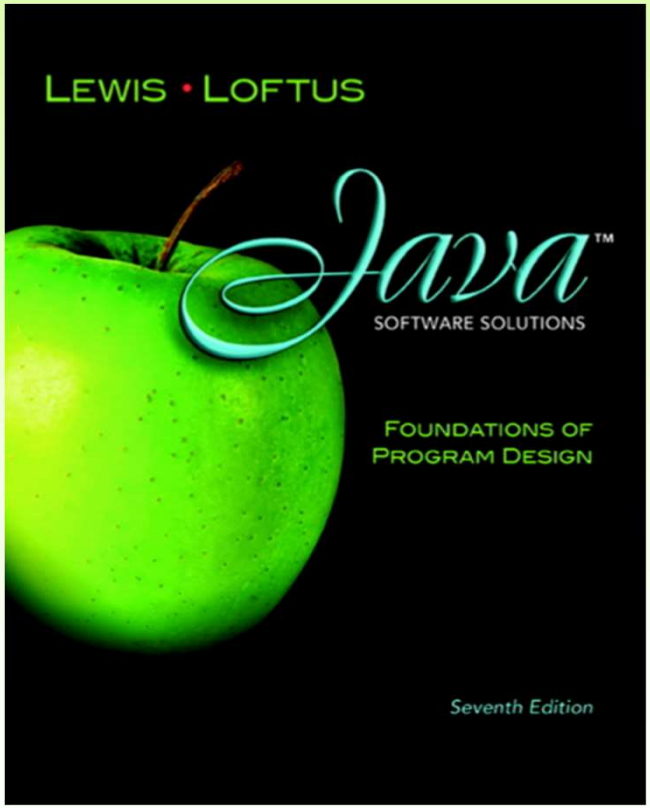
Chapter 11
Exceptions



Java Software Solutions
Foundations of Program Design
Seventh Edition

John Lewis
William Loftus

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Exceptions

- Exception handling is an important aspect of object-oriented design
- Chapter 11 focuses on:
  - the purpose of exceptions
  - exception messages
  - the try-catch statement
  - propagating exceptions
  - the exception class hierarchy
  - GUI mnemonics and tool tips
  - more GUI components and containers

Outline

Exception Handling

The try-catch Statement

Exception Classes

I/O Exceptions

Tool Tips and Mnemonics

Combo Boxes

Scroll Panes and Split Panes

Exceptions

- An *exception* is an object that describes an unusual or erroneous situation
- Exceptions are *thrown* by a program, and may be *caught* and *handled* by another part of the program
- A program can be separated into a normal execution flow and an *exception execution flow*
- An *error* is also represented as an object in Java, but usually represents a unrecoverable situation and should not be caught

Exception Handling

- The Java API has a predefined set of exceptions that can occur during execution
- A program can deal with an exception in one of three ways:
  - ignore it
  - handle it where it occurs
  - handle it an another place in the program
- The manner in which an exception is processed is an important design consideration

Exception Handling

- If an exception is ignored (not caught) by the program, the program will terminate and produce an appropriate message
- The message includes a *call stack trace* that:
  - indicates the line on which the exception occurred
  - shows the method call trail that lead to the attempted execution of the offending line
- See `Zero.java`

```
//********************************************************************
//  Zero.java       Author: Lewis/Loftus
//
//  Demonstrates an uncaught exception.
//********************************************************************

public class Zero
{
   //-----------------------------------------------------------------
   //  Deliberately divides by zero to produce an exception.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      int numerator = 10;
      int denominator = 0;

      System.out.println (numerator / denominator);

      System.out.println ("This text will not be printed.");
   }
}
```

Output (when program terminates)

```
Exception in thread "main" java.lang.ArithmeticException: / by zero
        at Zero.main(Zero.java:17)
```

```
public class Zero
{
   //-----------------------------------------------------------------
   //  Deliberately divides by zero to produce an exception.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      int numerator = 10;
      int denominator = 0;

      System.out.println (numerator / denominator);

      System.out.println ("This text will not be printed.");
   }
}
```

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The try Statement

- To handle an exception in a program, use a *try-catch statement*
- A *try block* is followed by one or more *catch* clauses
- Each catch clause has an associated exception type and is called an *exception handler*
- When an exception occurs within the try block, processing immediately jumps to the first catch clause that matches the exception type
- See `ProductCodes.java`

```
//********************************************************************
//  ProductCodes.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a try-catch block.
//********************************************************************

import java.util.Scanner;

public class ProductCodes
{
   //-----------------------------------------------------------------
   //  Counts the number of product codes that are entered with a
   //  zone of R and and district greater than 2000.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      String code;
      char zone;
      int district, valid = 0, banned = 0;

      Scanner scan = new Scanner (System.in);

      System.out.print ("Enter product code (XXX to quit): ");
      code = scan.nextLine();
```

continue

continue

```
      while (!code.equals ("XXX"))
      {
         try
         {
            zone = code.charAt(9);
            district = Integer.parseInt(code.substring(3, 7));
            valid++;
            if (zone == 'R' && district > 2000)
               banned++;
         }
         catch (StringIndexOutOfBoundsException exception)
         {
            System.out.println ("Improper code length: " + code);
         }
         catch (NumberFormatException exception)
         {
            System.out.println ("District is not numeric: " + code);
         }

         System.out.print ("Enter product code (XXX to quit): ");
         code = scan.nextLine();
      }

      System.out.println ("# of valid codes entered: " + valid);
      System.out.println ("# of banned codes entered: " + banned);
   }
}
```

continue

Sample Run

```
Enter product code (XXX to quit): TRV2475A5R-14
Enter product code (XXX to quit): TRD1704A7R-12
Enter product code (XXX to quit): TRL2k74A5R-11
District is not numeric: TRL2k74A5R-11
Enter product code (XXX to quit): TRQ2949A6M-04
Enter product code (XXX to quit): TRV2105A2
Improper code length: TRV2105A2
Enter product code (XXX to quit): TRQ2778A7R-19
Enter product code (XXX to quit): XXX
# of valid codes entered: 4
# of banned codes entered: 2
```

```
wh
{
            }
            catch (NumberFormatException exception)
            {
               System.out.println ("District is not numeric: " + code);
            }

            System.out.print ("Enter product code (XXX to quit): ");
            code = scan.nextLine();
         }

         System.out.println ("# of valid codes entered: " + valid);
         System.out.println ("# of banned codes entered: " + banned);
      }
}
```

