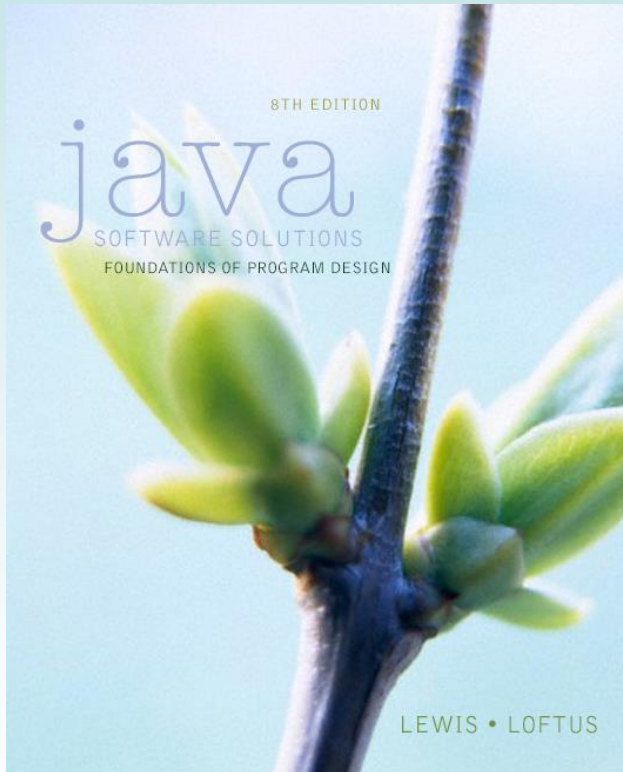


Chapter 3

Using Classes and Objects



Java Software Solutions

Foundations of Program Design

8th Edition

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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 API class library
 - the `Random` and `Math` classes
 - formatting output
 - enumerated types
 - wrapper classes
 - graphical components and containers
 - labels and images

Outline



Creating Objects

The String Class

The Random and Math Classes

Formatting Output

Enumerated Types

Wrapper Classes

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Images

Creating Objects

- A variable holds either a primitive value 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
- Creating an object is called *instantiation*
- An object is an *instance* of a particular class

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



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

Invoking Methods

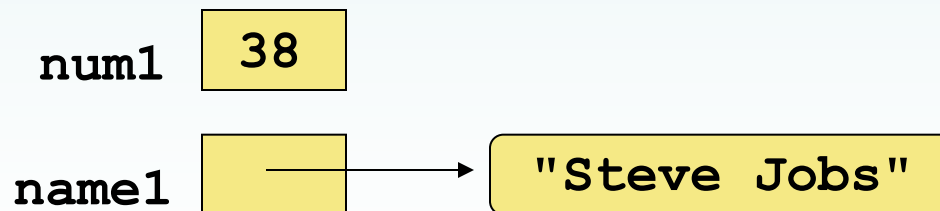
- We've seen that once an object has been instantiated, we can use the *dot operator* to invoke its methods

```
numChars = 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:

Before:

num1	38
num2	96

```
num2 = num1;
```

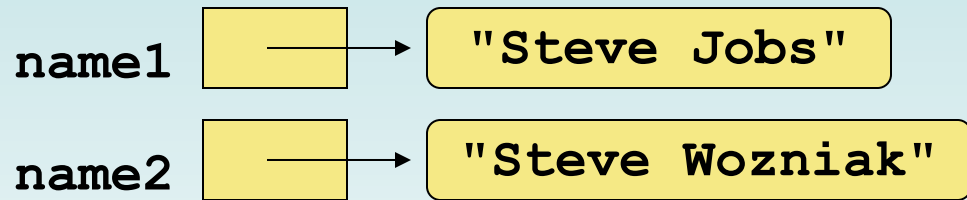
After:

num1	38
num2	38

Reference Assignment

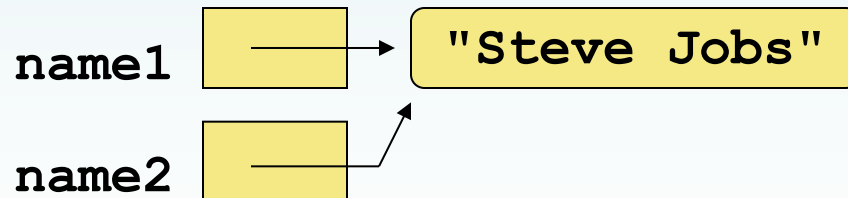
- For object references, assignment copies the address:

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

Creating Objects



The String Class

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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
- Therefore 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

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`

