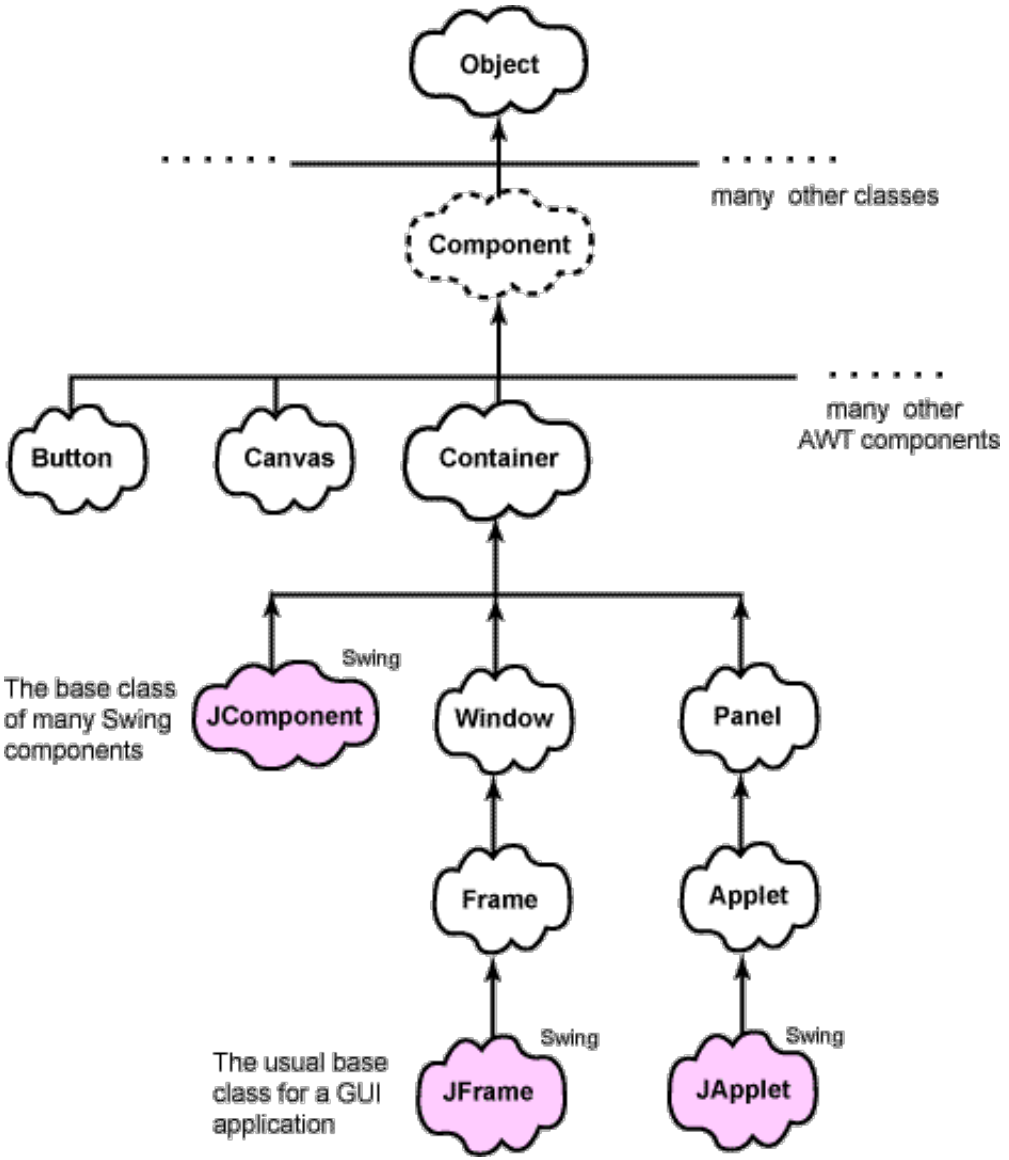
AWT hierarchy

AWT

- Java AWT (Abstract Window Toolkit) contains the fundamental classes used for developing GUI or window-based applications in java.
- AWT is heavyweight, use OS resource components directly. That is, appearance of component changes with OS version.
- The **java.awt** package provides classes for AWT api such as TextField, Label, TextArea, RadioButton, CheckBox, Choice, List etc.
- The abstract **Component** class is the base class for the AWT.
- Many AWT classes are derived from it. These are the old AWT components that are no longer in use.
- Some examples of the AWT classes derived from Component are Button, Canvas, and Container.