The finally Clause

- A try statement can have an optional `finally` clause, which is always executed
- If no exception is generated, the statements in the finally clause are executed after the statements in the try block finish
- If an exception is generated, the statements in the finally clause are executed after the statements in the appropriate catch clause finish

Exception Propagation

- An exception can be handled at a higher level if it is not appropriate to handle it where it occurs
- Exceptions *propagate* up through the method calling hierarchy until they are caught and handled or until they reach the level of the `main` method
- See `Propagation.java`
- See `ExceptionScope.java`

```
//********************************************************************
//  Propagation.java       Author: Lewis/Loftus
//
//  Demonstrates exception propagation.
//********************************************************************

public class Propagation
{
   //-----------------------------------------------------------------
   //  Invokes the level1 method to begin the exception demonstration.
   //-----------------------------------------------------------------
   static public void main (String[] args)
   {
      ExceptionScope demo = new ExceptionScope();

      System.out.println("Program beginning.");
      demo.level1();
      System.out.println("Program ending.");
   }
}
```

Output

```
Program beginning.
Level 1 beginning.
Level 2 beginning.
Level 3 beginning.

The exception message is: / by zero

The call stack trace:
java.lang.ArithmeticException: / by zero
        at ExceptionScope.level3(ExceptionScope.java:54)
        at ExceptionScope.level2(ExceptionScope.java:41)
        at ExceptionScope.level1(ExceptionScope.java:18)
         at Propagation.main(Propagation.java:17)

Level 1 ending.
Program ending.
```

```
//********************************************************************
//  ExceptionScope.java       Author: Lewis/Loftus
//
//  Demonstrates exception propagation.
//********************************************************************

public class ExceptionScope
{
   //-----------------------------------------------------------------
   //  Catches and handles the exception that is thrown in level3.
   //-----------------------------------------------------------------
   public void level1()
   {
      System.out.println("Level 1 beginning.");

      try
      {
         level2();
      }
      catch (ArithmeticException problem)
      {
         System.out.println ();
         System.out.println ("The exception message is: " +
                             problem.getMessage());
         System.out.println ();
```

continue

continue

```
            System.out.println ("The call stack trace:");
            problem.printStackTrace();
            System.out.println ();
        }

        System.out.println("Level 1 ending.");
    }

    //-----------------------------------------------------------------
    //  Serves as an intermediate level.  The exception propagates
    //  through this method back to level1.
    //-----------------------------------------------------------------
    public void level2()
    {
        System.out.println("Level 2 beginning.");
        level3 ();
        System.out.println("Level 2 ending.");
    }
```

continue

continue

```
   //-----------------------------------------------------------------
   //  Performs a calculation to produce an exception.  It is not
   //  caught and handled at this level.
   //-----------------------------------------------------------------
   public void level3 ()
   {
      int numerator = 10, denominator = 0;

      System.out.println("Level 3 beginning.");
      int result = numerator / denominator;
      System.out.println("Level 3 ending.");
   }
}
```

Outline

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The try-catch Statement

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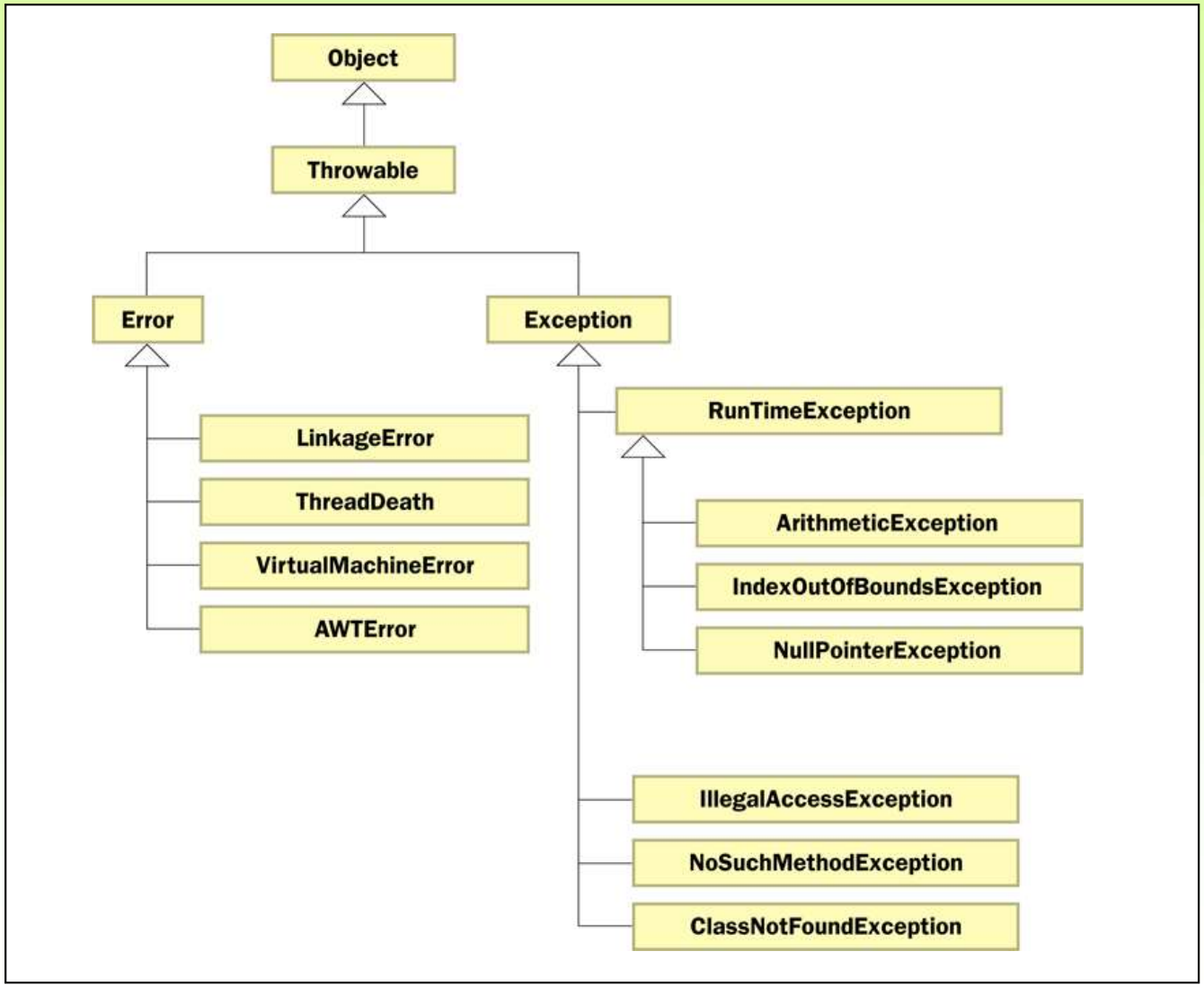
Scroll Panes and Split Panes

