`true` if the frame's peer should allow resizing, `false` to prevent resizing.
Description	Changes the resize state of the frame's peer.	

setTitle

```
public abstract void setTitle (String title)
```

Parameters	*title*	New title to use for the frame's peer.
Description	Changes the title of the frame's peer.	

See Also

`Image`, `MenuBar`, `String`, `WindowPeer`

23.12 LabelPeer

Description

`LabelPeer` is an interface that defines the basis for label components.

Interface Definition

```
public abstract interface java.awt.peer.LabelPeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void setAlignment (int alignment);
  public abstract void setText (String label);
}
```

Interface Methods

setAlignment

```
public abstract void setAlignment (int alignment)
```

Parameters	*alignment*	New alignment for label's peer.
Description	Changes the current alignment of label's peer.	

setText

```
public abstract void setText (String label)
```

Parameters	*label*	New text for label's peer.
Description	Changes the current text of label's peer.	

See Also

`ComponentPeer`, `String`

23.13 LightweightPeer ★

Description

`LightweightPeer` is an interface that defines the basis for components that don't have a visual representation. When you directly subclass Component or Container, a `LightweightPeer` is used.

Interface Definition

```
public abstract interface java.awt.peer.LightweightPeer
   extends java.awt.peer.ComponentPeer {
}
```

See Also

`ComponentPeer`

23.14 ListPeer

Description

`ListPeer` is an interface that defines the basis for list components.

Interface Definition

```
public abstract interface java.awt.peer.ListPeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void add (String item, int index); ★
  public abstract void addItem (String item, int index); ☆
  public abstract void clear(); ☆
  public abstract void delItems (int start, int end);
  public abstract void deselect (int index);
  public abstract Dimension getMinimumSize (int rows); ★
  public abstract Dimension getPreferredSize (int rows); ★
  public abstract int[] getSelectedIndexes();
  public abstract void makeVisible (int index);
  public abstract Dimension minimumSize (int rows); ☆
  public abstract Dimension preferredSize (int rows); ☆
  public abstract void removeAll(); ★
  public abstract void select (int position);
  public abstract void setMultipleMode (boolean b); ★
  public abstract void setMultipleSelections (boolean value); ☆
}
```

Interface Methods

add

`public abstract void add (String item, int index) ★`

Parameters	*item*	Text of an entry to add to the list.
	index	Position in which to add the entry; position 0 is the first entry in the list.
Description	Adds a new entry to the available choices of the list's peer at the designated position.	

addItem

`public abstract void addItem (String item, int index) ☆`

Parameters	*item*	Text of an entry to add to the list.
	index	Position in which to add the entry; position 0 is the first entry in the list.
Description	Adds a new entry to the available choices of the list's peer at the designated position. Replaced by `add(String, int)`.	

clear

`public abstract void clear() ☆`

Description — Clears all the entries out of the list's peer. Replaced by `removeAll()`.

delItems

`public abstract void delItems (int start, int end)`

Parameters	*start*	Starting position of entries to delete.
	end	Ending position of entries to delete.
Description	Removes a set of entries from the list's peer.	

deselect

`public abstract void deselect (int index)`

Parameters	*index*	Position to deselect.
Description	Deselects entry at designated position, if selected.	

getMinimumSize

`public abstract Dimension getMinimumSize (int rows) ★`

Parameters	*rows*	Number of rows within list's peer to size.
Returns	The minimum dimensions of a list's peer of the given size.	

getPreferredSize

`public abstract Dimension getPreferredSize (int rows) ★`

Parameters	*rows*	Number of rows within list's peer to size.
Returns	The preferred dimensions of a list's peer of the given size.	

getSelectedIndexes

`public abstract int[] getSelectedIndexes()`

Returns Array of positions of currently selected entries in list's peer.

makeVisible

`public abstract void makeVisible (int index)`

Parameters	*index*	Position to make visible on screen.
Description	Ensures an item is displayed on the screen in the list's peer.	

minimumSize

`public abstract Dimension minimumSize (int rows) ☆`

Parameters	*rows*	Number of rows within list's peer to size.
Returns	The minimum dimensions of a list's peer of the given size. Replaced by `getMinimumSize(int)`.	

preferredSize

`public abstract Dimension preferredSize (int rows) ☆`

Parameters	*rows*	Number of rows within list's peer to size.
Returns	The preferred dimensions of a list's peer of the given size. Replaced by `getPreferredSize(int)`.	

removeAll

`public abstract void removeAll() ★`

Description Clears all the entries out of the list's peer.

select

```
public abstract void select (int position)
```

Parameters	*position*	Position to select; 0 indicates the first item in the list.
Description	Makes the given entry the selected item for the list's peer; deselects other selected entries if multiple selections are not enabled.	

setMultipleMode

`public abstract void setMultipleMode (boolean value)` ★

Parameters	*value*	`true` to allow multiple selections within the list's peer; `false` to disallow multiple selections.
Description	Changes list peer's selection mode.	

setMultipleSelections

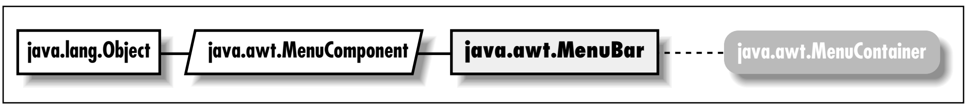
`public abstract void setMultipleSelections (boolean value)`
☆

Parameters	*value*	`true` to allow multiple selections within the list's peer; `false` to disallow multiple selections.
Description	Changes list peer's selection mode. `Replaced by setMultipleMode(boolean).`	

See Also

`ComponentPeer`, `Dimension`, `String`

23.15 MenuBarPeer



Description

`MenuBarPeer` is an interface that defines the basis for menu bars.

Interface Definition

```
public abstract interface java.awt.peer.MenuBarPeer
    extends java.awt.peer.MenuComponentPeer {

   // Interface Methods
   public abstract void addHelpMenu (Menu m);
```

```
  public abstract void addMenu (Menu m);
  public abstract void delMenu (int index);
}
```

Interface Methods

addHelpMenu

`public abstract void addHelpMenu (Menu m)`

Parameters	*m*	Menu to designate as the help menu with the menu bar's peer.
Description	Sets a particular menu to be the help menu of the menu bar's peer.	

addMenu

`public abstract void addMenu (Menu m)`

Parameters	*m*	Menu to add to the menu bar's peer
Description	Adds a menu to the menu bar's peer.	

delMenu

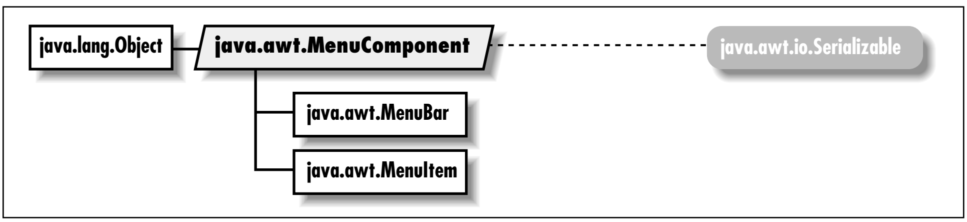
`public abstract void delMenu (int index)`

Parameters	*index*	Menu position to delete from the menu bar's peer.
Description	Deletes a menu from the menu bar's peer.	

See Also

`Menu`, `MenuComponentPeer`

23.16 MenuComponentPeer



Description

MenuComponentPeer is an interface that defines the basis for all menu GUI peer interfaces.

Interface Definition

```
public abstract interface java.awt.peer.MenuComponentPeer {

  // Interface Methods
  public abstract void dispose();
}
```

Interface Methods

dispose

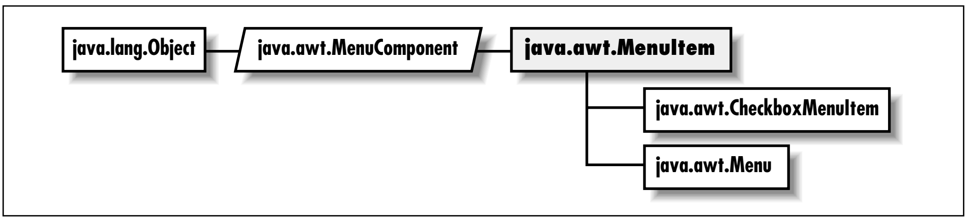
```
public abstract void dispose()
```

Description Releases resources used by peer.

See Also

MenuBarPeer, MenuItemPeer

23.17 MenuItemPeer



Description

MenuBarPeer is an interface that defines the basis for menu bars.