```

//*****
//  StringMutation.java          Author: Lewis/Loftus
//
//  Demonstrates the use of the String class and its methods.
//*****

public class StringMutation
{
    //-----
    //  Prints a string and various mutations of it.
    //-----
    public static void main(String[] args)
    {
        String phrase = "Change is inevitable";
        String mutation1, mutation2, mutation3, mutation4;

        System.out.println("Original string: \"" + phrase + "\"");
        System.out.println("Length of string: " + phrase.length());

        mutation1 = phrase.concat(", except from vending machines.");
        mutation2 = mutation1.toUpperCase();
        mutation3 = mutation2.replace('E', 'X');
        mutation4 = mutation3.substring(3, 30);
    }
}

```

continued

continued

```
// Print each mutated string
System.out.println("Mutation #1: " + mutation1);
System.out.println("Mutation #2: " + mutation2);
System.out.println("Mutation #3: " + mutation3);
System.out.println("Mutation #4: " + mutation4);

System.out.println("Mutated length: " + mutation4.length());
}
}
```

Output

Original string: "Change is inevitable"

Length of string: 20

Mutation #1: Change is inevitable, except from vending machines.

Mutation #2: CHANGE IS INEVITABLE, EXCEPT FROM VENDING MACHINES.

Mutation #3: CHANGX IS INXVITABLX, XXCXPT FROM VXNDING MACHINXS.

Mutation #4: NGX IS INXVITABLX, XXCXPT F

Mutated length: 27

```
        System.out.println("Mutated length: " + mutation4.length());  
    }  
}
```

Quick Check

What output is produced by the following?

```
String str = "Space, the final frontier.";
System.out.println(str.length());
System.out.println(str.substring(7));
System.out.println(str.toUpperCase());
System.out.println(str.length());
```

Quick Check

What output is produced by the following?

```
String str = "Space, the final frontier.";
System.out.println(str.length());
System.out.println(str.substring(7));
System.out.println(str.toUpperCase());
System.out.println(str.length());
```