The Exception Class Hierarchy

- Exception classes in the Java API are related by inheritance, forming an exception class hierarchy
- All error and exception classes are descendents of the `Throwable` class
- A programmer can define an exception by extending the `Exception` class or one of its descendants
- The parent class used depends on how the new exception will be used

The Exception Class Hierarchy



Checked Exceptions

- An exception is either *checked* or *unchecked*
- A *checked exception* must either be caught or must be listed in the *throws clause* of any method that may throw or propagate it
- A throws clause is appended to the method header
- The compiler will issue an error if a checked exception is not caught or listed in a throws clause

Unchecked Exceptions

- An unchecked exception does not require explicit handling, though it could be processed that way
- The only unchecked exceptions in Java are objects of type `RuntimeException` or any of its descendants
- Errors are similar to `RuntimeException` and its descendants in that:
  - Errors should not be caught
  - Errors do not require a throws clause

Quick Check

Which of these exceptions are checked and which are unchecked?

`NullPointerException`

`IndexOutOfBoundsException`

`ClassNotFoundException`

`NoSuchMethodException`

`ArithmeticException`

Quick Check

Which of these exceptions are checked and which are unchecked?

`NullPointerException`	`Unchecked`
`IndexOutOfBoundsException`	`Unchecked`
`ClassNotFoundException`	`Checked`
`NoSuchMethodException`	`Checked`
`ArithmeticException`	`Unchecked`

The throw Statement

- Exceptions are thrown using the *throw* statement
- Usually a throw statement is executed inside an if statement that evaluates a condition to see if the exception should be thrown
- See `CreatingExceptions.java`
- See `OutOfRangeException.java`

```
//********************************************************************
//  CreatingExceptions.java       Author: Lewis/Loftus
//
//  Demonstrates the ability to define an exception via inheritance.
//********************************************************************

import java.util.Scanner;

public class CreatingExceptions
{
   //-----------------------------------------------------------------
   //  Creates an exception object and possibly throws it.
   //-----------------------------------------------------------------
   public static void main (String[] args) throws OutOfRangeException
   {
      final int MIN = 25, MAX = 40;

      Scanner scan = new Scanner (System.in);

      OutOfRangeException problem =
         new OutOfRangeException ("Input value is out of range.");
```

continue

continue

```
      System.out.print ("Enter an integer value between " + MIN +
                        " and " + MAX + ", inclusive: ");
      int value = scan.nextInt();

      //  Determine if the exception should be thrown
      if (value < MIN || value > MAX)
         throw problem;

      System.out.println ("End of main method.");  // may never reach
   }
}
```

Sample Run

```
Enter an integer value between 25 and 40, inclusive: 69
Exception in thread "main" OutOfRangeException:
    Input value is out of range.
    at CreatingExceptions.main(CreatingExceptions.java:20)
```

```
        if (value < MIN || value > MAX)
           throw problem;

        System.out.println ("End of main method.");  // may never reach
    }
}
```

```
//********************************************************************
//  OutOfRangeException.java       Author: Lewis/Loftus
//
//  Represents an exceptional condition in which a value is out of
//  some particular range.
//********************************************************************

public class OutOfRangeException extends Exception
{
   //-----------------------------------------------------------------
   //  Sets up the exception object with a particular message.
   //-----------------------------------------------------------------
   OutOfRangeException (String message)
   {
      super (message);
   }
}
```

Quick Check

What is the matter with this code?

```
System.out.println("Before throw");
throw new OutOfRangeException("Too High");
System.out.println("After throw");
```

Quick Check

What is the matter with this code?

```
System.out.println("Before throw");
throw new OutOfRangeException("Too High");
System.out.println("After throw");
```

The throw is not conditional and therefore always occurs. The second `println` statement can never be reached.

Outline

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I/O Exceptions

- Let's examine issues related to exceptions and I/O
- A *stream* is a sequence of bytes that flow from a source to a destination
- In a program, we read information from an input stream and write information to an output stream
- A program can manage multiple streams simultaneously

Standard I/O

- There are three standard I/O streams:
  - *standard output* – defined by `System.out`
  - *standard input* – defined by `System.in`
  - *standard error* – defined by `System.err`
- We use `System.out` when we execute `println` statements
- `System.out` and `System.err` typically represent the console window
- `System.in` typically represents keyboard input, which we've used many times with `Scanner`

The IOException Class

- Operations performed by some I/O classes may throw an `IOException`
  - A file might not exist
  - Even if the file exists, a program may not be able to find it
  - The file might not contain the kind of data we expect
- An `IOException` is a checked exception