Interface Definition

```
public abstract interface java.awt.peer.MenuItemPeer
    extends java.awt.peer.MenuComponentPeer {

  // Interface Methods
  public abstract void disable(); ☆
  public abstract void enable(); ☆
  public abstract void setEnabled (boolean b); ★
  public abstract void setLabel (String label);
}
```

Interface Methods

disable

```
public abstract void disable() ☆
```

Description	Disables the menu item's peer so that it is unresponsive to user interactions. Replaced by `setEnabled(false)`.	

enable

```
public abstract void enable() ☆
```

Description	Enables the menu item's peer so that it is responsive to user interactions. Replaced by `setEnabled(true)`.	

setEnabled

```
public abstract void setEnabled (boolean b) ★
```

Parameters	*b*	`true` to enable the peer; `false` to disable it.
Description	Enables or disables the menu item's peer.	

setLabel

```
public abstract void setLabel (String label)
```

Parameters	*label*	New text to appear on the menu item's peer.
Description	Changes the label of the menu item's peer.	

See Also

`CheckboxMenuItemPeer`, `MenuComponentPeer`, `MenuPeer`, `String`

23.18 MenuPeer

Description

`MenuPeer` is an interface that defines the basis for menus.

Interface Definition

```
public abstract interface java.awt.peer.MenuPeer
   extends java.awt.peer.MenuItemPeer {

  // Interface Methods
  public abstract void addItem (MenuItem item);
  public abstract void addSeparator();
  public abstract void delItem (int index);
}
```

Interface Methods

addItem

```
public abstract void addItem (MenuItem item)
```

Parameters	*item*	`MenuItem` to add to the menu's peer
Description	Adds a menu item to the menu's peer.	

addSeparator

```
public abstract void addSeparator()
```

Description — Adds a menu separator to the menu's peer.

delItem

```
public abstract void delItem (int index)
```

Parameters	*index*	`MenuItem` position to delete from the menu's peer.
Description	Deletes a menu item from the menu's peer.	

See Also

`MenuItem`, `MenuItemPeer`

23.19 PanelPeer

Description

`PanelPeer` is an interface that defines the basis for a panel.

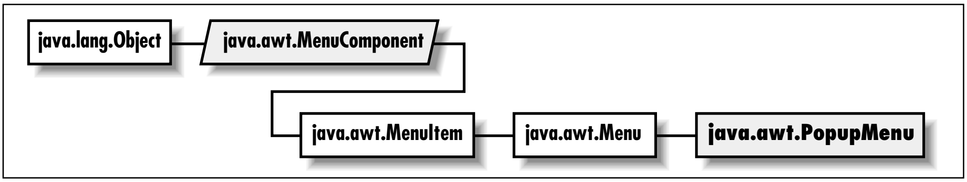
Interface Definition

```
public abstract interface java.awt.peer.PanelPeer
   extends java.awt.peer.ContainerPeer {
}
```

See Also

`ContainerPeer`

23.20 PopupMenuPeer ★



Description

PopupMenuPeer is an interface that defines the basis for a popup menu.

Interface Definition

```
public abstract interface java.awt.peer.PopupMenuPeer
   extends java.awt.peer.MenuPeer {

  // Interface Methods
  public abstract void show (Event e);
}
```

Interface Methods

show

`public abstract void show (Event e)`

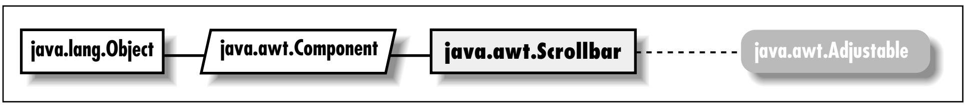
Parameters *e* A mouse down event that begins the display of the popup menu.

Description Shows the peer at the location encapsulated in e.

See Also

Event, MenuPeer

23.21 ScrollbarPeer



Description

ScrollbarPeer is an interface that defines the basis for scrollbar components.

Interface Definition

```
public abstract interface java.awt.peer.ScrollbarPeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract void setLineIncrement (int amount);
  public abstract void setPageIncrement (int amount);
  public abstract void setValues (int value, int visible, int minimum, int maximum);
}
```

Interface Methods

setLineIncrement

`public abstract void setLineIncrement (int amount)`

Parameters	*amount*	New line increment amount.
Description	Changes the line increment amount for the scrollbar's peer.	

setPageIncrement

`public abstract void setPageIncrement (int amount)`

Parameters	*amount*	New paging increment amount.
Description	Changes the paging increment amount for the scrollbar's peer.	

setValues

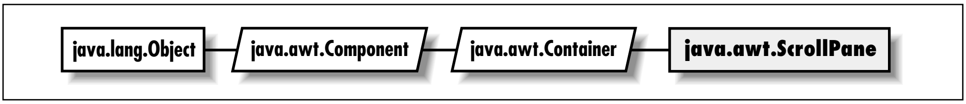
`public abstract void setValues (int value, int visible, int minimum, int maximum)`

Parameters	*value*	New value for the scrollbar's peer.
	visible	New slider width.
	minimum	New minimum value for the scrollbar's peer.
	maximum	New maximum value for the scrollbar's peer.
Description	Changes the settings of the scrollbar's peer to the given amounts.	

See Also

ComponentPeer

23.22 ScrollPanePeer ★



Description

`ScrollPanePeer` is an interface that defines the basis for a scrolling container.

Interface Definition

```
public abstract interface java.awt.peer.ScrollPanePeer
   extends java.awt.peer.ContainerPeer {

  // Interface Methods
  public abstract void childResized (int w, int h);
  public abstract int getHScrollbarHeight();
  public abstract int getVScrollbarWidth();
  public abstract void setScrollPosition (int x, int y);
  public abstract void setUnitIncrement (Adjustable adj, int u);
  public abstract void setValue (Adjustable adj, int v);
}
```

Interface Methods

childResized

```
public abstract void childResized (int w, int h)
```

Parameters	*w*	The new child width.
	h	The new child height.
Description	Tells the peer that the child has a new size.	

getHScrollbarHeight

```
public abstract int getHScrollbarHeight()
```

Returns	Height that a horizontal scrollbar would occupy.
Description	The height is returned regardless of whether the scrollbar is showing or not.

getVScrollbarWidth

```
public abstract int getVScrollbarWidth()
```

Returns	Width that a vertical scrollbar would occupy.

Description The width is returned regardless of whether the scrollbar is showing or not.

`setScrollPosition`

```
public abstract void setScrollPosition (int x, int y)
```

Parameters *x* The new horizontal position.
y The new vertical position.
Description Changes the coordinate of the child component that is displayed at the origin of the `ScrollPanePeer`.

`setUnitIncrement`

```
public abstract void setUnitIncrement (Adjustable adj, int
u)
```

Parameters *adj* The `Adjustable` object to change.
u The new value.
Description Changes the unit increment of the given `Adjustable` object.

`setValue`

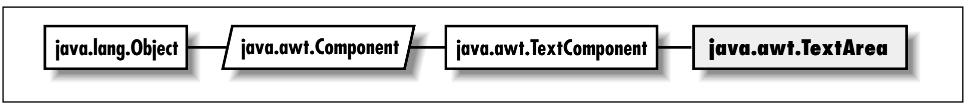
```
public abstract void setValue (Adjustable adj, int v)
```

Parameters *adj* The `Adjustable` object to change.
v The new value.
Description Changes the value of the given `Adjustable` object.

See Also

`Adjustable`, `ContainerPeer`, `Scrollbar`

23.23 TextAreaPeer



Description

`TextAreaPeer` is an interface that defines the basis for text areas.