```
26
the final frontier.
SPACE, THE FINAL FRONTIER.
26
```

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Class Libraries

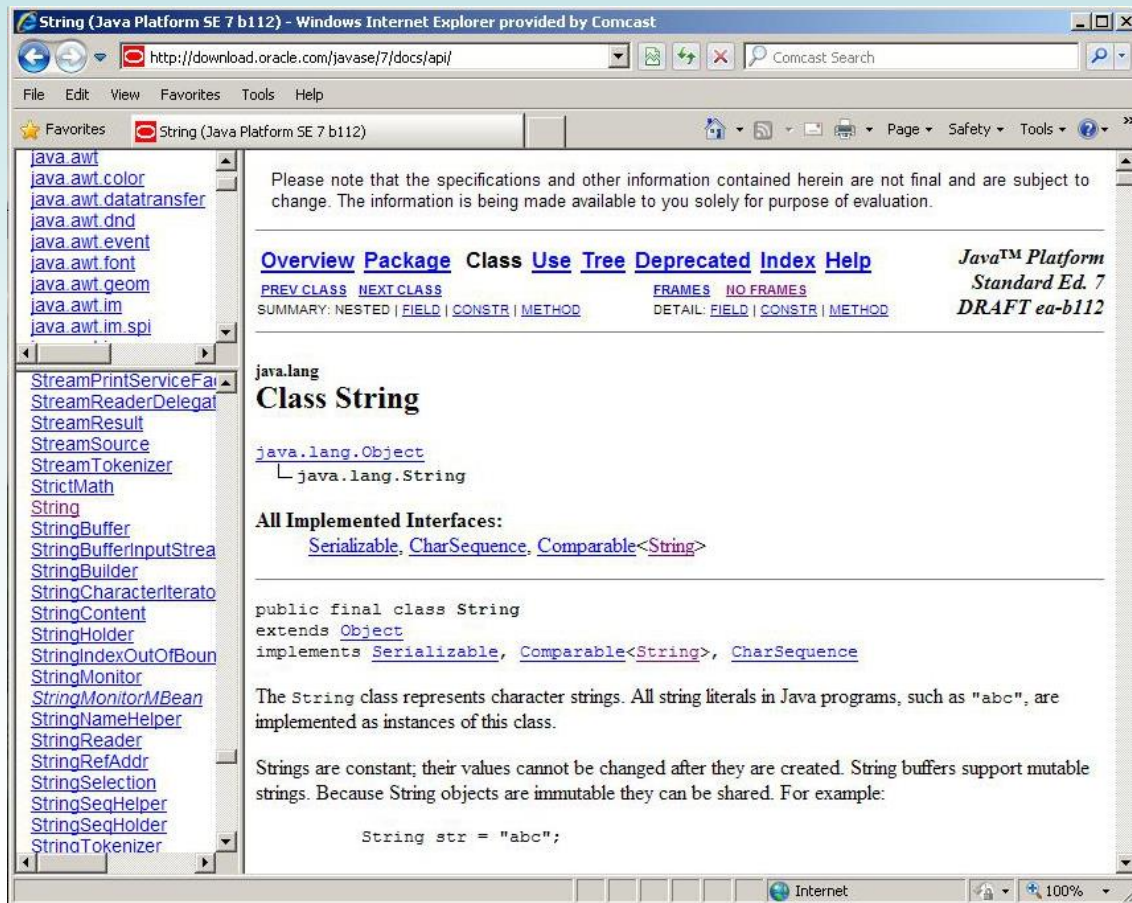
- A *class library* is a collection of classes that we can use when developing programs
- The *Java standard class library* is part of any Java development environment
- Its classes are not part of the Java language per se, but we rely on them heavily
- Various classes we've already used (`System`, `Scanner`,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

The Java API

- The Java class library is sometimes referred to as the Java API
- API stands for Application Programming Interface
- Clusters of related classes are sometimes referred to as specific APIs:
 - The Swing API
 - The Database API

The Java API

- Get comfortable navigating the online Java API documentation



Packages

- For purposes of accessing them, classes in the Java API are organized into *packages*
- These often overlap with specific APIs
- Examples:

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`

```

//*****
//  RandomNumbers.java          Author: Lewis/Loftus
//
//  Demonstrates the creation of pseudo-random numbers using the
//  Random class.
//*****

import java.util.Random;

public class RandomNumbers
{
    //-----
    //  Generates random numbers in various ranges.
    //-----
    public static void main(String[] args)
    {
        Random generator = new Random();
        int num1;
        float num2;

        num1 = generator.nextInt();
        System.out.println("A random integer: " + num1);

        num1 = generator.nextInt(10);
        System.out.println("From 0 to 9: " + num1);
    }
}

```

continued

continued

```
num1 = generator.nextInt(10) + 1;
System.out.println("From 1 to 10: " + num1);

num1 = generator.nextInt(15) + 20;
System.out.println("From 20 to 34: " + num1);

num1 = generator.nextInt(20) - 10;
System.out.println("From -10 to 9: " + num1);

num2 = generator.nextFloat();
System.out.println("A random float (between 0-1): " + num2);

num2 = generator.nextFloat() * 6; // 0.0 to 5.999999
num1 = (int)num2 + 1;
System.out.println("From 1 to 6: " + num1);
}
}
```

continued

Sample Run

```
num1 A random integer: 672981683
Syst From 0 to 9: 0
      From 1 to 10: 3
num1 From 20 to 34: 30
Syst From -10 to 9: -4
      A random float (between 0-1): 0.18538326
num1 From 1 to 6: 3
Syst
```