Writing Text Files

- In Chapter 5 we explored the use of the `Scanner` class to read input from a text file
- Let's now examine other classes that let us write data to a text file
- The `FileWriter` class represents a text output file, but with minimal support for manipulating data
- Therefore, we also rely on `PrintStream` objects, which have `print` and `println` methods defined for them

Writing Text Files

- Finally, we'll also use the `PrintWriter` class for advanced internationalization and error checking
- We build the class that represents the output file by combining these classes appropriately
- Output streams should be closed explicitly
- See `TestData.java`

```
//********************************************************************
//  TestData.java       Author: Lewis/Loftus
//
//  Demonstrates I/O exceptions and the use of a character file
//  output stream.
//********************************************************************

import java.util.Random;
import java.io.*;

public class TestData
{
   //-----------------------------------------------------------------
   //  Creates a file of test data that consists of ten lines each
   //  containing ten integer values in the range 10 to 99.
   //-----------------------------------------------------------------
   public static void main (String[] args) throws IOException
   {
      final int MAX = 10;

      int value;
      String file = "test.dat";

      Random rand = new Random();
```

continue

continue

```
      FileWriter fw = new FileWriter (file);
      BufferedWriter bw = new BufferedWriter (fw);
      PrintWriter outFile = new PrintWriter (bw);

      for (int line=1; line <= MAX; line++)
      {
         for (int num=1; num <= MAX; num++)
         {
            value = rand.nextInt (90) + 10;
            outFile.print (value + "   ");
         }
         outFile.println ();
      }

      outFile.close();
      System.out.println ("Output file has been created: " + file);
   }
}
```

continue

```
        FileW
        BufferedWriter bw = new BufferedWriter (fw);
        PrintWriter outFile = new PrintWriter (bw);

        for (int line=1; line <= MAX; line++)
        {

        }

        ou
        Sy                                                    );
    }
}
```

Output

```
Output file has been created: test.dat
```

Sample test.dat File

```
77    46    24    67    45    37    32    40    39
10
90    91    71    64    82    80    68    18    83
89
25    80    45    75    74    40    15    90    79
59
44    43    95    85    93    61    15    20    52
86
60    85    18    73    56    41    35    67    21
42
93    25    89    47    13    27    51    94    76
13
33    25    48    42    27    24    88    18    32
17
71    10    90    88    60    19    89    54    21
```

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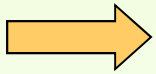

Tool Tips and Mnemonics

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Tool Tips

- A *tool tip* provides a short pop-up description when the mouse cursor rests momentarily on a component
- A tool tip is assigned using the `setToolTipText` method of a Swing component

```
JButton button = new JButton("Compute");
button.setToolTipText("Calculate size");
```

Mnemonics

- A *mnemonic* is a keyboard alternative for pushing a button or selecting a menu option
- The mnemonic character should be chosen from the component's label, and is underlined
- The user activates the component by holding down the ALT key and pressing the mnemonic character

```
JButton button = new JButton("Calculate");
button.setMnemonic("C");
```

Disabled Components

- Components can be *disabled* if they should not be used
- A disabled component is "grayed out" and will not respond to user interaction
- The status is set using the `setEnabled` method:

```
JButton button = new JButton ("Do It");
button.setEnabled (false);
```

Light Bulb Example

- The right combination of special features such as tool tips and mnemonics can enhance the usefulness of a GUI
- See `LightBulb.java`
- See `LightBulbPanel.java`
- See `LightBulbControls.java`

```
//********************************************************************
//  LightBulb.java       Author: Lewis/Loftus
//
//  Demonstrates mnemonics and tool tips.
//********************************************************************

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

public class LightBulb
{
   //-----------------------------------------------------------------
   //  Sets up a frame that displays a light bulb image that can be
   //  turned on and off.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      JFrame frame = new JFrame ("Light Bulb");
      frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);

      LightBulbPanel bulb = new LightBulbPanel();
      LightBulbControls controls = new LightBulbControls (bulb);
```

continue

continue

```
        JPanel panel = new JPanel();
        panel.setBackground (Color.black);
        panel.setLayout (new BoxLayout(panel, BoxLayout.Y_AXIS));
        panel.add (Box.createRigidArea (new Dimension (0, 20)));
        panel.add (bulb);
        panel.add (Box.createRigidArea (new Dimension (0, 10)));
        panel.add (controls);
        panel.add (Box.createRigidArea (new Dimension (0, 10)));

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

continue

```
        JPa
        pa                                    lac
        pa                                    ut(
        pa                                    ea
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        fra                                   ane
        fra
        frame.setVisible(true);
    }
}
```

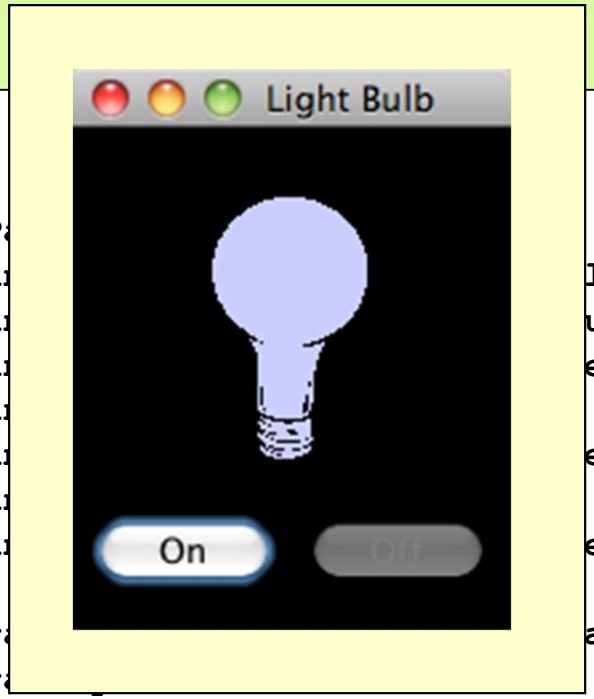

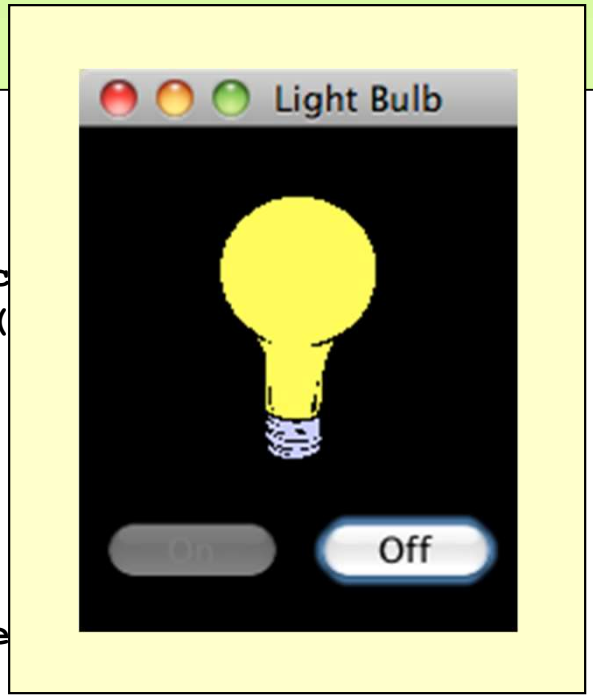