Interface Definition

```
public abstract interface java.awt.peer.TextAreaPeer
   extends java.awt.peer.TextComponentPeer {

  // Interface Methods
  public abstract Dimension getMinimumSize (int rows, int columns); ★
  public abstract Dimension getPreferredSize (int rows, int columns); ★
  public abstract void insert (String string, int position); ★
  public abstract void insertText (String string, int position); ☆
  public abstract Dimension minimumSize (int rows, int columns); ☆
  public abstract Dimension preferredSize (int rows, int columns); ☆
  public abstract void replaceRange (String string, int startPosition, int endPositio
  public abstract void replaceText (String string, int startPosition, int endPosition
}
```

Interface Methods

getMinimumSize

```
public abstract Dimension getMinimumSize
(int rows, int columns) ★
```

Parameters	*rows*	Number of rows within the text area's peer.
	columns	Number of columns within the text area's peer.
Returns	The minimum dimensions of a text area's peer of the given size.	

getPreferredSize

```
public abstract Dimension getPreferredSize
(int rows, int columns) ★
```

Parameters	*rows*	Number of rows within the text area's peer.
	columns	Number of columns within the text area's peer.
Returns	The preferred dimensions of a text area's peer of the given size.	

insert

```
public abstract void insert (String string, int position)
★
```

Parameters	*string*	Content to place within the text area's peer.
	position	Location at which to insert the content.
Description	Places additional text within the text area's peer.	

insertText

`public abstract void insertText (String string, int position)` ☆

Parameters	*string*	Content to place within the text area's peer.
	position	Location at which to insert the content.
Description	Places additional text within the text area's peer. Replaced by `insert(String, int)`.	

minimumSize

`public abstract Dimension minimumSize (int rows, int columns)` ☆

Parameters	*rows*	Number of rows within the text area's peer.
	columns	Number of columns within the text area's peer.
Returns	The minimum dimensions of a text area's peer of the given size. Replaced by `getMinimumSize(int, int)`.	

preferredSize

`public abstract Dimension preferredSize (int rows, int columns)` ☆

Parameters	*rows*	Number of rows within the text area's peer.
	columns	Number of columns within the text area's peer.
Returns	The preferred dimensions of a text area's peer of the given size. Replaced by `getPreferredSize(int, int)`.	

replaceRange

`public abstract void replaceRange (String string, int startPosition, int endPosition)` ★

Parameters	*string*	New content to place in the text area's peer.
	startPosition	Starting position of the content to replace.
	endPosition	Ending position of the content to replace.
Description	Replaces a portion of the text area peer's content with the given text.	

replaceText

`public abstract void replaceText (String string, int startPosition, int endPosition)` ☆

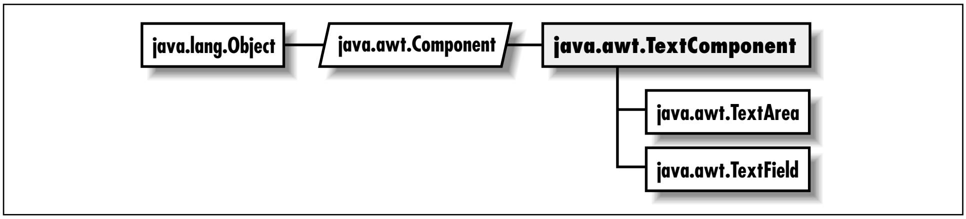
Parameters	*string*	New content to place in the text area's peer.

	startPosition	Starting position of the content to replace.
	endPosition	Ending position of the content to replace.
Description	Replaces a portion of the text area peer's content with the given text. Replaced by `replaceRange(String, int, int)`.	

See Also

`Dimension`, `String`, `TextComponentPeer`

23.24 TextComponentPeer



Description

`TextComponentPeer` is an interface that defines the basis for text components.

Interface Definition

```
public abstract interface java.awt.peer.TextComponentPeer
   extends java.awt.peer.ComponentPeer {

  // Interface Methods
  public abstract int getCaretPosition(); ★
  public abstract int getSelectionEnd();
  public abstract int getSelectionStart();
  public abstract String getText();
  public abstract void select (int selectionStart, int selectionEnd);
  public abstract void setCaretPosition (int pos); ★
  public abstract void setEditable (boolean state);
  public abstract void setText (String text);
}
```

Interface Methods

`getCaretPosition`

`public abstract int getCaretPosition()` ★

Returns The current position of the caret (text cursor).

getSelectionEnd

`public abstract int getSelectionEnd()`

Returns The ending cursor position of any selected text.

getSelectionStart

`public abstract int getSelectionStart()`

Returns The initial position of any selected text.

getText

`public abstract String getText()`

Returns The current contents of the text component's peer.

select

`public abstract void select (int selectionStart, int selectionEnd)`

Parameters *selectionStart* Beginning position of the text to select.
selectionEnd Ending position of the text to select.

Description Selects text in the text component's peer.

selectCaretPosition

`public abstract void selectCaretPosition (int pos)`

Parameters *pos* New caret position.

Description Changes the position of the caret (text cursor).

setEditable

`public abstract void setEditable (boolean state)`

Parameters *state* `true` if the user can change the contents of the text component's peer (i.e., `true` to make the peer editable); `false` to make the peer read-only.

Description Allows you to change the current editable state of the text component's peer.

setText

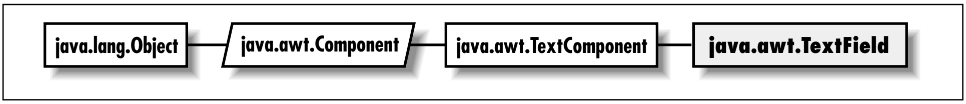
```
public abstract void setText (String text)
```

Parameters *text* New text for the text component's peer .
Description Sets the content of the text component's peer.

See Also

`ComponentPeer`, `String`, `TextAreaPeer`, `TextFieldPeer`

23.25 TextFieldPeer



Description

`TextFieldPeer` is an interface that defines the basis for text fields.

Interface Definition

```
public abstract interface java.awt.peer.TextFieldPeer
   extends java.awt.peer.TextComponentPeer {

  // Interface Methods
  public abstract Dimension getMinimumSize (int rows, int columns); ★
  public abstract Dimension getPreferredSize (int rows, int columns); ★
  public abstract Dimension minimumSize (int rows, int columns); ☆
  public abstract Dimension preferredSize (int rows, int columns); ☆
  public abstract void setEchoChar (char echoChar); ★
  public abstract void setEchoCharacter (char c); ☆
}
```

Interface Methods

getMinimumSize

```
public abstract Dimension getMinimumSize (int rows) ★
```

Parameters *rows* Number of rows within the text field's peer.
Returns The minimum dimensions of a text field's peer of the given size.

getPreferredSize

`public abstract Dimension getPreferredSize (int rows)` ★

Parameters	*rows*	Number of rows within the text field's peer.
Returns	The preferred dimensions of a text field's peer of the given size.	

minimumSize

`public abstract Dimension minimumSize (int rows)` ☆

Parameters	*rows*	Number of rows within the text field's peer.
Returns	Replaced by `getMinimumSize(int)`.	

preferredSize

`public abstract Dimension preferredSize (int rows)` ☆

Parameters	*rows*	Number of rows within the text field's peer.
Returns	Replaced by `getPreferredSize(int)`.	

setEchoChar

`public abstract void setEchoChar (char c)` ★

Parameters	*c*	The character to display for all input.
Description	Changes the character that is displayed to the user for every character he or she types in the text field.	

setEchoCharacter

`public abstract void setEchoCharacter (char c)` ☆

Parameters	*c*	The character to display for all input.
Description	Replaced by `setEchoChar(char)`.	

See Also

`Dimension`, `TextComponentPeer`

23.26 WindowPeer

Description

`WindowPeer` is an interface that defines the basis for a window.

Interface Definition

```
public abstract interface java.awt.peer.WindowPeer
   extends java.awt.peer.ContainerPeer {

  // Interface Methods
  public abstract void toBack();
  public abstract void toFront();
}
```

Interface Methods

toBack

`public abstract void toBack()`

Description Puts the window's peer in the background of the display.

toFront

`public abstract void toFront()`

Description Brings the window's peer to the foreground of the display.

See Also

`ContainerPeer`, `DialogPeer`, `FramePeer`

In this appendix:
- *System Properties*
- *Server Properties*
- *Resource Bundles*

A

Using Properties and Resources

Java provides "property lists" that are similar to Xdefaults in the X Window system. Programs can use properties to customize their behavior or find out information about the run-time environment; by reading a property list, a program can set defaults, choose colors and fonts, and more, without any changes to the code. Java 1.1 makes property lists much more general. Although the basic features of property lists did not change between Java 1.0 and 1.1, the way you access them did. Instead of providing specific locations for files, Java 1.1 provides access to these resource bundles in a more general scheme, described in Section A.3.

A.1 System Properties

Although Java applications can define property lists as conveniences, there is one special property list that is common to all applications and applets: System Properties. This list currently has 14 properties in Java 1.0 and 21 in Java 1.1, although you may add to it, and more standard properties may be added in the future. An application has access to all of them. Because of security restrictions, an applet has access only to 9. Among other things, these properties allow you to customize your code for different platforms if you want to provide workarounds for platform-specific deficiencies or load native methods if available.

Table A-1 contains the complete list of system properties. The last column specifies whether an applet can access each property; applications can access all properties. As a word of caution, different vendors may report different values for the same environment (for example, `os.arch` could be x86 or 80486). The values in the property list reflect the run-time environment, not the development environment.