```
num2 = generator.nextFloat();
System.out.println("A random float (between 0-1): " + num2);

num2 = generator.nextFloat() * 6; // 0.0 to 5.999999
num1 = (int)num2 + 1;
System.out.println("From 1 to 6: " + num1);
}
}
```

Quick Check

Given a `Random` object named `gen`, what range of values are produced by the following expressions?

`gen.nextInt(25)`

`gen.nextInt(6) + 1`

`gen.nextInt(100) + 10`

`gen.nextInt(50) + 100`

`gen.nextInt(10) - 5`

`gen.nextInt(22) + 12`

Quick Check

Given a `Random` object named `gen`, what range of values are produced by the following expressions?

	<u>Range</u>
<code>gen.nextInt(25)</code>	0 to 24
<code>gen.nextInt(6) + 1</code>	1 to 6
<code>gen.nextInt(100) + 10</code>	10 to 109
<code>gen.nextInt(50) + 100</code>	100 to 149
<code>gen.nextInt(10) - 5</code>	-5 to 4
<code>gen.nextInt(22) + 12</code>	12 to 33

Quick Check

Write an expression that produces a random integer in the following ranges:

Range

0 to 12

1 to 20

15 to 20

-10 to 0

Quick Check

Write an expression that produces a random integer in the following ranges:

Range

0 to 12	<code>gen.nextInt(13)</code>
1 to 20	<code>gen.nextInt(20) + 1</code>
15 to 20	<code>gen.nextInt(6) + 15</code>
-10 to 0	<code>gen.nextInt(11) - 10</code>

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 are invoked through the class name – no object of the `Math` class is needed

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

- We discuss static methods further in Chapter 7
- See `Quadratic.java`

```

//*****
//  Quadratic.java      Author: Lewis/Loftus
//
//  Demonstrates the use of the Math class to perform a calculation
//  based on user input.
//*****

import java.util.Scanner;

public class Quadratic
{
    //-----
    //  Determines the roots of a quadratic equation.
    //-----

    public static void main(String[] args)
    {
        int a, b, c;  // ax^2 + bx + c
        double discriminant, root1, root2;

        Scanner scan = new Scanner(System.in);

        System.out.print("Enter the coefficient of x squared: ");
        a = scan.nextInt();

```

continued

continued

```
System.out.print("Enter the coefficient of x: ");
b = scan.nextInt();

System.out.print("Enter the constant: ");
c = scan.nextInt();

// Use the quadratic formula to compute the roots.
// Assumes a positive discriminant.

discriminant = Math.pow(b, 2) - (4 * a * c);
root1 = ((-1 * b) + Math.sqrt(discriminant)) / (2 * a);
root2 = ((-1 * b) - Math.sqrt(discriminant)) / (2 * a);

System.out.println("Root #1: " + root1);
System.out.println("Root #2: " + root2);
    }
}
```

continued

Sample Run

```
System.out.println("Enter the coefficient of x squared: 3");
b = scanner.nextInt();
System.out.println("Enter the coefficient of x: 8");
c = scanner.nextInt();
System.out.println("Enter the constant: 4");
Root #1: -0.6666666666666666
Root #2: -2.0
```

```
// Use the quadratic formula to compute the roots.
// Assumes a positive discriminant.
```

```
discriminant = Math.pow(b, 2) - (4 * a * c);
root1 = ((-1 * b) + Math.sqrt(discriminant)) / (2 * a);
root2 = ((-1 * b) - Math.sqrt(discriminant)) / (2 * a);
```

```
System.out.println("Root #1: " + root1);
System.out.println("Root #2: " + root2);
```

```
}
```

```
}
```

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Enumerated Types

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Formatting Output

- It is often necessary to format output 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`

```

//*****
//  Purchase.java          Author: Lewis/Loftus
//
//  Demonstrates the use of the NumberFormat class to format output.
//*****

import java.util.Scanner;
import java.text.NumberFormat;

public class Purchase
{
    //-----
    //  Calculates the final price of a purchased item using values
    //  entered by the user.
    //-----
    public static void main(String[] args)
    {
        final double TAX_RATE = 0.06;  // 6% sales tax

        int quantity;
        double subtotal, tax, totalCost, unitPrice;