AWT hierarchy



AWT hierarchy(2)

- The **Component** class
  - It is at the top of the AWT hierarchy.
  - Encapsulates all of the attributes of a visual component.
  - Defines over a hundred public methods for managing events, such as mouse and keyboard input, positioning and sizing the window, foreground color , background color and repainting
- The **Container** class
  - A subclass of Component
  - Contains other components like buttons, textfields, labels etc.
  - A container lays out (positioning) any components that it contains by using various layout managers

AWT hierarchy(3)

- The **Panel** class
  - A concrete subclass of Container
  - Doesn't contain title bar, border and menu bars.
  - It can have other components like button, textfield etc.
- The **window** class
  - Creates a top-level window
  - Frame subclass is used for this purpose
  - Have no borders and menu bars. Must use frame, dialog or another window for creating a window.

AWT hierarchy(4)

- The **Frame** class
  - A subclass of Window
  - Contains title bar and can have menu bars.
  - It can have other components like button, textfield etc.
- The **JComponent** class is derived from Container and is one of the base classes of Swing.
- The **JFrame** class is derived from the AWT Frame class. It is usually the main container for a GUI application.
- The **JApplet** class is derived from the AWT Applet class and is used for modern applets.

Swing

Why AWTs are no longer in use?

- Because the AWT components use native code resources, they are referred to as heavyweight.
- Problems with AWTs
  - A component might look, or even act, differently on different platforms (OS).
  - This threatened the overarching philosophy of Java: write once, run anywhere.
  - The use of heavyweight components caused some frustrating restrictions. For example, a heavyweight component is always rectangular and opaque.

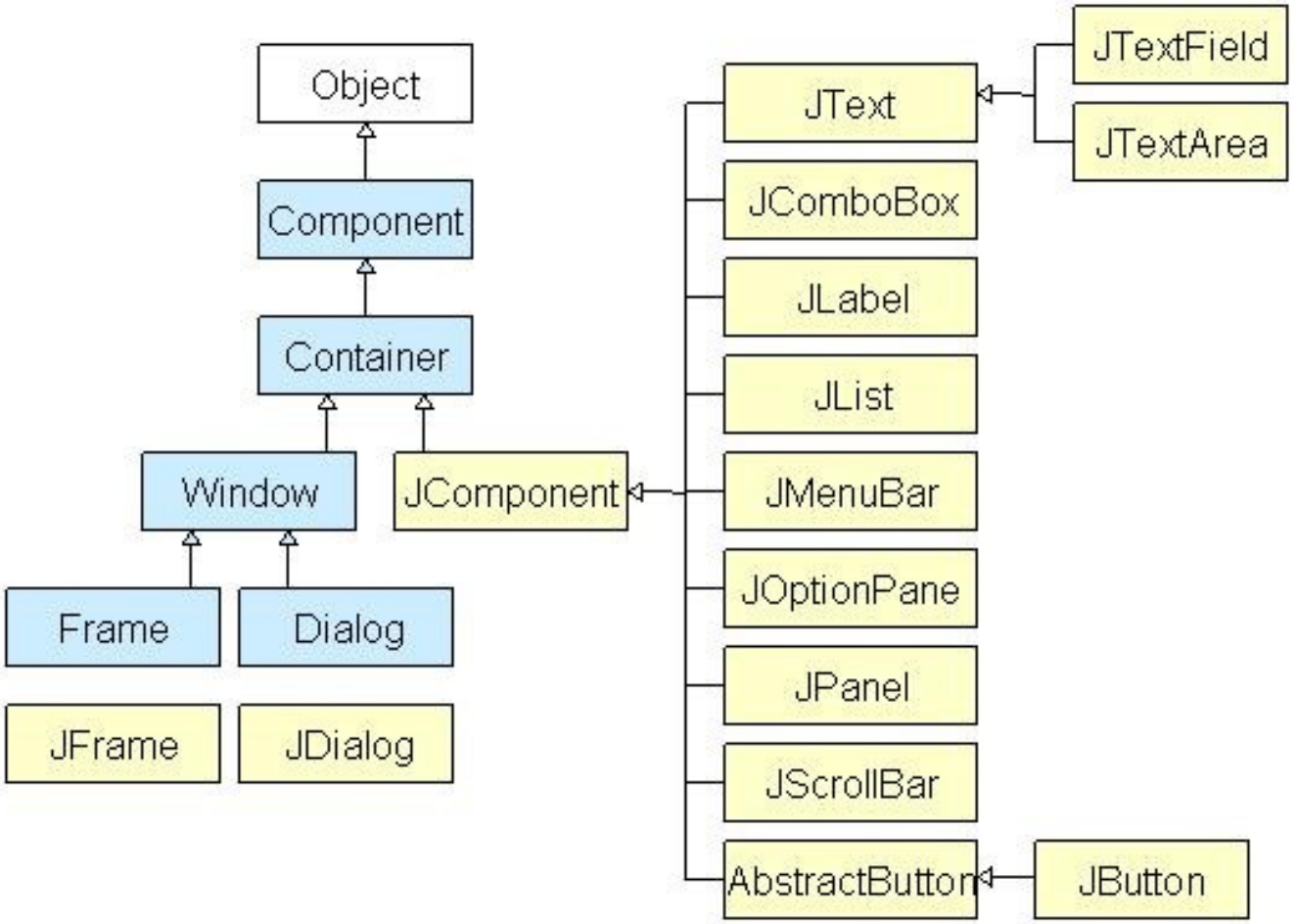
How Swing taken care these issues?