Table A–1: System Properties

Name	Description	Sample Value	Applet
awt.toolkit ★	Toolkit vendor	sun.awt.window.Wtoolkit	No
file.encoding ★	File encoding	8859_1	No
file.encoding.pkg ★	File encoding package	sun.io	No
file.separator	File separator	"\" or "/"	Yes
java.class.path	Java's CLASSPATH	C:\JAVA\LIB;.; C:\JAVA\BIN\..\classes; C:\JAVA\BIN\..\lib\classes.zip	No
java.class.version	Java's class library version	45.3	Yes
java.home	Java's installation directory	C:\JAVA	No
java.vendor	Java's virtual machine vendor	Netscape Communications	Yes
java.vendor.url	Java vendor's URL	http://www.netscape.com	Yes
java.version	Java version	1.021	Yes
line.separator	Line separator	"\n"	Yes
os.arch	Operating system architecture	x86 or 80486	Yes
os.name	Operating system name	Windows NT	Yes
os.version ★	Operating system version	4.0	Yes
path.separator	Path separator	";" or ":"	Yes
user.dir	User's working directory	C:\JAZ\AWTCode\Chapter2	No
user.home	User's home directory	C:\JAVA	No
user.language ★	User's language	en	No
user.name ★	User's login name	JOHNZ	No
user.region ★	User's geographic region	US	No
user.timezone ★	User's time zone	EST	No

To read one of the system properties, use the `getProperty()` method of the `System` class:

```
System.getProperty (String s);    // for the property you want
```

If `s` is a valid property and is accessible by your program, the system retrieves the current value as a `String`. If it is not, the return value is `null`. For example, the following line of code retrieves the vendor for the Java platform you are working with:

```
String s = System.getProperty ("java.vendor");
```

If an applet tries to access a property it does not have permission to read, a security exception is thrown.

For an application, the Java interpreter can add additional system properties at run-time with the *-D* flag. The following command runs the program *className*, adding the `program.name` property to the list of available properties; the value of this property is the string `Foo`:

```
java -Dprogram.name=Foo className
```

An application can also modify its property list by calling various methods of the `Properties` class. The following code duplicates the effect of the *-D* flag in the previous example:

```
Properties p = System.getProperties ();
p.put ("program.name", "Foo");  // To add a new one
p.put ("java.vendor", "O'Reilly");  // To replace the current one
System.setProperties(p);
```

An applet running within Netscape Navigator or Internet Explorer may not add or change system properties since Netscape Navigator and Internet Explorer do not let applets touch the local filesystem, and calls to `getProperties()` generate a security violation. Version 1.0 of HotJava, the JDK, and the *appletviewer* allow you to set properties with the *properties* file in the *.hotjava* directory. Other browsers may or may not enable this option.

NOTE The location of the system properties file depends on the run-time environment you are using. Ordinarily, the file will go into a subdirectory of the installation directory or, for environments where users have home directories, in a subdirectory for the user.

Users may add properties to the system property file by hand; of course, in this case, it's the Java developer's responsibility to document what properties the program reads, and to provide reasonable defaults in case those properties aren't set. The `Color` and `Font` classes have methods to read colors and fonts from the system properties list. These are two areas in which it would be appropriate for a program to define its own properties, expecting the user to set an appropriate value. For example, a program might expect the property `myname.awt.drawingColor` to define a default color for drawing; it would be the user's responsibility to add a line defining this property in the property file:

```
myname.awt.drawingColor=0xe0e0e0    #default drawing color: light gray
```

A.2 Server Properties

Java programs can read properties from any file to which they have access. Applications, of course, can open files on the platform where they execute; applets cannot. However, applets can read certain files from the server. Example A-1 is an applet that reads a properties file from its server and uses those properties to customize itself. This is a useful technique for developers working on commercial applets: you can deliver an applet to a customer and let the customer customize the applet by providing a property sheet. The alternative, having the applet read all of its customizations from HTML parameter tags, is a bit more clumsy. Server properties let you distinguish between global customizations like company name (which would be the same on all instances of the applet) and situation-specific customizations, like the name of the animation the user wants to display (the user may use the same applet for many animation sequences). The company name should be configured through a style sheet; the animation filename should be configured by using a `<PARAM>` tag.

Example A-1 uses a properties list to read a message and font information. Following the source is the actual property file. The property file must be in the same directory as the HTML file because we use `getDocumentBase()` to build the property file's URL. Once we have loaded the property list, we can use `getProperty()` to read individual properties. Unfortunately, in Java 1.0, we cannot use the `Font` class's methods to read the font information directly; `getFont()` can only read properties from the system property list. Therefore, we need to read the font size, name, and type as strings, and call the `Font` constructor using the pieces as arguments. Java 1.1 does a lot to fix this problem; we'll see how in the next section.

Example A–1: Getting Properties from a Server File

```
import java.util.Properties;
import java.awt.*;
import java.io.IOException;
import java.io.InputStream;
import java.net.URL;
import java.net.MalformedURLException;

public class Prop extends java.applet.Applet {
    Properties p;
```

Example A–1: Getting Properties from a Server File (continued)

```
    String theMessage;
    public void init () {
        p = new Properties();
        try {
            URL propSource = new URL (getDocumentBase(), "prop.list");
            InputStream propIS = propSource.openStream();
            p.load(propIS);
            p.list(System.out);
            initFromProps(p);
            propIS.close();
        } catch (MalformedURLException e) {
            System.out.println ("Invalid URL");
        } catch (IOException e) {
            System.out.println ("Error loading properties");
        }
    }
    public void initFromProps (Properties p) {
        String fontsize = p.getProperty ("MyProg.font.size");
        String fontname = p.getProperty ("MyProg.font.name");
        String fonttype = p.getProperty ("MyProg.font.type");
        String message  = p.getProperty ("MyProg.message");
        int size;
        int type;
        if (fontsize == null) {
            size = 12;
        } else {
            size = Integer.parseInt (fontsize);
        }
        if (fontname == null) {
            fontname = "TimesRoman";
        }
        type = Font.PLAIN;
        if (fonttype != null) {
            fonttype.toLowerCase();
            boolean bold = (fonttype.indexOf ("bold") != -1);
            boolean italic = (fonttype.indexOf ("italic") != -1);
            if (bold) type |= Font.BOLD;
            if (italic) type |= Font.ITALIC;
        }
        if (message == null) {
            theMessage = "Welcome to Java";
        } else {
            theMessage = message;
        }
        setFont (new Font (fontname, type, size));
    }
    public void paint (Graphics g) {
        g.drawString (theMessage, 50, 50);
    }
}
```

The file *prop.list*:

```
MyProg.font.size=20
MyProg.font.type=italic-bold
MyProg.font.name=Helvetica
MyProg.message=Hello World
```

Figure A-1 results from using this applet with this property file.

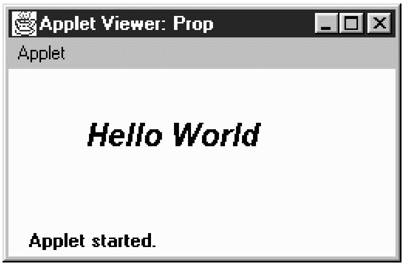


Figure A–1: Reading server properties

A.3 Resource Bundles

Java 1.1 adds two new pieces to make its property lists more general and flexible. The first is the ability to use localized resource bundles; the second is the use of resource files.

Resource bundles let you write internationalized programs. The general idea is that any string you want to display (for example, a button label) shouldn't be specified as a literal constant. Instead, you want to look up the string in a table of equivalents—a "resource bundle"—that contains equivalent strings for different locales. For example, the string "yes" is equivalent to "ja", "si", "oui", and many other language-specific alternatives. A resource bundle lets your program look up the right alternative at run-time, depending on the user's locale. The list of alternatives must be implemented as a subclass of `ResourceBundle` or `ListResourceBundle`, in which you provide a key value pair for each label. For each locale you support, a separate subclass and list must be provided. Then you look up the appropriate string through the `ResourceBundle.getString()` method. A complete example of how to use resource bundles could easily require an entire chapter; I hope this is enough information to get you started.*

Resource bundles have one important implication for more mundane programs. Resource bundles can be saved in files and read at run-time. To support them, Java 1.1 has added the ability to load arbitrary properties files. In Example A-1, we looked for the *prop.list* file on the applet server. What if we want to permit users to

---

* See the *Java Fundamental Classes Reference* for a more complete description.

modify the default font to be what they want, not what we think they want? With Java 1.0, that could not be done because there was no way for an applet to access the local filesystem. Now, with Java 1.1, you can access read-only resource files located in the CLASSPATH. To do so, you use the Class.getResource() method, which takes the name of a properties list file as an argument. This method returns the URL of the file requested, which could be available locally or on the applet server; where it actually looks depends on the ClassLoader. Once the file is found, treat it as a Properties file, as in Example A-1, or do anything you want with it. A similar method, Class.getResourceAsStream(), returns the InputStream to work with, instead of the URL.