        Scanner scan = new Scanner(System.in);

```

continued

continued

```
NumberFormat fmt1 = NumberFormat.getCurrencyInstance();
NumberFormat fmt2 = NumberFormat.getPercentInstance();

System.out.print("Enter the quantity: ");
quantity = scan.nextInt();

System.out.print("Enter the unit price: ");
unitPrice = scan.nextDouble();

subtotal = quantity * unitPrice;
tax = subtotal * TAX_RATE;
totalCost = subtotal + tax;

// Print output with appropriate formatting
System.out.println("Subtotal: " + fmt1.format(subtotal));
System.out.println("Tax: " + fmt1.format(tax) + " at "
                  + fmt2.format(TAX_RATE));
System.out.println("Total: " + fmt1.format(totalCost));
    }
}
```

continued

Sample Run

```
Enter the quantity: 5
Enter the unit price: 3.87
Subtotal: $19.35
Tax: $1.16 at 6%
Total: $20.51
```

```
NumberFormat f
NumberFormat f
```

```
System.out.print
quantity = sca
```

```
tance();
tance();
```

```
System.out.print("Enter the unit price: ");
unitPrice = scan.nextDouble();
```

```
subtotal = quantity * unitPrice;
tax = subtotal * TAX_RATE;
totalCost = subtotal + tax;
```

```
// Print output with appropriate formatting
```

```
System.out.println("Subtotal: " + fmt1.format(subtotal));
System.out.println("Tax: " + fmt1.format(tax) + " at "
                    + fmt2.format(TAX_RATE));
System.out.println("Total: " + fmt1.format(totalCost));
```

```
}
```

```
}
```

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`

```

//*****
//  CircleStats.java      Author: Lewis/Loftus
//
//  Demonstrates the formatting of decimal values using the
//  DecimalFormat class.
//*****

import java.util.Scanner;
import java.text.DecimalFormat;

public class CircleStats
{
    //-----
    //  Calculates the area and circumference of a circle given its
    //  radius.
    //-----
    public static void main(String[] args)
    {
        int radius;
        double area, circumference;

        Scanner scan = new Scanner(System.in);

```

continued

continued

```
System.out.print ("Enter the circle's radius: ");
radius = scan.nextInt();

area = Math.PI * Math.pow(radius, 2);
circumference = 2 * Math.PI * radius;

// Round the output to three decimal places
DecimalFormat fmt = new DecimalFormat ("0.###");

System.out.println ("The circle's area: " + fmt.format(area));
System.out.println ("The circle's circumference: "
                    + fmt.format(circumference));
}
}
```

Sample Run

continued

```
System.out.println("Enter the circle's radius: ");
radius = 5;
System.out.println("The circle's area: " + Math.PI * radius * radius);
System.out.println("The circle's circumference: " + 2 * Math.PI * radius);
```

```
area = Math.PI * Math.pow(radius, 2);
circumference = 2 * Math.PI * radius;
```

```
// Round the output to three decimal places
```

```
DecimalFormat fmt = new DecimalFormat("0.###");
```

```
System.out.println("The circle's area: " + fmt.format(area));
```

```
System.out.println("The circle's circumference: "
    + fmt.format(circumference));
```

```
}
```

```
}
```

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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 declaration lists 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 referenced 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`

```

//*****
//  IceCream.java          Author: Lewis/Loftus
//
//  Demonstrates the use of enumerated types.
//*****

public class IceCream
{
    enum Flavor {vanilla, chocolate, strawberry, fudgeRipple, coffee,
                 rockyRoad, mintChocolateChip, cookieDough}

    //-----
    //  Creates and uses variables of the Flavor type.
    //-----

    public static void main (String[] args)
    {
        Flavor cone1, cone2, cone3;

        cone1 = Flavor.rockyRoad;
        cone2 = Flavor.chocolate;

        System.out.println("cone1 value: " + cone1);
        System.out.println("cone1 ordinal: " + cone1.ordinal());
        System.out.println("cone1 name: " + cone1.name());
    }
}

```

continued

continued