- Swing is built on the foundation of the AWT. This is why the AWT is still a crucial part of Java.
- Swing also uses the same event handling mechanism as the AWT
- Swing components are lightweight. This means that they are written entirely in Java and do not map directly to platform-specific peers (a few exceptions)
- Swing supports a pluggable look and feel (PLAF).

Swing Components and Containers

- A **component** is an independent visual control, such as a push button or slider.
- A **container** is a special type of component designed to holds a group of components.
- In order for a component to be displayed, it must be held within a container.
- Thus, all Swing GUIs will have at least one container.
- Swing can define a containment hierarchy, at the top of which must be a top-level container.

Components


Object
Component
Container
Window
JComponent
Frame
Dialog
JFrame
JDialog
JText
JTextField
JTextArea
JComboBox
JLabel
JList
JMenuBar
JOptionPane
JPanel
JScrollBar
AbstractButton
JButton

Top-level container panes

- Each top-level container defines a set of panes.
- At the top of the hierarchy is an instance of **JRootPane**. It manages the other panes and the optional menu bar.
- The root pane: glass pane, content pane, and layered pane.
- **Glass pane**
  - The top-level pane sits above and completely covers all other panes.
  - By default, it is a transparent instance of **JPanel**.
  - Enables to manage mouse events that affect the entire container
  - to paint over any other component
- **Layered pane**
  - An instance of JLayeredPane
  - allows components to be given a depth value that determines which component overlays another

Top-level container panes(2)

- **Content pane**
- The layers of a container can be thought as transparent film that overlays the container.
- In Java Swing, the layer that is used to hold objects is called the **content pane**.
- The content pane is an object created by the Java run time environment.
- Objects are added to the content pane layer of the container.
- The getContentPane() method
  - It retrieves the content pane layer to add an object to it.
  - When you use getContentPane(), the content pane object then is substituted there so that you can apply a method to it.
  - A JFrame is the head component which is put together with other subcomponents.
  - For example, a JMenuBar is placed in another area next to the contentPane of a frame.

Layout Managers

- A layout manager is an instance of any class that implements the LayoutManager interface.
- The layout manager is set by the setLayout( ) method.
- If no call to setLayout( ) is made, then the default layout manager is used.
- On resizing a container, the layout manager is used to position each of the components within it.
- The setLayout( ) method:
  - **void setLayout(LayoutManager layoutObj)**
  - layoutObj is a reference to the desired layout manager
  - For manual layout, set layoutObj as null

Some Layout Managers Classes

- **FlowLayout**
  - Default layout manager
  - By default, orientation is left to right, top to bottom
- **FlowLayout constructors**
  - FlowLayout( )
  - FlowLayout(int how)
  - FlowLayout(int how, int horz, int vert)
  - Here, how is the alignment (FlowLayout.LEFT, FlowLayout.CENTER, FlowLayout.RIGHT, FlowLayout.LEADING, and FlowLayout.TRAILING)
  - horz and vert are the horizontal and vertical space between components respcetively

Some Layout Managers Classes(2)

- **GridLayout**
  - It lays out components in a two-dimensional grid.
  - Requires the number of rows and columns when instantiated.
- **GridLayout constructors:**
  - GridLayout( )
  - GridLayout(int numRows, int numColumns)
  - GridLayout(int numRows, int numColumns, int horz, int vert)

Some Layout Managers Classes(3)

- **GridBagLayout**
- We can specify the component's positions within cells inside a grid.
- It's a collection of small grids joined together.
  - GridBagLayout constructors: GridBagLayout( )
- One important method is **setConstraints( )**
  - void setConstraints(**Component** comp, **GridBagConstraints** cons)
  - Here, comp is the component for which the constraints specified by cons apply.
  - **GridBagConstraints** defines several fields that you can set to govern the size, placement, and spacing of a component