Example A-2 is similar to Example A-1. The file *prop11.list* includes three properties: the font to use, a message, and an image. We need only a single property because we can use the new Font.decode() method to convert a complete font specification into a Font object: we don't need to load the font information in pieces, as we did in the earlier example. As an added bonus, this example displays an image. The name of the image is given by the property MyProg.image. Like the property file itself, the image file can be located anywhere. Here's the properties list, which should be placed in the file *prop11.list*:

```
MyProg.font=Helvetica-italic-30
MyProg.message=Hello World
MyProg.image=ora-icon.gif
```

And the code for the applet is in Example A-2.

Example A–2: Getting Properties from a Resource File

```
// Java 1.1 only
import java.io.*;
import java.net.*;
import java.awt.*;
import java.util.Properties;
import java.applet.Applet;
public class Prop11 extends Applet {
    Image im;
    Font f;
    String msg;
    public void paint (Graphics g) {
        g.setFont (f);
        if (im != null)
            g.drawImage (im, 50, 100, this);
        if (msg != null)
            g.drawString (msg, 50, 50);
    }
    public void init () {
        InputStream is = getClass().getResourceAsStream("prop11.list");
        Properties p = new Properties();
        try {
            p.load (is);
```

Example A–2: Getting Properties from a Resource File (continued)

```
            f = Font.decode(p.getProperty("MyProg.font"));
            msg = p.getProperty("MyProg.message");
            String name = p.getProperty("MyProg.image");
            URL url = getClass().getResource(name);
            im = getImage (url);
        } catch (IOException e) {
            System.out.println ("error loading props...");
        }
    }
}
```

In this appendix:

- *The Applet Tag*

B

HTML Markup For Applets

B.1 The Applet Tag

The introduction of Java created the need for additional HTML tags. In the alpha release of Java, the HotJava browser used the <APP> tag to include applets within HTML files. However, <APP> was unacceptable to the standards committee because it could have an infinite number of parameters. It was replaced by the <APPLET> tag, used in conjunction with the <PARAM> tag. Apparently, the standards folks did not like the <APPLET> tag either, so you can expect it to be replaced eventually, although at this point, there is no agreement about its successor, and it is highly unlikely that any production browser would stop supporting <APPLET>.

The syntax of the <APPLET> tag is shown below; the order of the parameters does not matter:

```
<APPLET
    [ALIGN = alignment]
    [ALT = alternate-text]
    CODE = applet-filename or OBJECT = serialized-applet
    [CODEBASE = applet-directory-url]
    [ARCHIVE = filename.zip/filename.jar]
    HEIGHT = applet-pixel-height
    [HSPACE = horizontal-pixel-margin]
    [MAYSCRIPT = true/false]
    [NAME = applet-name]
    [VSPACE = vertical-pixel-margin]
    WIDTH = applet-pixel-width
>
<PARAM NAME=parameter1 VALUE=value1>
<PARAM NAME=parameter2 VALUE=value2>
<PARAM NAME=parameter3 VALUE=value3>
...
[alternate-html]
</APPLET>
```

<APPLET>

The <APPLET> tag specifies where and how to display an applet within the HTML document. If the browser does not understand the <APPLET> and <PARAM> tags, it displays the `alternate-html`. (It displays the `alternate-html` because it doesn't understand the surrounding tags and ignores them. There's no magic to the `alternate-html` itself.) If a browser does understand <APPLET> but cannot run Java (for example, a browser on Windows 3.1) or Java has been disabled, the browser displays the `alternate-html` or the `alternate-text` specified by the optional `ALT` parameter. The `CODE`, `WIDTH`, and `HEIGHT` parameters are required. Parameters within the <APPLET> tag are separated by spaces, not by commas.

</APPLET>

Closes the <APPLET> tag. Anything prior to </APPLET> is considered `alternate-html` if it is not a <PARAM> tag. The `alternate-html` is displayed when Java is disabled, when Java cannot be run in the current browser, or when the browser does not understand the <APPLET> tag.

The following parameters may appear inside the <APPLET> tag.

ALIGN

`alignment`, optional. Specifies the applet's alignment on the Web page. Valid values are: `left`, `right`, `top`, `texttop`, `middle`, `absmiddle`, `baseline`, `bottom`, `absbottom`. Default: `left`. The alignment values have the same meanings as they do in the <IMG> tag.

ALT

`alternate-text`, optional. The alternate text is displayed when the browser understands the <APPLET> tag but is incapable of executing applets, either because Java is disabled or not supported on the platform. Support of this tag is browser dependent; most browsers just display the `alternate-html` since that is not restricted to text.

ARCHIVE

`filename.zip/filename.jar`, optional. Points to a comma-separated list of uncompressed ZIP or JAR files that contain one or more Java classes. Each file is downloaded once to the user's disk and searched for the class named in the `CODE` parameter, and any helper classes required to execute that class. JAR files may be signed to grant additional access. (JAR files are Java archives, a new archive format defined in Java 1.1. JAR files support features like digital signatures and compression. While they are not yet in wide use, they should become an important way of distributing sets of Java classes.)

`CODE`

`applet-filename`. This parameter or the `OBJECT` parameter is required. Name of applet *.class* file. The *.class* extension is not required in the `<APPLET>` tag but is required in the class's actual filename. The filename has to be a quoted string only if it includes whitespace.

`CODEBASE`

`applet-directory-url`, optional. Relative or absolute URL specifying the directory in which to locate the *.class* file or ZIP archive for the applet. Default: html directory.

`HEIGHT`

`applet-pixel-height`, required. Initial height of applet in pixels. Many browsers do not allow applets to change their height.

`HSPACE`

`horizontal-pixel-margin`, optional. Horizontal margin left and right of the applet, in pixels.

`MAYSCRIPT`

Required for applets that wish to use LiveConnect and the `netscape.javascript` classes to interact with JavaScript. Set to `true` to communicate with JavaScript. Set to `false`, or omit this parameter to disable communication with JavaScript. Both Java and JavaScript must be enabled in the browser.

`NAME`

`applet-name`, optional. Allows simultaneously running applets to communicate by this name. Default: the applet's class name.

`OBJECT`

`serialized-applet`. This parameter or the `CODE` parameter is required. Name of applet saved to a file as a serialized object. When loaded, `init()` is not called again but `start()` is. Parameters for running the applet are taken from this `<APPLET>` tag, not the original.

`VSPACE`

`vertical-pixel-margin`, optional. Vertical margin above and below the applet, in pixels.

`WIDTH`

`applet-pixel-width`, required. Initial width of applet in pixels. Many browsers do not allow applets to change their width.

The `<PARAM>` tag may appear between the `<APPLET>` and `</APPLET>` tags:

<PARAM>

The <PARAM> tag allows the HTML author to provide run-time parameters to the applet as a series of NAME and VALUE pairs. The NAME is case insensitive, a String. See Chapter 14, *And Then There Were Applets* for a discussion of how to read parameters in an applet. Quotes are required around the parameter name or its value if there are any embedded spaces. There can be an infinite number of <PARAM> tags, and they all must appear between <APPLET> and </APPLET>

The special parameter name CABBASE is used for sending CAB files with Internet Explorer 3.0. CAB files are similar to ZIP files but are compressed into a CABinet file and can store audio and image files, in addition to classes. (For a full explanation see: http://207.68.137.43/workshop/java/overview.htm.) When *.class* files are placed within a CAB file, they are decompressed at the local end. Here's an example:

```
<APPLET CODE="oreilly.class" WIDTH=400 HEIGHT=400>
<PARAM NAME="cabbase" VALUE="ora.cab>
</APPLET>
```

The special parameter name ARCHIVES is reserved for sending JAR files. JAR files can also be specified using the ARCHIVES parameter to the <APPLET> tag.*
Here's an example:

```
<APPLET CODE="oreilly.class" WIDTH=400 HEIGHT=400>
<PARAM NAME="archives" VALUE="ora.jar>
</APPLET>
```

* For a full explanation see http://www.javasoft.com/products/JDK/1.1/docs/guide/jar/index.html.

In this appendix:

- *The Results*
- *Test Program*

C

Platform-Specific Event Handling

My life with Java began in September of 1995. I started on a Sun Sparc20 and have since used Java on Windows 95, Windows NT (3.51/4.0), a PowerMac, and an early version of a Java terminal. At the time I started using Java, it was in its alpha 3 release. Even before the beta release, the Internet crowd was hailing Java as the programming language for the next millennium, and people were lining up to take Sun's Java training classes.