```
System.out.println();  
System.out.println("cone2 value: " + cone2);  
System.out.println("cone2 ordinal: " + cone2.ordinal());  
System.out.println("cone2 name: " + cone2.name());  
  
cone3 = cone1;  
  
System.out.println();  
System.out.println("cone3 value: " + cone3);  
System.out.println("cone3 ordinal: " + cone3.ordinal());  
System.out.println("cone3 name: " + cone3.name());  
}  
}
```

continued

```
System.out.println("cone1 value: " + cone1.value());
System.out.println("cone1 ordinal: " + cone1.ordinal());
System.out.println("cone1 name: " + cone1.name());
System.out.println("cone2 value: " + cone2.value());
System.out.println("cone2 ordinal: " + cone2.ordinal());
System.out.println("cone2 name: " + cone2.name());

cone3 = cone1;
System.out.println("cone3 value: " + cone3.value());
System.out.println("cone3 ordinal: " + cone3.ordinal());
System.out.println("cone3 name: " + cone3.name());
System.out.println("cone3 name: " + cone3.name());
}
```

Output

```
cone1 value: rockyRoad
cone1 ordinal: 5
cone1 name: rockyRoad
cone2 value: chocolate
cone2 ordinal: 1
cone2 name: chocolate
cone3 value: rockyRoad
cone3 ordinal: 5
cone3 name: rockyRoad
```

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Wrapper Classes

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

<u>Primitive Type</u>	<u>Wrapper Class</u>
<code>byte</code>	<code>Byte</code>
<code>short</code>	<code>Short</code>
<code>int</code>	<code>Integer</code>
<code>long</code>	<code>Long</code>
<code>float</code>	<code>Float</code>
<code>double</code>	<code>Double</code>
<code>char</code>	<code>Character</code>
<code>boolean</code>	<code>Boolean</code>

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);
```

- They 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

Quick Check

Are the following assignments valid? Explain.

```
Double value = 15.75;
```

```
Character ch = new Character('T');  
char myChar = ch;
```

Quick Check

Are the following assignments valid? Explain.

```
Double value = 15.75;
```

Yes. The double literal is autoboxed into a `Double` object.

```
Character ch = new Character('T');  
char myChar = ch;
```

Yes, the char in the object is unboxed before the assignment.

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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 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 (like a frame or another panel) 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 and/or an image
- 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
- This program is not interactive, but the frame can be repositioned and resized
- See `Authority.java`

```

//*****
//  Authority.java          Author: Lewis/Loftus
//
//  Demonstrates the use of frames, panels, and labels.
//*****

import java.awt.*;
import javax.swing.*;

public class Authority
{
    //-----
    //  Displays some words of wisdom.
    //-----
    public static void main(String[] args)
    {
        JFrame frame = new JFrame("Authority");

        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        JPanel primary = new JPanel();
        primary.setBackground(Color.yellow);
        primary.setPreferredSize(new Dimension(250, 75));
    }
}

```

continued

continued

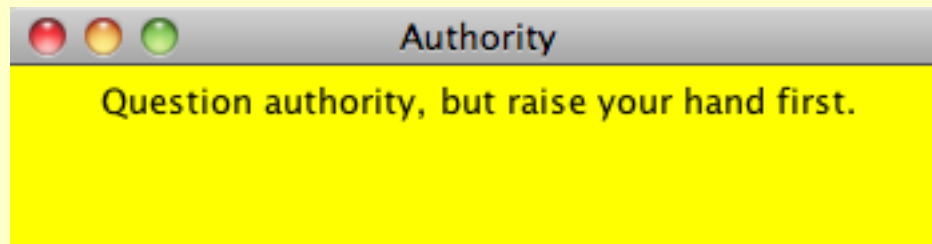
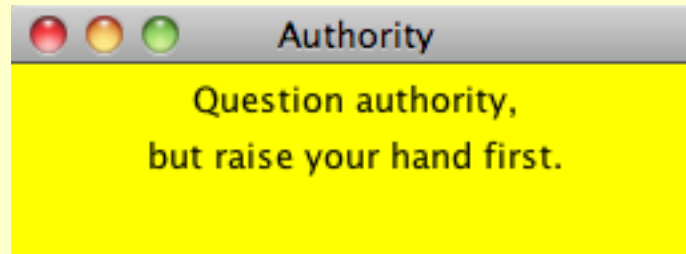
```
JLabel label1 = new JLabel("Question authority,");
JLabel label2 = new JLabel("but raise your hand first.");

primary.add(label1);
primary.add(label2);

frame.getContentPane().add(primary);
frame.pack();
frame.setVisible(true);
    }
}
```