The Swing Packages

javax.swing	javax.swing.border	javax.swing.colorchooser
javax.swing.event	javax.swing.filechooser	javax.swing.plaf
javax.swing.plaf.basic	javax.swing.plaf.metal	javax.swing.plaf.multi
javax.swing.plaf.synth	javax.swing.table	javax.swing.text
javax.swing.text.html	javax.swing.text.html.parser	javax.swing.text.rtf
javax.swing.tree	javax.swing.undo	

A Simple Example

```
// A simple Swing application.
import javax.swing.*;
class SwingDemo {
        SwingDemo() {
                // Create a new JFrame container.
                JFrame jfrm = new JFrame("A Simple Swing Application");
                // Give the frame an initial size.
                jfrm.setSize(275, 100);
                // Terminate the program when the user closes the application.
                jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
                // Create a text-based label.
                JLabel jlab = new JLabel(" Swing means powerful GUIs.");
                // Add the label to the content pane.
                jfrm.add(jlab);
                // Display the frame.
                jfrm.setVisible(true);
        }
        public static void main(String args[]) {
                // Create the frame on the event dispatching thread.
                SwingUtilities.invokeLater(new Runnable() {
                        public void run() {
                                new SwingDemo();
                        }
                });
        }
}
```

Event Handling

- **Delegation event model**
  - Defines standard and consistent mechanisms to generate and process **events**.
  - A **source** generates an event and sends it to one or more **listeners**.
  - The listener simply waits until it **receives** an event.
  - Once an event is received, the listener **processes** the event and then returns
  - Listeners must **register** with a source in order to receive an event notification.
- **The advantage**
  - The application logic that processes events is cleanly separated from the user interface logic that generates those events.
  - A user interface element is able to “delegate” the processing of an event to a separate piece of code.
  - Notifications are sent only to listeners that want to receive them.
  - Eliminates this overhead of old approach of event handling

Events

- An event is an object that describes a state change in a source.
- A consequence of a person interacting with the elements in a GUI.
  - Pressing a button
  - Entering a character via the keyboard
  - Selecting an item in a list
  - Clicking the mouse and many more
- Events may also occur that are not directly caused by interactions with a user interface.
  - When a timer expires
  - A counter exceeds a value
  - A software or hardware failure occurs
  - An operation is completed.

Event Sources

- A source is an object that generates an event. May generate more than one type of event.
- A source must register listeners in order for the listeners to receive notifications about a specific type of event.
- Each type of event has its own registration method.
- The general form:
  - public void addTypeListener(TypeListener el)
- Example
  - AddKeyListener( ), addMouseMotionListener( ).
- When an event occurs, all registered listeners are notified and receive a copy of the event object via multicasting the event.
- In all cases, notifications are sent only to listeners that register to receive them.

Event Listeners

- General form of adding one and only one listener
  - public void addTypeListener(TypeListener el) throws java.util.TooManyListenersException
- Event is notified to the registered listener using unicasting of the event.
- A source must also provide a method that allows a listener to unregister an interest in a specific type of event.
  - public void removeTypeListener(TypeListener el) // Example removeKeyListener( ).

Events in Swing p1

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

class EventDemo {
        JLabel jlab;
        EventDemo() {
                JFrame jfrm = new JFrame("An Event Example");
                jfrm.setLayout(new FlowLayout()); // Specify FlowLayout for the layout manager.
                jfrm.setSize(220, 90);
                jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

                JButton jbtnAlpha = new JButton("Alpha");
                JButton jbtnBeta = new JButton("Beta");

                jbtnAlpha.addActionListener(new ActionListener() { // Add action listener for Alpha.
                        public void actionPerformed(ActionEvent ae) {
                                jlab.setText("Alpha was pressed.");
                        }
                });
                jbtnBeta.addActionListener(new ActionListener() { // Add action listener for Beta.
                        public void actionPerformed(ActionEvent ae) {
                                jlab.setText("Beta was pressed.");
                        }
                });
```

Events in Swing p2

```
        jfrm.add(jbtnAlpha);
        jfrm.add(jbtnBeta);
        jlab = new JLabel("Press a button."); // Create a text-based label.

        jfrm.add(jlab);
        jfrm.setVisible(true);
    }
    public static void main(String args[]) {
        SwingUtilities.invokeLater(new Runnable() { // Create the frame on the event dispatching thread.
            public void run() {
                new EventDemo();
            }
        });
    }
}
```

JLabel and ImageIcon

- It creates a label
- JLabel can be used to display text and/or an icon.
- A passive component (no response to user input)
- Some JLabel constructors
  - JLabel(Icon icon)
  - JLabel(String str)
  - JLabel(String str, Icon icon, int align)
- ImageIcon class is the easy way to get an icon
  - ImageIcon(String filename)
- The icon and text associated with the label can be obtained by
  - Icon getIcon( )
  - String getText( )
- The icon and text associated with a label can be set by
  - void setIcon(Icon icon)
  - void setText(String str)

Example