Although Java has many important features, probably the most important is platform independence: you can compile a program once and run it anywhere. At least, that was the goal; and Java came impressively close to meeting that goal. However, there are some problems, particularly in the area of event handling. Java programs just do not act the same, from platform to platform, environment to environment. Even if you stay within Sun's Java Developer's Kit, you cannot take a program created on one platform, move it to another, and be guaranteed that it will react the same way to the user's interactions. To make matters worse, Netscape, the makers of the first run-time environment for beta API applets, Netscape, decided to take matters into its own hands with Navigator version 3.0; its version of AWT behaves slightly differently than the JDK's. On top of that, Navigator itself differs from platform to platform. Version 1.1 of the JDK introduces more idiosyncrasies, even as it resolves some others.

With more Java environments available, HotJava, Internet Explorer, and Java terminals to name a few, and new official extensions to AWT coming out, the differences are expanding, instead of contracting. Hopefully, there will be a day when this appendix can go away, completely. Until that time, I've tried to document the behavior of different run-time systems, on different platforms. If the platform is not included in this appendix, the source for a test program is. If you run the program on your platform and send the results to me at *jaz@ora.com*, they will be included in a future printing or provided online. The test program requires user-interaction, so please follow directions carefully. Between printings, the book's Web site will maintain the latest information at http://www.ora.com/catalog/javawt/. Only the results from using the latest releases of each platform are included in Table C-1.

C.1 The Results

Table C-1 shows the events delivered to each component on the major platforms in Java 1.0. An ✓ in a particular entry means that the event is passed to Java from the component's peer; a dash means it is not.

Table C–1: Component Events in Java 1.0

Component/Events vs. Run-time/Platform	**NN3.0 NT/ Win95**	**NN3.0 Mac**	**NN3.0 Sun**	**SDK NT/ Win95**	**JDK NT/ Win95**	**JDK Mac**	**JDK Sun Win95**	**IE3.0 NT/ Win95**	**HJ NT/**	**HJ Sun**
					Button					
KEY_PRESS	✓	—	✓	✓	✓	—	✓	✓	✓	✓
KEY_RELEASE	✓	—	✓	✓	✓	—	✓	✓	✓	✓
KEY_ACTION	✓	—	—	✓	✓	—	✓	✓	✓	✓
KEY_ACTION_RELEASE	✓	—	—	✓	✓	—	✓	✓	✓	✓
MOUSE_DOWN	✓	—	—	—	—		—	—	—	—
MOUSE_UP	✓	✓	—	—	—		—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GOT_FOCUS	✓	—	—	—	—	—	✓	—	—	—
LOST_FOCUS	✓	—	—	—	—	—	✓	—	—	—
					Canvas					
KEY_PRESS	✓	✓	✓	✓	✓	✓	—	✓	✓	—
KEY_RELEASE	✓	✓	✓	✓	✓	✓	—	✓	✓	—
KEY_ACTION	✓	✓	—	✓	✓	✓	—	✓	✓	—
KEY_ACTION_RELEASE	✓	✓	—	✓	✓	—	—	✓	✓	—
MOUSE_DOWN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MOUSE_UP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table C–1: Component Events in Java 1.0 (continued)

Component/Events vs. Run-time/Platform	**NN3.0 NT/ Win95**	**NN3.0 Mac**	**NN3.0 Sun**	**SDK NT/ Win95**	**JDK NT/ Win95**	**JDK Mac**	**JDK Sun Win95**	**IE3.0 NT/ Win95**	**HJ NT/**	**HJ Sun**
MOUSE_MOVE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MOUSE_ENTER	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MOUSE_EXIT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MOUSE_DRAG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ACTION_EVENT	—	—	—	—	—	—	—	—	—	—
GOT_FOCUS	✓	✓	—	✓	✓	✓	—	✓	✓	—
LOST_FOCUS	✓	✓	—	✓	✓	✓	—	✓	✓	—
Checkbox										
KEY_PRESS	✓	—	✓	✓	✓	—	✓	✓	✓	—
KEY_RELEASE	✓	—	✓	✓	✓	—	✓	✓	✓	—
KEY_ACTION	✓	—	—	✓	✓	—	✓	✓	✓	—
KEY_ACTION_RELEASE	✓	—	—	✓	✓	—	✓	✓	✓	—
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GOT_FOCUS	✓	—	—	—	—	—	✓	—	—	—
LOST_FOCUS	✓	—	—	—	—	—	✓	—	—	—
Choice										
KEY_PRESS	✓	—	—	✓	✓	—	—	✓	✓	—
KEY_RELEASE	✓	—	—	✓	✓	—	—	✓	✓	—
KEY_ACTION	✓	—	—	✓	✓	—	—	✓	✓	—
KEY_ACTION_RELEASE	✓	—	—	✓	✓	—	—	✓	✓	—
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	—	✓	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	✓	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	✓	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	✓	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table C–1: Component Events in Java 1.0 (continued)

Component/Events vs. Run-time/Platform	**NN3.0 NT/ Win95**	**NN3.0 Mac**	**NN3.0 Sun**	**SDK NT/ Win95**	**JDK NT/ Win95**	**JDK Mac**	**JDK Sun Win95**	**IE3.0 NT/ Win95**	**HJ NT/**	**HJ Sun**
GOT_FOCUS	✓	—	—	—	—	—	—	—	—	—
LOST_FOCUS	✓	—	—	—	—	—	—	—	—	—
Label										
KEY_PRESS	✓	—	✓	—	—	—	✓	—	—	—
KEY_RELEASE	✓	—	✓	—	—	—	✓	—	—	—
KEY_ACTION	✓	—	—	—	—	—	✓	—	—	—
KEY_ACTION_RELEASE	✓	—	—	—	—	—	✓	—	—	—
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	—	—	—	—	—	—	—	—	—	—
GOT_FOCUS	✓	—	—	—	—	—	—	—	—	—
LOST_FOCUS	✓	—	—	—	—	—	—	—	—	—
List										
KEY_PRESS	✓	—	—	✓	✓	—	✓	✓	✓	—
KEY_RELEASE	✓	—	—	✓	✓	—	✓	✓	✓	—
KEY_ACTION	✓	—	—	✓	✓	—	✓	✓	✓	—
KEY_ACTION_RELEASE	✓	—	—	✓	✓	—	✓	✓	✓	—
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
LIST_SELECT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LIST_DESELECT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ACTION_EVENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GOT_FOCUS	✓	—	—	—	—	—	✓	—	—	—
LOST_FOCUS	✓	—	—	—	—	—	✓	—	—	—

Table C–1: Component Events in Java 1.0 (continued)

Component/Events vs. Run-time/Platform	**NN3.0 NT/ Win95**	**NN3.0 Mac**	**NN3.0 Sun**	**SDK NT/ Win95**	**JDK NT/ Win95**	**JDK Mac**	**JDK Sun Win95**	**IE3.0 NT/ Win95**	**HJ NT/**	**HJ Sun**
					Scrollbar					
KEY_PRESS	—	—	✓	—	—	—	—	—	—	—
KEY_RELEASE	—	—	✓	—	—	—	—	—	—	—
KEY_ACTION	—	—	—	—	—	—	—	—	—	—
KEY_ACTION_RELEASE	—	—	—	—	—	—	—	—	—	—
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	—	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	—	✓	—	—	—	—	—	—	—	—
SCROLL_LINE_UP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SCROLL_LINE_DOWN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SCROLL_PAGE_UP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SCROLL_PAGE_DOWN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SCROLL_ABSOLUTE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ACTION_EVENT	—	—	—	—	—	—	—	—	—	—
GOT_FOCUS	—	—	—	—	—	—	✓	—	—	—
LOST_FOCUS	—	—	—	—	—	—	✓	—	—	—
					TextArea					
KEY_PRESS	✓	✓	—	✓	✓	✓	✓	✓	✓	✓
KEY_RELEASE	✓	✓	—	✓	✓	✓	✓	✓	✓	✓
KEY_ACTION	✓	—	—	✓	✓	✓	✓	✓	✓	✓
KEY_ACTION_RELEASE	✓	—	—	✓	✓	—	✓	✓	✓	✓
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	—	—	—	—	—	—	—	—	—	—
GOT_FOCUS	✓	✓	✓	—	—	✓	✓	—	—	✓
LOST_FOCUS	✓	✓	✓	—	—	✓	✓	—	—	✓

Table C–1: Component Events in Java 1.0 (continued)

Component/Events vs. Run-time/Platform	**NN3.0 NT/ Win95**	**NN3.0 Mac**	**NN3.0 Sun**	**SDK NT/ Win95**	**JDK NT/ Win95**	**JDK Mac**	**JDK Sun Win95**	**IE3.0 NT/ Win95**	**HJ NT/**	**HJ Sun**
TextField										
KEY_PRESS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KEY_RELEASE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KEY_ACTION	✓	✓	—	✓	✓	✓	✓	✓	✓	✓
KEY_ACTION_RELEASE	✓	✓	—	✓	✓	—	✓	✓	✓	✓
MOUSE_DOWN	✓	—	—	—	—	—	—	—	—	—
MOUSE_UP	✓	✓	—	—	—	—	—	—	—	—
MOUSE_MOVE	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_ENTER	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_EXIT	✓	✓	—	—	—	✓	—	—	—	—
MOUSE_DRAG	✓	✓	—	—	—	—	—	—	—	—
ACTION_EVENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GOT_FOCUS	✓	✓	✓	—	—	✓	✓	—	—	✓
LOST_FOCUS	✓	✓	✓	—	—	✓	✓	—	—	✓

Key:

IE Microsoft's Internet Explorer

HJ Sun's Hot Java Prebeta 1

JDK
Java Developer's Kit 1.0.2 (*appletviewer*/Java)

NN
Netscape Navigator

SDK
Microsoft SDK

Sun
Solaris 2.x (UNIX/Motif)

Yes, things changed again with the 1.1 release. Table C-2 shows which Java 1.0 events are generated for each component in Java 1.1. Fortunately, there is one clear improvement: the Java 1.1 event model promises much more uniform event processing, since it's largely under your control. For example, you can attach a `MouseListener` to a `Label` and receive mouse events that would not be generated with the 1.0 event model.