continued

```
JLabel label1;  
JLabel label2;  
  
primary.add  
primary.add(label2);  
  
frame.ge  
frame.pa  
frame.se  
}  
}
```



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`

```

//*****
//  NestedPanels.java          Author: Lewis/Loftus
//
//  Demonstrates a basic componenet hierarchy.
//*****

import java.awt.*;
import javax.swing.*;

public class NestedPanels
{
    //-----
    //  Presents two colored panels nested within a third.
    //-----
    public static void main(String[] args)
    {
        JFrame frame = new JFrame("Nested Panels");
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        // Set up first subpanel
        JPanel subPanel1 = new JPanel();
        subPanel1.setPreferredSize(new Dimension(150, 100));
        subPanel1.setBackground(Color.green);
        JLabel label1 = new JLabel("One");
        subPanel1.add(label1);
    }
}

```

continued

continued

```
// Set up second subpanel
JPanel subPanel2 = new JPanel();
subPanel2.setPreferredSize(new Dimension(150, 100));
subPanel2.setBackground(Color.red);
JLabel label2 = new JLabel("Two");
subPanel2.add(label2);

// Set up primary panel
JPanel primary = new JPanel();
primary.setBackground(Color.blue);
primary.add(subPanel1);
primary.add(subPanel2);

frame.getContentPane().add(primary);
frame.pack();
frame.setVisible(true);
}
}
```

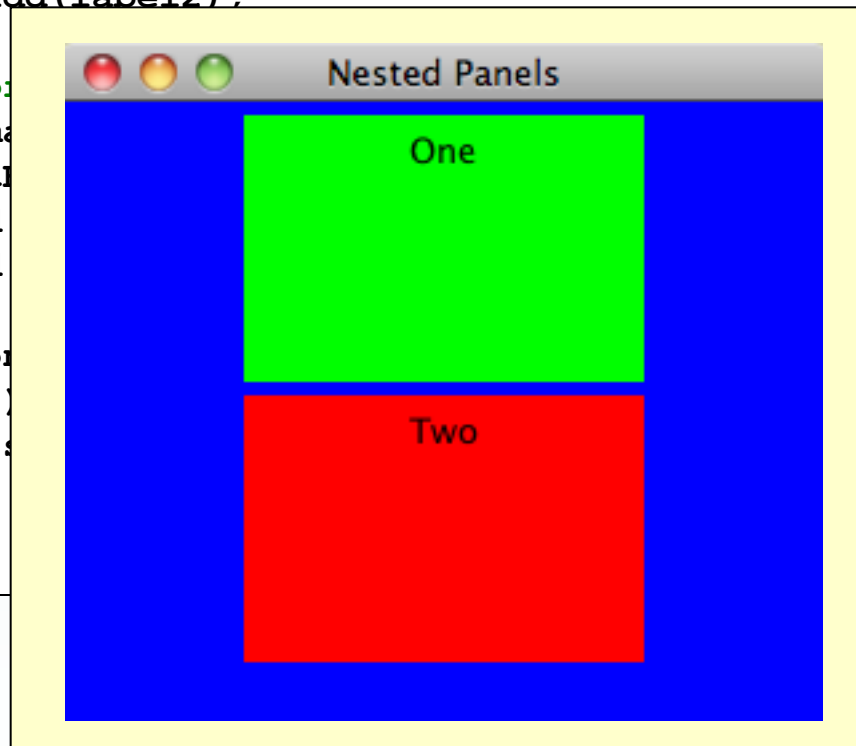
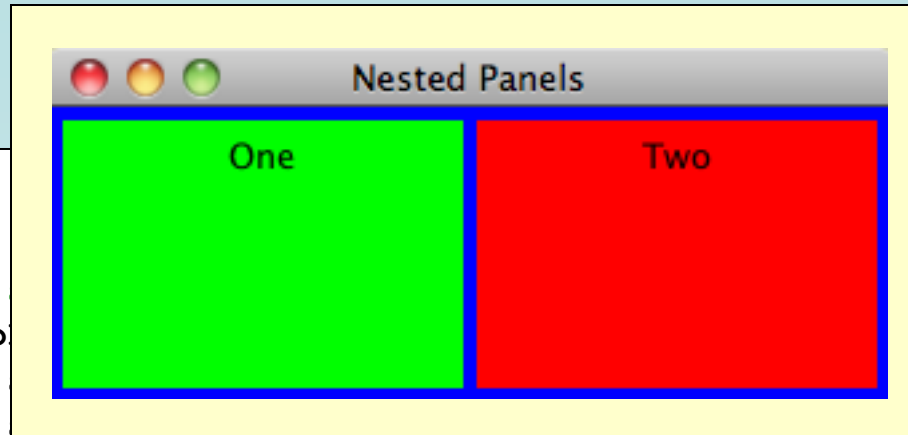
continued

```
// Set up
JPanel sub
subPanel2.
subPanel2.
JLabel label2 = new JLabel("Two");
subPanel2.add(label2);

// Set up p
JPanel prima
primary.setL
primary.add
primary.add

frame.getCo
frame.pack()
frame.setVis

}
}
```