```
//********************************************************************
//  LightBulbPanel.java       Author: Lewis/Loftus
//
//  Represents the image for the LightBulb program.
//********************************************************************

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

public class LightBulbPanel extends JPanel
{
   private boolean on;
   private ImageIcon lightOn, lightOff;
   private JLabel imageLabel;
```

continue

continue

```
   //-----------------------------------------------------------------
   //  Constructor: Sets up the images and the initial state.
   //-----------------------------------------------------------------
   public LightBulbPanel()
   {
      lightOn = new ImageIcon ("lightBulbOn.gif");
      lightOff = new ImageIcon ("lightBulbOff.gif");

      setBackground (Color.black);

      on = true;
      imageLabel = new JLabel (lightOff);
      add (imageLabel);
   }
```

continue

continue

```
   //-----------------------------------------------------------------
   //  Paints the panel using the appropriate image.
   //-----------------------------------------------------------------
   public void paintComponent (Graphics page)
   {
      super.paintComponent(page);

      if (on)
         imageLabel.setIcon (lightOn);
      else
         imageLabel.setIcon (lightOff);
   }

   //-----------------------------------------------------------------
   //  Sets the status of the light bulb.
   //-----------------------------------------------------------------
   public void setOn (boolean lightBulbOn)
   {
      on = lightBulbOn;
   }
}
```

```
//********************************************************************
//  LightBulbControls.java       Author: Lewis/Loftus
//
//  Represents the control panel for the LightBulb program.
//********************************************************************

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

public class LightBulbControls extends JPanel
{
   private LightBulbPanel bulb;
   private JButton onButton, offButton;
```

continue

continue

```
   //-----------------------------------------------------------------
   //  Sets up the lightbulb control panel.
   //-----------------------------------------------------------------
   public LightBulbControls (LightBulbPanel bulbPanel)
   {
      bulb = bulbPanel;

      onButton = new JButton ("On");
      onButton.setEnabled (false);
      onButton.setMnemonic ('n');
      onButton.setToolTipText ("Turn it on!");
      onButton.addActionListener (new OnListener());

      offButton = new JButton ("Off");
      offButton.setEnabled (true);
      offButton.setMnemonic ('f');
      offButton.setToolTipText ("Turn it off!");
      offButton.addActionListener (new OffListener());

      setBackground (Color.black);
      add (onButton);
      add (offButton);
   }
```

continue

continue

```
//*****************************************************************
//  Represents the listener for the On button.
//*****************************************************************
private class OnListener implements ActionListener
{
   //--------------------------------------------------------------
   //  Turns the bulb on and repaints the bulb panel.
   //--------------------------------------------------------------
   public void actionPerformed (ActionEvent event)
   {
      bulb.setOn (true);
      onButton.setEnabled (false);
      offButton.setEnabled (true);
      bulb.repaint();
   }
}
```

continue

continue

```
   //*****************************************************************
   //  Represents the listener for the Off button.
   //*****************************************************************
   private class OffListener implements ActionListener
   {
      //--------------------------------------------------------------
      //  Turns the bulb off and repaints the bulb panel.
      //--------------------------------------------------------------
      public void actionPerformed (ActionEvent event)
      {
         bulb.setOn (false);
         onButton.setEnabled (true);
         offButton.setEnabled (false);
         bulb.repaint();
      }
   }
}
```

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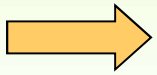


Combo Boxes

Scroll Panes and Split Panes

Combo Boxes

- A *combo box* provides a menu from which the user can choose one of several options
- The currently selected option is shown in the combo box
- A combo box shows its options only when the user presses it using the mouse
- Options can be established using an array of strings or using the `addItem` method

The JukeBox Program

- A combo box generates an action event when the user makes a selection from it
- See `JukeBox.java`
- See `JukeBoxControls.java`

```
//********************************************************************
//  JukeBox.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a combo box.
//********************************************************************

import javax.swing.*;

public class JukeBox
{
   //-----------------------------------------------------------------
   //  Creates and displays the controls for a juke box.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      JFrame frame = new JFrame ("Java Juke Box");
      frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);

      JukeBoxControls controlPanel = new JukeBoxControls();

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


```
//**********                                                    **********
//   JukeBox.j
//
//   Demonstra
//**********                                                    **********

import javax.

public class
{
   //-----------------------------------------------------------------
   //  Creates and displays the controls for a juke box.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      JFrame frame = new JFrame ("Java Juke Box");
      frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);

      JukeBoxControls controlPanel = new JukeBoxControls();

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

```
//********************************************************************
//  JukeBoxControls.java       Author: Lewis and Loftus
//
//  Represents the control panel for the juke box.
//********************************************************************

import java.awt.*;
import java.awt.event.*;
import javax.swing.*;
import java.applet.AudioClip;
import java.net.URL;

public class JukeBoxControls extends JPanel
{
   private JComboBox musicCombo;
   private JButton stopButton, playButton;
   private AudioClip[] music;
   private AudioClip current;

