Chapter 11
Exceptions

Java Software Solutions
Foundations of Program Design
Seventh Edition

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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:

  1. ignore it
  2. handle it where it occurs
  3. 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
/**
 * 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.");
    }
}
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)
Outline

Exception Handling
The try-catch Statement
Exception Classes
I/O Exceptions
Tool Tips and Mnemonics
Combo Boxes
Scroll Panes and Split Panes
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*
import java.util.Scanner;

public class ProductCodes {
    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
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);
}
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.
//********************************************************************

class Propagation {

    static public void main (String[] args)
    {
        ExceptionScope demo = new ExceptionScope();
        System.out.println("Program beginning.");
        demo.level1();
        System.out.println("Program ending.");
    }
}

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.
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
        }
    }
}
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.");
}
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

Exception Handling
The try-catch Statement
Exception Classes
I/O Exceptions
Tool Tips and Mnemonics
Combo Boxes
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

- **Object**
  - **Throwable**
    - **Error**
      - **LinkageError**
      - **ThreadDeath**
      - **VirtualMachineError**
      - **AWTError**
    - **Exception**
      - **RuntimeException**
        - **ArithmeticException**
        - **IndexOutOfBoundsException**
        - **NullPointerException**
          - **IllegalArgumentException**
          - **NoSuchMethodException**
          - **ClassNotFoundException**

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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
Outline

Exception Handling
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Exception Classes
I/O Exceptions
Tool Tips and Mnemonics
Combo Boxes
Scroll Panes and Split Panes
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 (writes one character per time)

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

public class TestData
{
    
    public static void main (String[] args) throws IOException
    {
        final int MAX = 10;

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

        Random rand = new Random();

        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);
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 | 92 |
| 45 | 26 | 47 | 68 | 55 | 98 | 34 | 38 | 98 | 38 |
| 48 | 59 | 90 | 12 | 86 | 36 | 11 | 65 | 41 | 62 |
Outline

Exception Handling
The try-catch Statement
Exception Classes
I/O Exceptions

Tool Tips and Mnemonics
Combo Boxes
Scroll Panes and Split Panes
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

```java
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+ctrl keys 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:

```java
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
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

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

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

    continue
public LightBulbPanel()
{
    lightOn = new ImageIcon ("lightBulbOn.gif");
    lightOff = new ImageIcon ("lightBulbOff.gif");
    setBackground (Color.black);
    on = true;
    imageLabel = new JLabel (lightOff);
    add (imageLabel);
}
// 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
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);
}
private class OnListener implements ActionListener {

    public void actionPerformed(ActionEvent event) {
        bulb.setOn(true);
        onButton.setEnabled(false);
        offButton.setEnabled(true);
        bulb.repaint();
    }
}
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();
    }
}
}
Outline

Exception Handling
The try-catch Statement
Exception Classes
I/O Exceptions
Tool Tips and Mnemonics
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
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);
    }
}
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);
    }
}
/**
 * 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;

        /*
         * TODO: Implement the initialization logic for the JukeBoxControls.
         */
    }

    public void play() {
        // Play the selected music
    }

    public void stop() {
        // Stop the music
    }

    public void selectMusic(int index) {
        // Select the music at the given index
    }

    // Other methods...
}

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);
// Create the list of strings for the combo box options
String[] musicNames = {"Make A Selection...", "Western Beat", "Classical Melody", "Jeopardy Theme", "New Age Rythm", "Eighties Jam", "Alfred Hitchcock's Theme"};
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));
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()];
    }
}
private class ButtonListener implements ActionListener {
    // Represents the action listener for both control buttons.
    // 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
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

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

ListPanel imageList = new ListPanel (imageLabel);
// imageList has a reference to the JLabel shown on
// imagePanel - it can change the Icon shown on
// imagePanel
JSplitPane sp = new JSplitPane(JSplitPane.HORIZONTAL_SPLIT,
   imageList, imagePanel);

sp.setOneTouchExpandable (true);
frame.getContentPane().add (sp);
frame.pack();
frame.setVisible(true);
}
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);
import java.awt.*;
import javax.swing.*;
import javax.swing.event.*;

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

    continue
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);
}
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