Outline

Creating Objects

The String Class

The Random and Math Classes

Formatting Output

Enumerated Types

Wrapper Classes

Components and Containers



Images

Images

- Images can be displayed in a Java program in various ways
- 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, an image, or both at the same time

Images

- The `ImageIcon` class is used to represent the image that is stored in a label
- If text is also included, 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`

```

//*****
//  LabelDemo.java          Author: Lewis/Loftus
//
//  Demonstrates the use of image icons in labels.
//*****

import java.awt.*;
import javax.swing.*;

public class LabelDemo
{
    //-----
    //  Creates and displays the primary application frame.
    //-----
    public static void main(String[] args)
    {
        JFrame frame = new JFrame("Label Demo");
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        ImageIcon icon = new ImageIcon("devil.gif");

        JLabel label1, label2, label3;

        label1 = new JLabel("Devil Left", icon, SwingConstants.CENTER);

```

continued

continued

```
label2 = new JLabel("Devil Right", icon, SwingConstants.CENTER);  
label2.setHorizontalTextPosition(SwingConstants.LEFT);  
label2.setVerticalTextPosition(SwingConstants.BOTTOM);
```

```
label3 = new JLabel("Devil Above", icon, SwingConstants.CENTER);  
label3.setHorizontalTextPosition(SwingConstants.CENTER);  
label3.setVerticalTextPosition(SwingConstants.BOTTOM);
```

```
JPanel panel = new JPanel();  
panel.setBackground(Color.cyan);  
panel.setPreferredSize(new Dimension(200, 250));  
panel.add(label1);  
panel.add(label2);  
panel.add(label3);
```

```
frame.getContentPane().add(panel);  
frame.pack();  
frame.setVisible(true);
```

```
}
```

```
}
```

continued

```
label2 = new JLabel();  
label2.setHorizontalTextPosition(JLabel.  
label2.setVerticalTextPosition(JLabel.
```

```
label3 = new JLabel();  
label3.setHorizontalTextPosition(JLabel.  
label3.setVerticalTextPosition(JLabel.
```

```
JPanel panel = new JPanel();  
panel.setBackground(Color.CYAN);  
panel.setPreferredSize(new Dimension(250, 250));  
panel.add(label2);  
panel.add(label3);  
panel.add(label4);
```

```
frame.getContentPane().add(panel);  
frame.pack();  
frame.setVisible(true);
```

```
}
```

```
}
```



```
ingConstants.CENTER);  
ants.LEFT);  
ts.BOTTOM);
```

```
ingConstants.CENTER);  
ants.CENTER);  
ts.BOTTOM);
```

```
250));
```

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