Table C–2: Java 1.0 Component Events in Java 1.1

Component/Events vs. Run-time/Platform	**HJ/JDK WinNT/95**	**HJ/JDK Sun**
Button		
KEY_PRESS	✓	✓
KEY_RELEASE	✓	✓
KEY_ACTION	✓	✓
KEY_ACTION_RELEASE	✓	✓
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	✓	✓
GOT_FOCUS	✓	✓
LOST_FOCUS	✓	✓
Canvas		
KEY_PRESS	—	—
KEY_RELEASE	—	—
KEY_ACTION	—	—
KEY_ACTION_RELEASE	—	—
MOUSE_DOWN	✓	✓
MOUSE_UP	✓	✓
MOUSE_MOVE	✓	✓
MOUSE_ENTER	✓	✓
MOUSE_EXIT	✓	✓
MOUSE_DRAG	✓	✓
ACTION_EVENT	—	—
GOT_FOCUS	—	—
LOST_FOCUS	—	—
Checkbox		
KEY_PRESS	✓	✓
KEY_RELEASE	✓	✓
KEY_ACTION	✓	—
KEY_ACTION_RELEASE	✓	—
MOUSE_DOWN	—	—

Table C–2: Java 1.0 Component Events in Java 1.1 (continued)

Component/Events vs. Run-time/Platform	**HJ/JDK WinNT/95**	**HJ/JDK Sun**
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	✓	✓
GOT_FOCUS	✓	✓
LOST_FOCUS	✓	✓
Choice		
KEY_PRESS	✓	—
KEY_RELEASE	✓	—
KEY_ACTION	✓	—
KEY_ACTION_RELEASE	✓	—
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	✓	✓
GOT_FOCUS	✓	—
LOST_FOCUS	✓	—
Label		
KEY_PRESS	—	—
KEY_RELEASE	—	—
KEY_ACTION	—	—
KEY_ACTION_RELEASE	—	—
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	—	—

Table C–2: Java 1.0 Component Events in Java 1.1 (continued)

Component/Events vs. Run-time/Platform	**HJ/JDK WinNT/95**	**HJ/JDK Sun**
GOT_FOCUS	—	—
LOST_FOCUS	—	—
List		
KEY_PRESS	✓	✓
KEY_RELEASE	✓	✓
KEY_ACTION	✓	✓
KEY_ACTION_RELEASE	✓	✓
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
LIST_SELECT	✓	✓
LIST_DESELECT	✓	✓
ACTION_EVENT	✓	✓
GOT_FOCUS	✓	✓
LOST_FOCUS	✓	✓
ScrollBar		
KEY_PRESS	—	—
KEY_RELEASE	—	—
KEY_ACTION	—	—
KEY_ACTION_RELEASE	—	—
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
SCROLL_LINE_UP	✓	✓
SCROLL_LINE_DOWN	✓	✓
SCROLL_PAGE_UP	✓	✓
SCROLL_PAGE_DOWN	✓	✓
SCROLL_ABSOLUTE	✓	✓

Table C–2: Java 1.0 Component Events in Java 1.1 (continued)

Component/Events vs. Run-time/Platform	**HJ/JDK WinNT/95**	**HJ/JDK Sun**
ACTION_EVENT	—	—
GOT_FOCUS	—	✓
LOST_FOCUS	—	✓
TextArea		
KEY_PRESS	✓	✓
KEY_RELEASE	✓	✓
KEY_ACTION	✓	✓
KEY_ACTION_RELEASE	✓	✓
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	—	—
GOT_FOCUS	✓	✓
LOST_FOCUS	✓	✓
TextField		
KEY_PRESS	✓	✓
KEY_RELEASE	✓	✓
KEY_ACTION	✓	✓
KEY_ACTION_RELEASE	✓	✓
MOUSE_DOWN	—	—
MOUSE_UP	—	—
MOUSE_MOVE	—	—
MOUSE_ENTER	—	—
MOUSE_EXIT	—	—
MOUSE_DRAG	—	—
ACTION_EVENT	✓	✓
GOT_FOCUS	✓	✓
LOST_FOCUS	✓	✓

Key:

HJ Sun's Hot Java Prebeta 2

JDK
Java Developer's Kit 1.1 (*appletviewer*/Java)

Sun
Solaris 2.x (UNIX/Motif)

C.2 Test Program

The test program, `compList`, listed in Section C.2.2 shows the events peers pass along to the Java run-time system. You can then examine the output to see how the run-time system reacts to the different events. When you run `compList`, the screen looks something like the one in Figure C-1.

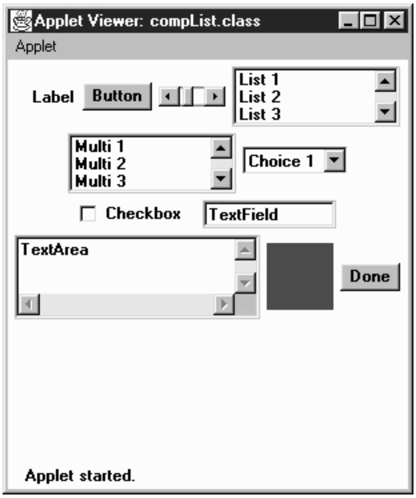


Figure C–1: Test program

C.2.1 How to Use the Program

Java does not have an automated record and playback feature, so the work is left for you to do. The program displays 10 components: `Label`, `Button`, `Scrollbar`, `List`, multiselection `List`, `Choice`, `Checkbox`, `TextField`, `TextArea`, and `Canvas` (the black box in Figure C-1). Basically, you must manually trigger every event for every component.

For *every* component on the screen (except Done), do the following:

With the mouse
: Move the cursor over the object, press the mouse button and release, and drag the cursor over the object.

With the keyboard
: Press and release an alphabetic key, press and release the Home and End keys, arrow keys, and function keys. Do this for every component, even for components like `Button` and `Label` that have no logical reason for using keyboard events.

For items with choices
: Select and deselect a few choices; double-click and single-click selections.

For the scrollbar
: Click on each arrow, drag the slider, and click in the paging area (the space between each arrow and the slider).

For the text field
: Press Enter.

When finished
: Press the Done button, and analyze the results. Run the program again (without exiting), and check the results again. Try to trigger any specific events that you expect but didn't appear in the output from the first pass. Generating some events requires a little work. For example, on a Macintosh, in order to get the `MOUSE_UP` and `MOUSE_DRAG` events, you must do a `MOUSE_DOWN` off the component; otherwise, the `MOUSE_DOWN`/`MOUSE_UP` combination turns into an `ACTION_EVENT`, if that component can generate it.

NOTE The SunTest business unit of Sun Microsystems has an early version of a record and playback Java GUI testing tool called JavaSTAR. Information about it is available at http://www.suntest.com/JavaSTAR/JavaSTAR.html. In the future, it may be possible to use JavaSTAR to help automate this process.

