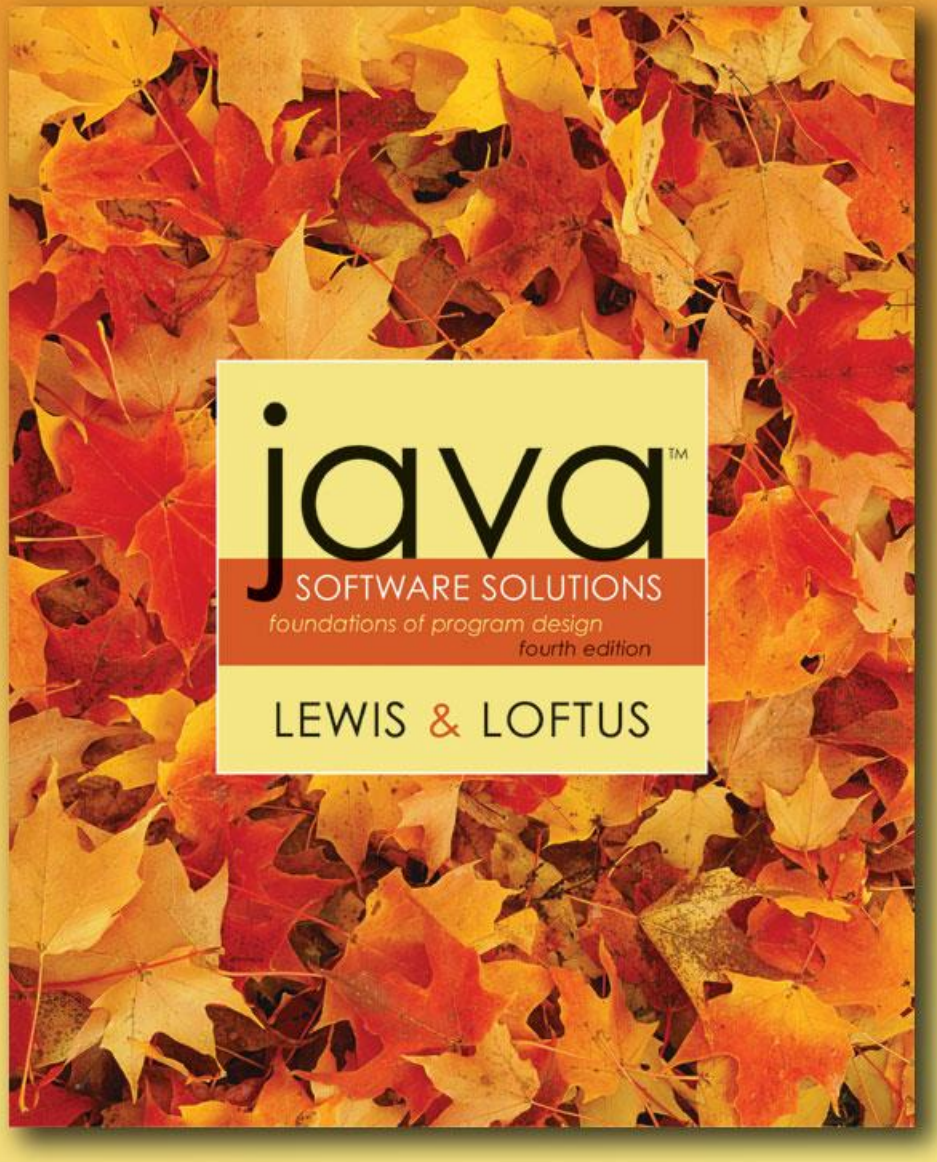
Chapter 3

Using Classes and Objects

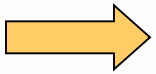


PEARSON Addison Wesley

Using Classes and Objects

- We can create more interesting programs using predefined classes and related objects
- Chapter 3 focuses on:
  - object creation and object references
  - the `String` class and its methods
  - the Java standard class library
  - the `Random` and `Math` classes
  - formatting output
  - enumerated types
  - wrapper classes
  - graphical components and containers
  - labels and images

Outline



- Creating Objects
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- Packages
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- Images

Creating Objects

- A variable holds either a primitive type or a *reference* to an object
- A class name can be used as a type to declare an *object reference variable*

```
String title;
```

- No object is created with this declaration
- An object reference variable holds the address of an object
- The object itself must be created separately

Creating Objects

- Generally, we use the `new` operator to create an object

```
title = new String ("Java Software Solutions");
```

This calls the String *constructor*, which is a special method that sets up the object

- Creating an object is called *instantiation*
- An object is an *instance* of a particular class