   //-----------------------------------------------------------------
   //  Sets up the GUI for the juke box.
   //-----------------------------------------------------------------
   public JukeBoxControls()
   {
      URL url1, url2, url3, url4, url5, url6;
      url1 = url2 = url3 = url4 = url5 = url6 = null;
```

continue

continue

```
// Obtain and store the audio clips to play
try
{
   url1 = new URL ("file", "localhost", "westernBeat.wav");
   url2 = new URL ("file", "localhost", "classical.wav");
   url3 = new URL ("file", "localhost", "jeopardy.au");
   url4 = new URL ("file", "localhost", "newAgeRythm.wav");
   url5 = new URL ("file", "localhost", "eightiesJam.wav");
   url6 = new URL ("file", "localhost", "hitchcock.wav");
}
catch (Exception exception) {}

music = new AudioClip[7];
music[0] = null;  // Corresponds to "Make a Selection..."
music[1] = JApplet.newAudioClip (url1);
music[2] = JApplet.newAudioClip (url2);
music[3] = JApplet.newAudioClip (url3);
music[4] = JApplet.newAudioClip (url4);
music[5] = JApplet.newAudioClip (url5);
music[6] = JApplet.newAudioClip (url6);

JLabel titleLabel = new JLabel ("Java Juke Box");
titleLabel.setAlignmentX (Component.CENTER_ALIGNMENT);
```

continue

continue

```
        musicCombo = new JComboBox (musicNames);
        musicCombo.setAlignmentX (Component.CENTER_ALIGNMENT);

        //  Set up the buttons
        playButton = new JButton ("Play", new ImageIcon ("play.gif"));
        playButton.setBackground (Color.white);
        playButton.setMnemonic ('p');
        stopButton = new JButton ("Stop", new ImageIcon ("stop.gif"));
        stopButton.setBackground (Color.white);
        stopButton.setMnemonic ('s');

        JPanel buttons = new JPanel();
        buttons.setLayout (new BoxLayout (buttons, BoxLayout.X_AXIS));
        buttons.add (playButton);
        buttons.add (Box.createRigidArea (new Dimension(5,0)));
        buttons.add (stopButton);
        buttons.setBackground (Color.cyan);

        //  Set up this panel
        setPreferredSize (new Dimension (300, 100));
        setBackground (Color.cyan);
        setLayout (new BoxLayout (this, BoxLayout.Y_AXIS));
```

continue

continue

```
      musicCombo.addActionListener (new ComboListener());
      stopButton.addActionListener (new ButtonListener());
      playButton.addActionListener (new ButtonListener());

      current = null;
   }

   //*****************************************************************
   //  Represents the action listener for the combo box.
   //*****************************************************************
   private class ComboListener implements ActionListener
   {
      //--------------------------------------------------------------
      //  Stops playing the current selection (if any) and resets
      //  the current selection to the one chosen.
      //--------------------------------------------------------------
      public void actionPerformed (ActionEvent event)
      {
         if (current != null)
            current.stop();

         current = music[musicCombo.getSelectedIndex()];
      }
    }
```

continue

continue

```
   //*****************************************************************
   //  Represents the action listener for both control buttons.
   //*****************************************************************
   private class ButtonListener implements ActionListener
   {
      //--------------------------------------------------------------
      //  Stops the current selection (if any) in either case. If
      //  the play button was pressed, start playing it again.
      //--------------------------------------------------------------
      public void actionPerformed (ActionEvent event)
      {
         if (current != null)
            current.stop();

         if (event.getSource() == playButton)
            if (current != null)
               current.play();
      }
   }
}
```

Outline

Exception Handling

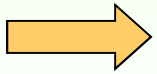
The try-catch Statement

Exception Classes

I/O Exceptions

Tool Tips and Mnemonics

Combo Boxes



Scroll Panes and Split Panes

Scroll Panes

- A *scroll pane* is useful for images or information too large to fit in a reasonably-sized area
- A scroll pane offers a limited view of the component it contains
- It provides vertical and/or horizontal scroll bars that allow the user to scroll to other areas of the component
- No event listener is needed for a scroll pane
- See `TransitMap.java`

```
//********************************************************************
//  TransitMap.java       Authors: Lewis/Loftus
//
//  Demonstrates the use a scroll pane.
//********************************************************************

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

public class TransitMap
{
   //-----------------------------------------------------------------
   //  Presents a frame containing a scroll pane used to view a large
   //  map of the Philadelphia subway system.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      // SEPTA = SouthEast Pennsylvania Transit Authority
      JFrame frame = new JFrame ("SEPTA Transit Map");
```

continue

continue

```
        frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);

        ImageIcon image = new ImageIcon ("septa.jpg");
        JLabel imageLabel = new JLabel (image);

        JScrollPane sp = new JScrollPane (imageLabel);
        sp.setPreferredSize (new Dimension (450, 400));