C.2.2 Source Code

The following is the source code for the test program:

```
import java.awt.*;
import java.util.*;
import java.applet.*;
public class compList extends Applet {
    Button done = new Button ("Done");
    Hashtable values = new Hashtable();
```

```
public void init () {
    add (new Label ("Label"));
    add (new Button ("Button"));
    add (new Scrollbar (Scrollbar.HORIZONTAL, 50, 25, 0, 255));
    List l1 = new List (3, false);
    l1.addItem ("List 1");
    l1.addItem ("List 2");
    l1.addItem ("List 3");
    l1.addItem ("List 4");
    l1.addItem ("List 5");
    add (l1);
    List l2 = new List (3, true);
    l2.addItem ("Multi 1");
    l2.addItem ("Multi 2");
    l2.addItem ("Multi 3");
    l2.addItem ("Multi 4");
    l2.addItem ("Multi 5");
    add (l2);
    Choice c = new Choice ();
    c.addItem ("Choice 1");
    c.addItem ("Choice 2");
    c.addItem ("Choice 3");
    c.addItem ("Choice 4");
    c.addItem ("Choice 5");
    add (c);
    add (new Checkbox ("Checkbox"));
    add (new TextField ("TextField", 10));
    add (new TextArea ("TextArea", 3, 20));
    Canvas c1 = new Canvas ();
    c1.resize (50, 50);
    c1.setBackground (Color.blue);
    add (c1);
    add (done);
}
public boolean handleEvent (Event e) {
    if (e.target == done) {
        if (e.id == Event.ACTION_EVENT) {
            System.out.println (System.getProperty ("java.vendor"));
            System.out.println (System.getProperty ("java.version"));
            System.out.println (System.getProperty ("java.class.version"));
            System.out.println (System.getProperty ("os.name"));
            System.out.println (values);
        }
    }else {
        Vector v;
        Class c = e.target.getClass();
        v = (Vector)values.get(c);
        if (v == null)
            v = new Vector();
        Integer i = new Integer (e.id);
        if (!v.contains (i)) {
            v.addElement (i);
            values.put (c, v);
        }
```

```
        }

        return super.handleEvent (e);
    }
}
```

An HTML document to display the applet in a browser should look something like the following:

```
<APPLET code="compList.class" height=300 width=300>
</APPLET>
```

C.2.3 Examining Results

The results of the program are sent to standard output when you click on the Done button. What happens to the output depends on the platform. It may be sent to a log file (Internet Explorer), the Java Console (Netscape Navigator), or the command line (appletviewer). The following is sample output from Internet Explorer 3.0 on a Windows 95 platform.

```
Microsoft Corp.
1.0.2
45.3
Windows 95
{class java.awt.Canvas=[504, 503, 1004, 501, 506, 502, 505, 1005,
401, 402, 403, 404], class java.awt.Choice=[1001, 401, 402, 403,
404], class java.awt.Checkbox=[1001, 402, 401, 403, 404], class
compList=[504, 503, 501, 506, 502, 505, 1004, 1005], class java.
awt.TextField=[401, 402, 403, 404], class java.awt.List=[701,
1001, 401, 402, 403, 404, 702], class java.awt.Scrollbar=[602,
605, 604, 603, 601], class java.awt.TextArea=[401, 402, 403, 404],
class java.awt.Button=[1001, 401, 402, 403, 404]}
```

In addition to some identifying information about the run-time environment, the program displays a list of classes and the events they passed. The integers represent the event constants of the `Event` class; for example, `Canvas` received events with identifiers 504, 503, etc. The events are not sorted, so you can see the order in which they were sent. Unfortunately, you have to look up these constants in the source code yourself. The class listed as `compList` is the applet itself and shows you the events that the `Applet` class receives.

In this appendix:
- *How Images are Loaded*
- *A Brief Tour of sun.awt.image*

D

Image Loading

D.1 How Images are Loaded

You have seen how easy it is to display an image on screen and have probably guessed that there's more going on behind the scenes. The `getImage()` and `drawImage()` methods trigger a series of events that result in the image being available for display on the `ImageObserver`. The image is fetched asynchronously in another thread. The entire process* goes as follows:

1. The call to `getImage()` triggers `Toolkit` to call `createImage()` for the image's `InputStreamImageSource` (which is a `URLImageSource` in this case; it would be a `FileImageSource` if we were loading the image from a local file).
2. The `Toolkit` registers the image as being "desired." Desired just means that something will eventually want the image loaded. The system then waits until an `ImageObserver` registers its interest in the image.
3. The `drawImage()` method (use of `MediaTracker` or `prepareImage()`) registers an `ImageObserver` as interested.
4. Registering an `ImageObserver` kicks the image's `ImageRepresentation` into action; this is the start of the loading process, although image data isn't actually transferred until step 9. `ImageRepresentation` implements the `ImageConsumer` interface.
5. The start of production registers the image source (`ImageProducer` `URLImageSource`) with the `ImageFetcher` and also registers the `ImageRepresentation` as an `ImageConsumer` for the image.

* This summary covers Sun's implementation (JDK). Implementations that don't derive from the JDK may behave completely differently.

6. The ImageFetcher creates a thread to get the image from its source.
7. The ImageFetcher reads data and passes it along to the InputStreamImageSource, which is a URLImageSource.
8. The URLImageSource determines that JPEGImageDecoder is the proper ImageDecoder for converting the input stream into an Image. (Other ImageDecoders are used for other image types, like GIF.)
9. The ImageProducer starts reading the image data from the source; it calls the ImageConsumer (i.e., the ImageRepresentation) as it processes the image. The most important method in the ImageConsumer interface is setPixels(), which delivers pixel data to the consumer for rendering onscreen.
10. As the ImageConsumer (i.e., the ImageRepresentation) gets additional information, it notifies the ImageObserver via imageUpdate() calls.
11. When the image is fully acquired across the network, the thread started by the ImageFetcher stops.

As you see, there are a lot of unfamiliar moving pieces. Many of them are from the java.awt.image package and are discussed in Chapter 12, *Image Processing*. Others are from the sun.awt.image package; they are hidden in that you don't need to know anything about them to do image processing in Java. However, if you're curious, we'll briefly summarize these classes in the next section.

D.2 A Brief Tour of sun.awt.image

The classes in sun.awt.image do the behind-the-scenes work for rendering an image from a file or across the network. This information is purely for the curious; you should never have to work with these classes yourself.

Image

The Image class in this package represents a concrete Image instance. It contains the basis for the Image class that is actually used on the run-time platform, which exists in the package for the specific environment. For instance, the sun.awt.win32 package includes the W32Image (Java 1.0), the sun.awt.windows package includes WImage (Java 1.1), while the sun.awt.motif package includes the X11Image, and the sun.awt.macos package includes the MacImage.

ImageRepresentation

The ImageRepresentation is the ImageConsumer that watches the creation of the image and notifies the ImageObserver when it is time to update the display. It plays an important part in the overall control of the Image production process.

Image sources

A Java image can come from three different sources: memory (through `createImage()`), local disk, or the network (through `getImage()`).

- `OffScreenImageSource` implements `ImageProducer` for a single framed image in memory. When an `Image` created from an `OffScreenImageSource` is drawn with `drawImage()`, the `ImageObserver` parameter can be `null` since all the image information is already in memory and there is no need for periodic updating as more is retrieved from disk. You can get the graphics context of `OffScreenImageSource` images and use the context to draw on the image area. This is how double buffering works.
- `InputStreamImageSource` implements `ImageProducer` for an image that comes from disk or across the network. When an `Image` created from an `InputStreamImageSource` is drawn with `drawImage()`, the `ImageObserver` parameter should be the component being drawn on (usually `this`) since the image information will be loaded periodically with the help of the `ImageObserver` interface). This class determines how to decode the image type and initializes the `ImageDecoder` to one of `GifImageDecoder`, `JPEGImageDecoder`, or `XbmImageDecoder`, although that can be overridden by a subclass. It can use a `ContentHandler` to work with unknown image types.
- `FileImageSource` is a subclass of `InputStreamImageSource` for images that come from the filesystem. It uses the filename to determine the type of image to decode and checks the security manager to ensure that access is allowed.
- `URLImageSource` is a subclass of `InputStreamImageSource` for images that are specified by a URL.
- `ByteArrayImageSource` (Java 1.1 only) is a subclass of `InputStreamImageSource` for images that are created by calling `Toolkit.createImage(byte[])`.

Image decoders

An `ImageDecoder` is utilized to convert the image source to an image object. If there is no decoder for an image type, it can be read in with the help of a `ContentHandler` or your own class that implements `ImageProducer`, like the `PPMImageDecoder` shown in Chapter 12.

- `GifImageDecoder` reads in an image file in the GIF format.
- `JPEGImageDecoder` reads in an image file in the JPEG format.

- `XbmImageDecoder` reads in an image file in the XBM format. Although XBM support is not required by the language specification, support is provided with Netscape Navigator, Internet Explorer, HotJava, and the Java Developer's Kit from Sun.

`ImageFetcher`

The `ImageFetcher` class fetches the actual image from its source. This class creates a separate daemon thread to fetch each image. The thread is run at a higher priority than the default but not at the maximum priority.

Index

A

B

C

E

F

G

H

I

J

K

M

N

O

P

S

V

W

X