Invoking Methods

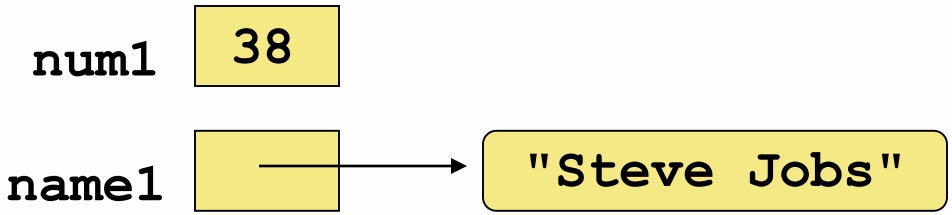
- We've seen that once an object has been instantiated, we can use the *dot operator* to invoke its methods

```
count = title.length()
```

- A method may *return a value*, which can be used in an assignment or expression
- A method invocation can be thought of as asking an object to perform a service

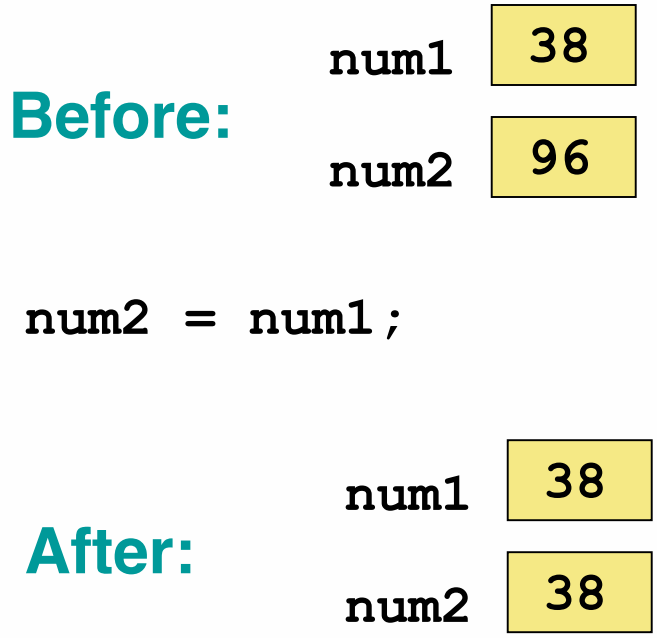
References

- Note that a primitive variable contains the value itself, but an object variable contains the address of the object
- An object reference can be thought of as a pointer to the location of the object
- Rather than dealing with arbitrary addresses, we often depict a reference graphically



Assignment Revisited

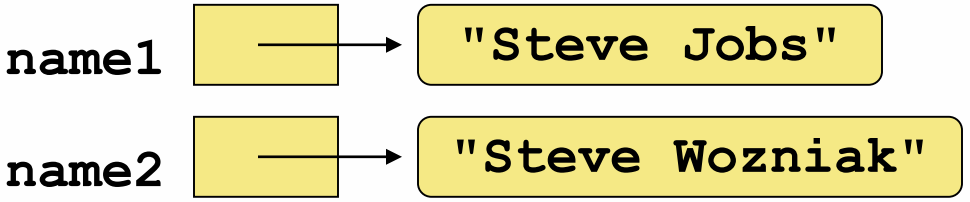
- The act of assignment takes a copy of a value and stores it in a variable
- For primitive types:



Reference Assignment

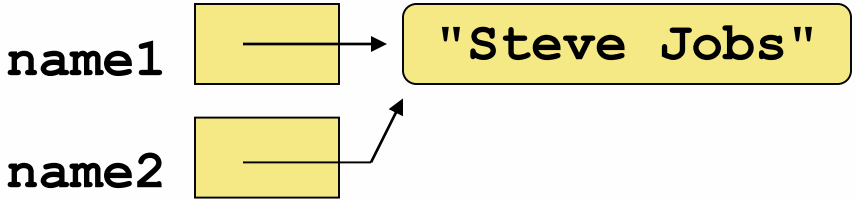
- **For object references, assignment copies the address:**

Before:




```
name2 = name1;
```

After:



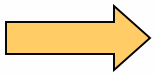
Aliases

- Two or more references that refer to the same object are called *aliases* of each other
- That creates an interesting situation: one object can be accessed using multiple reference variables
- Aliases can be useful, but should be managed carefully
- Changing an object through one reference changes it for all of its aliases, because there is really only one object

Garbage Collection

- When an object no longer has any valid references to it, it can no longer be accessed by the program
- The object is useless, and therefore is called *garbage*
- Java performs *automatic garbage collection* periodically, returning an object's memory to the system for future use
- In other languages, the programmer is responsible for performing garbage collection