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

continue

```
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        JS
        sp
        fr
        fr
        fr
    }
}
```
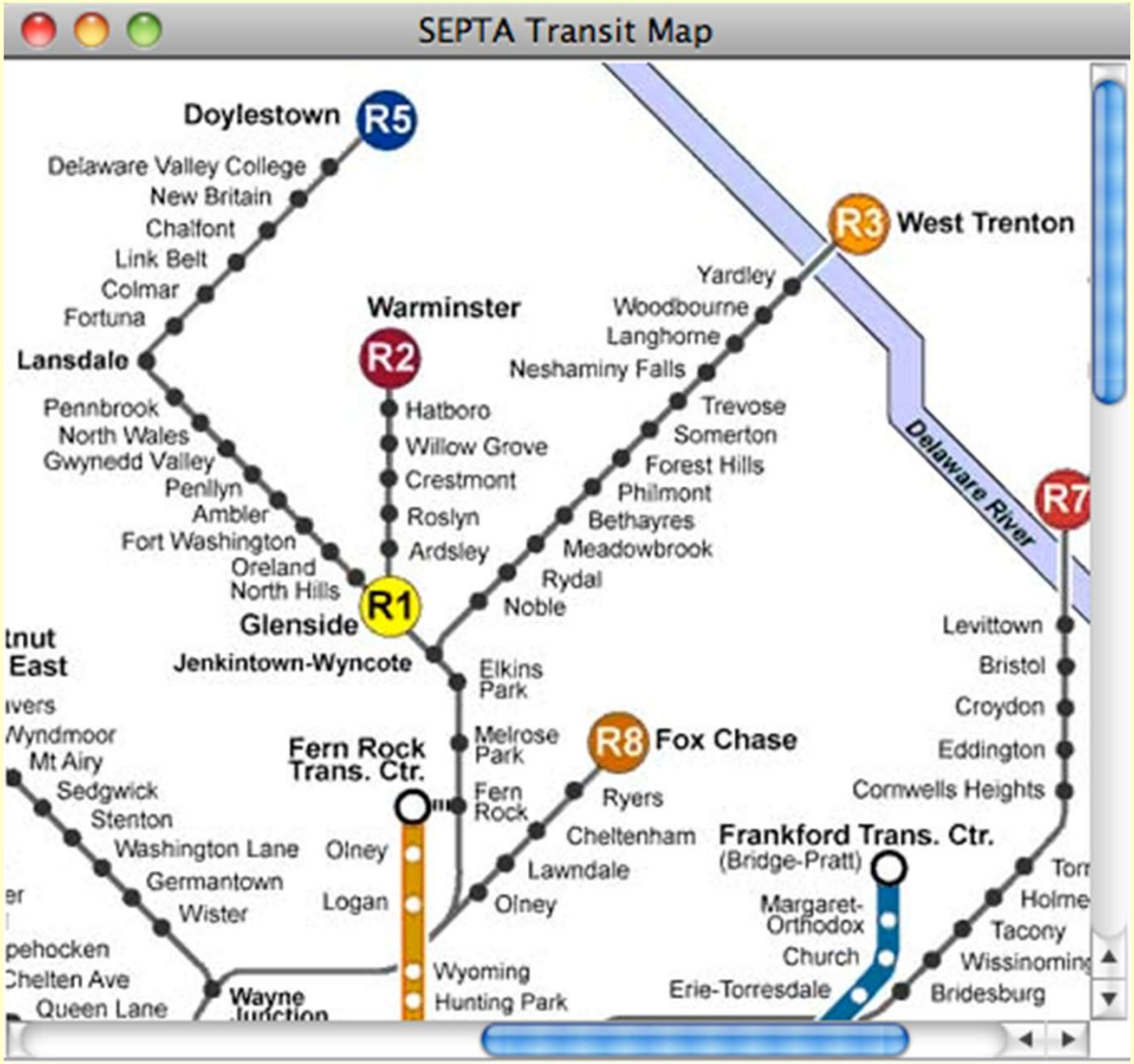
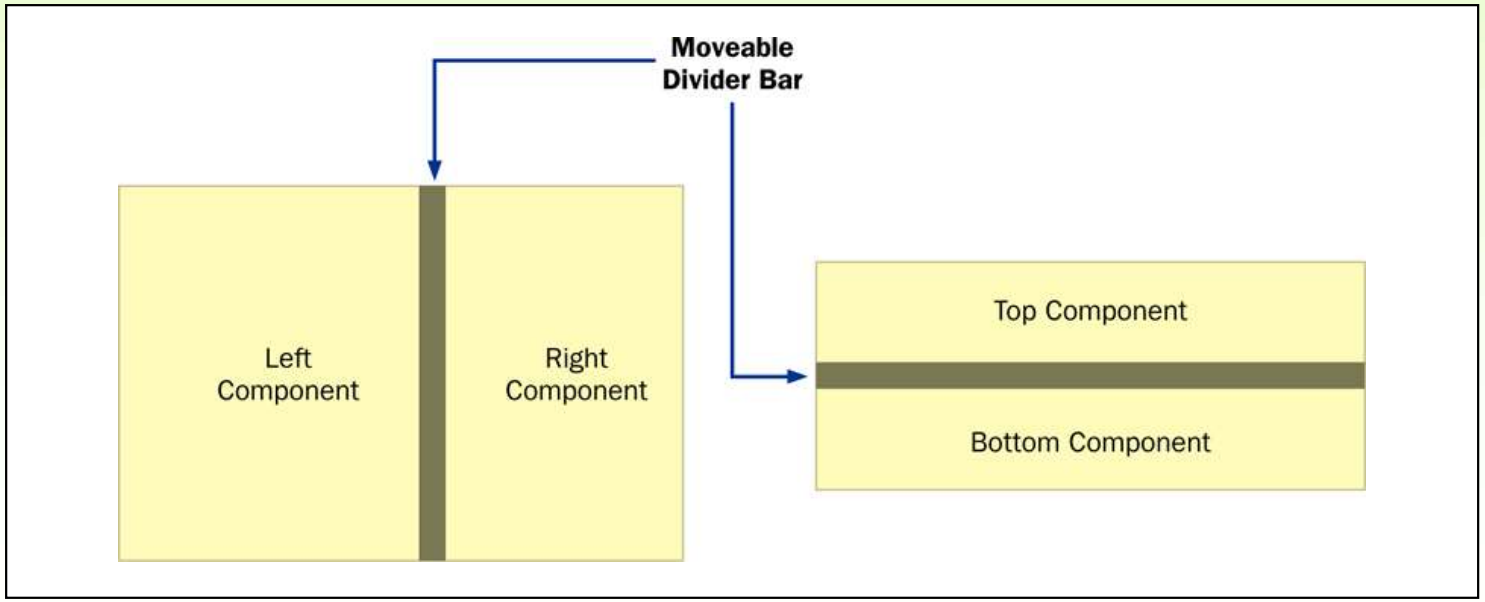



Split Panes

- A split pane is a container that displays two components separated by a moveable divider bar
- The two components can be displayed side by side, or one on top of the other