Outline



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The String Class

- Because strings are so common, we don't have to use the `new` operator to create a `String` object

```
title = "Java Software Solutions";
```

- This is special syntax that works only for strings
- Each string literal (enclosed in double quotes) represents a `String` object

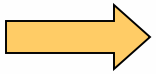
String Methods

- Once a `String` object has been created, neither its value nor its length can be changed
- Thus we say that an object of the `String` class is *immutable*
- However, several methods of the `String` class return new `String` objects that are modified versions of the original
- See the list of `String` methods on page 119 and in Appendix M

String Indexes

- It is occasionally helpful to refer to a particular character within a string
- This can be done by specifying the character's numeric *index*
- The indexes begin at zero in each string
- In the string `"Hello"`, the character `'H'` is at index 0 and the `'o'` is at index 4
- See StringMutation.java (page 120)

Outline



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Class Libraries

- A *class library* is a collection of classes that we can use when developing programs
- The *Java standard class library* is part of any Java development environment
- Its classes are not part of the Java language per se, but we rely on them heavily
- Various classes we've already used (`System`, `Scanner`, `String`) are part of the Java standard class library
- Other class libraries can be obtained through third party vendors, or you can create them yourself

Packages

- **The classes of the Java standard class library are organized into *packages***
- **Some of the packages in the standard class library are:**

Package	Purpose
java.lang	General support
java.applet	Creating applets for the web
java.awt	Graphics and graphical user interfaces
javax.swing	Additional graphics capabilities
java.net	Network communication
java.util	Utilities
javax.xml.parsers	XML document processing

The import Declaration

- When you want to use a class from a package, you could use its *fully qualified name*

```
java.util.Scanner
```

- Or you can *import* the class, and then use just the class name

```
import java.util.Scanner;
```

- To import all classes in a particular package, you can use the * wildcard character

```
import java.util.*;
```

The import Declaration

- All classes of the `java.lang` package are imported automatically into all programs
- It's as if all programs contain the following line:

```
import java.lang.*;
```

- That's why we didn't have to import the `System` or `String` classes explicitly in earlier programs
- The `Scanner` class, on the other hand, is part of the `java.util` package, and therefore must be imported

The Random Class

- The `Random` class is part of the `java.util` package
- It provides methods that generate pseudorandom numbers
- A `Random` object performs complicated calculations based on a *seed value* to produce a stream of seemingly random values
- See RandomNumbers.java (page 126)

The Math Class

- The `Math` class is part of the `java.lang` package
- The `Math` class contains methods that perform various mathematical functions
- These include:
  - absolute value
  - square root
  - exponentiation
  - trigonometric functions

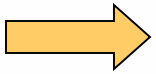
The Math Class

- The methods of the `Math` class are *static methods* (also called *class methods*)
- Static methods can be invoked through the class name – no object of the `Math` class is needed

```
value = Math.cos(90) + Math.sqrt(delta);
```

- See Quadratic.java (page 129)
- We discuss static methods further in Chapter 6

Outline



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Formatting Output

- It is often necessary to format values in certain ways so that they can be presented properly
- The Java standard class library contains classes that provide formatting capabilities
- The `NumberFormat` class allows you to format values as currency or percentages
- The `DecimalFormat` class allows you to format values based on a pattern
- Both are part of the `java.text` package

Formatting Output

- The `NumberFormat` class has static methods that return a formatter object

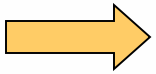
```
getCurrencyInstance()

getPercentInstance()
```

- Each formatter object has a method called `format` that returns a string with the specified information in the appropriate format
- See Purchase.java (page 131)

Formatting Output

- The `DecimalFormat` class can be used to format a floating point value in various ways
- For example, you can specify that the number should be truncated to three decimal places
- The constructor of the `DecimalFormat` class takes a string that represents a pattern for the formatted number
- See CircleStats.java (page 134)

Outline



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Enumerated Types

- Java allows you to define an enumerated type, which can then be used to declare variables
- An enumerated type establishes all possible values for a variable of that type
- The values are identifiers of your own choosing
- The following declaration creates an enumerated type called `Season`

```
enum Season {winter, spring, summer, fall};
```

- Any number of values can be listed

Enumerated Types

- Once a type is defined, a variable of that type can be declared

```
Season time;
```

  and it can be assigned a value

```
time = Season.fall;
```

- The values are specified through the name of the type
- Enumerated types are *type-safe* – you cannot assign any value other than those listed

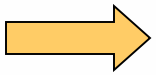
Ordinal Values

- Internally, each value of an enumerated type is stored as an integer, called its *ordinal value*
- The first value in an enumerated type has an ordinal value of zero, the second one, and so on
- However, you cannot assign a numeric value to an enumerated type, even if it corresponds to a valid ordinal value

Enumerated Types

- The declaration of an enumerated type is a special type of class, and each variable of that type is an object
- The `ordinal` method returns the ordinal value of the object
- The `name` method returns the name of the identifier corresponding to the object's value
- See IceCream.java (page 137)

Outline



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Wrapper Classes

- The `java.lang` package contains *wrapper classes* that correspond to each primitive type:

Primitive Type	Wrapper Class
`byte`	`Byte`
`short`	`Short`
`int`	`Integer`
`long`	`Long`
`float`	`Float`
`double`	`Double`
`char`	`Character`
`boolean`	`Boolean`
`void`	`Void`

Wrapper Classes

- The following declaration creates an `Integer` object which represents the integer 40 as an object

```
Integer age = new Integer(40);
```

- An object of a wrapper class can be used in any situation where a primitive value will not suffice
- For example, some objects serve as containers of other objects
- Primitive values could not be stored in such containers, but wrapper objects could be

Wrapper Classes

- Wrapper classes also contain static methods that help manage the associated type
- For example, the `Integer` class contains a method to convert an integer stored in a `String` to an `int` value:

```
num = Integer.parseInt(str);
```

- The wrapper classes often contain useful constants as well
- For example, the `Integer` class contains `MIN_VALUE` and `MAX_VALUE` which hold the smallest and largest `int` values

Autoboxing

- ***Autoboxing*** **is the automatic conversion of a primitive value to a corresponding wrapper object:**

```
Integer obj;
int num = 42;
obj = num;
```

- **The assignment creates the appropriate `Integer` object**
- **The reverse conversion (called *unboxing*) also occurs automatically as needed**

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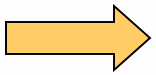

Graphical Applications

- Except for the applets seen in Chapter 2, the example programs we've explored thus far have been text-based
- They are called *command-line applications*, which interact with the user using simple text prompts
- Let's examine some Java applications that have graphical components
- These components will serve as a foundation to programs that have true graphical user interfaces (GUIs)

GUI Components

- A *GUI component* is an object that represents a screen element such as a button or a text field
- GUI-related classes are defined primarily in the `java.awt` and the `javax.swing` packages
- The *Abstract Windowing Toolkit* (AWT) was the original Java GUI package
- The *Swing* package provides additional and more versatile components
- Both packages are needed to create a Java GUI-based program

GUI Containers

- A *GUI container* is a component that is used to hold and organize other components
- A *frame* is a container that is used to display a GUI-based Java application
- A frame is displayed as a separate window with a title bar – it can be repositioned and resized on the screen as needed
- A *panel* is a container that cannot be displayed on its own but is used to organize other components
- A panel must be added to another container to be displayed

GUI Containers

- A GUI container can be classified as either heavyweight or lightweight
- A *heavyweight container* is one that is managed by the underlying operating system
- A *lightweight container* is managed by the Java program itself
- Occasionally this distinction is important
- A frame is a heavyweight container and a panel is a lightweight container

Labels

- A *label* is a GUI component that displays a line of text
- Labels are usually used to display information or identify other components in the interface
- Let's look at a program that organizes two labels in a panel and displays that panel in a frame
- See Authority.java (page 144)
- This program is not interactive, but the frame can be repositioned and resized

Nested Panels

- Containers that contain other components make up the *containment hierarchy* of an interface
- This hierarchy can be as intricate as needed to create the visual effect desired
- The following example nests two panels inside a third panel – note the effect this has as the frame is resized
- See NestedPanels.java (page 146)

Outline

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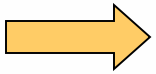

Images

Images

- Images are often used in a programs with a graphical interface
- Java can manage images in both JPEG and GIF formats
- As we've seen, a `JLabel` object can be used to display a line of text
- It can also be used to display an image
- That is, a label can be composed of text, and image, or both at the same time

Images

- The `ImageIcon` class is used to represent an image that is stored in a label
- The position of the text relative to the image can be set explicitly
- The alignment of the text and image within the label can be set as well
- See LabelDemo.java (page 149)

Summary

- **Chapter 3 focused on:**
  - **object creation and object references**
  - **the `String` class and its methods**
  - **the Java standard class library**
  - **the `Random` and `Math` classes**
  - **formatting output**
  - **enumerated types**
  - **wrapper classes**
  - **graphical components and containers**
  - **labels and images**