Split Panes

- The orientation of the split pane is set using the `HORIZONTAL_SPLIT` or `VERTICAL_SPLIT` constants
- The divider bar can be set so that it can be fully expanded with one click of the mouse
- The components can be continuously adjusted as the divider bar is moved, or wait until it stops moving
- Split panes can be nested

Lists

- The Swing `Jlist` class represents a list of items from which the user can choose
- The contents of a `JList` object can be specified using an array of objects
- A `JList` object generates a *list selection event* when the current selection changes
- See `PickImage.java`
- See `ListPanel.java`

```
//********************************************************************
//  PickImage.java       Authors: Lewis/Loftus
//
//  Demonstrates the use a split pane and a list.
//********************************************************************

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

public class PickImage
{
   //-----------------------------------------------------------------
   //  Creates and displays a frame containing a split pane. The
   //  user selects an image name from the list to be displayed.
   //-----------------------------------------------------------------
   public static void main (String[] args)
   {
      JFrame frame = new JFrame ("Pick Image");
      frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);
```

continue

continue

```
        JLabel imageLabel = new JLabel();
        JPanel imagePanel = new JPanel();
        imagePanel.add (imageLabel);
        imagePanel.setBackground (Color.white);

        ListPanel imageList = new ListPanel (imageLabel);

        JSplitPane sp = new JSplitPane(JSplitPane.HORIZONTAL_SPLIT,
                                       imageList, imagePanel);

        sp.setOneTouchExpandable (true);

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

continue

```
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        image

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        sp.se

        frame
        frame
        frame
    }
}
```

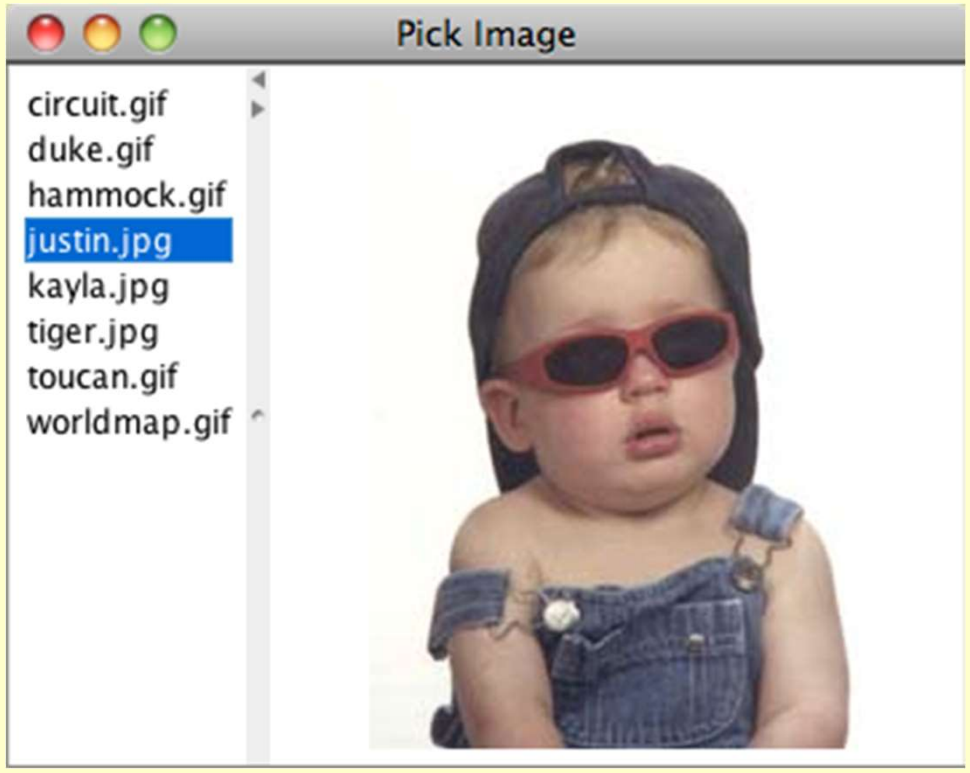

```
//********************************************************************
//  ListPanel.java       Authors: Lewis/Loftus
//
//  Represents the list of images for the PickImage program.
//********************************************************************

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

public class ListPanel extends JPanel
{
   private JLabel label;
   private JList list;
```

continue

continue

```
   //-----------------------------------------------------------------
   //  Loads the list of image names into the list.
   //-----------------------------------------------------------------
   public ListPanel (JLabel imageLabel)
   {
      label = imageLabel;

      String[] fileNames = { "circuit.gif",
                             "duke.gif",
                             "hammock.gif",
                             "justin.jpg",
                             "kayla.jpg",
                             "tiger.jpg",
                             "toucan.gif",
                             "worldmap.gif" };

      list = new JList (fileNames);
      list.addListSelectionListener (new ListListener());
      list.setSelectionMode (ListSelectionModel.SINGLE_SELECTION);

      add (list);
      setBackground (Color.white);
   }
```

continue

continue

```
    //*****************************************************************
    //  Represents the listener for the list of images.
    //*****************************************************************
    private class ListListener implements ListSelectionListener
    {
       public void valueChanged (ListSelectionEvent event)
       {
          if (list.isSelectionEmpty())
             label.setIcon (null);
          else
          {
             String fileName = (String)list.getSelectedValue();
             ImageIcon image = new ImageIcon (fileName);
             label.setIcon (image);
          }
       }
    }
}
```

Lists

- A `JList` object can be set so that multiple items can be selected at the same time
- The *list selection mode* can be one of three options:
  - single selection – only one item can be selected at a time
  - single interval selection – multiple, contiguous items can be selected at a time
  - multiple interval selection – any combination of items can be selected
- The list selection mode is defined by a `ListSelectionModel` object

Summary

- Chapter 11 has focused on:
  - the purpose of exceptions
  - exception messages
  - the try-catch statement
  - propagating exceptions
  - the exception class hierarchy
  - GUI mnemonics and tool tips
  - more GUI components and containers