```
import java.awt.*;
import javax.swing.*;
/*
<applet code="JLabelDemo" width=250 height=150>
</applet>
*/

public class JLabelDemo extends JApplet {
	public void init() {
		try {
			SwingUtilities.invokeAndWait(
				new Runnable() {
					public void run() {
						makeGUI();
					}
				}
			);
		} catch (Exception exc) {
			System.out.println("Can't create because of " + exc);
		}
	}
	private void makeGUI() {
		ImageIcon ii = new ImageIcon("france.gif");
		JLabel jl = new JLabel("France", ii, JLabel.CENTER);
		add(jl);
	}
}
```

JTextField

- JTextField allows you to edit one line of text.
- Derived from JtextComponent
- Provides the basic functionality common to Swing text components.
- JTextField uses the Document interface
- JTextField’s constructors:
  - JTextField(int cols)
  - JTextField(String str, int cols)
  - JTextField(String str)
- str is the string of initialization, and cols is the no. of columns in the text field.
- Field is intially empty, if no string is specified
- By default, no. of columns fit the specified string.

JTextField(2)

- JTextField generates events in response to user interaction.
  - Example:
  - ActionEvent is fired, when the user presses ENTER
  - CaretEvent is fired, when cursor changes position.
- The most common action is to obtain the string currently in the text field
  - using getText( ).

Example

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

public class JTextFieldDemo extends JFrame {
    JTextField jtf;
    JLabel jlab;

    JTextFieldDemo() {
        setLayout(new FlowLayout());

        jtf = new JTextField(15);
        add(jtf);

        jlab = new JLabel("Type something and press
Enter.");
        add(jlab);

        // Add ActionListener for the text field
        jtf.addActionListener(new ActionListener() {
```

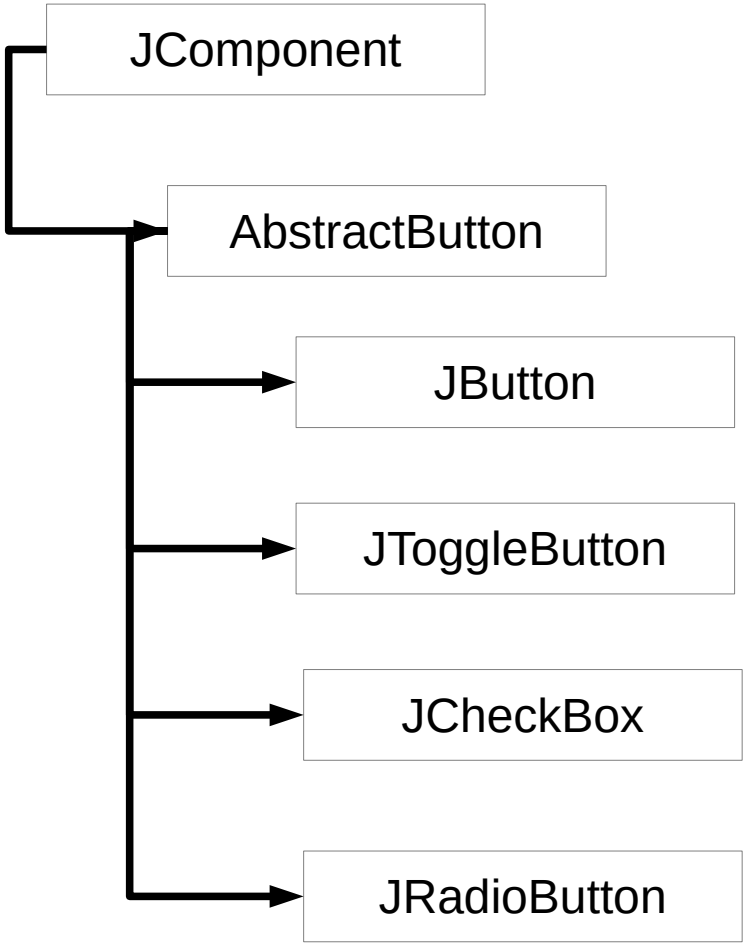
```
public void actionPerformed(ActionEvent ae) {
                jlab.setText("You typed: " + jtf.getText());
            }
        });

        setTitle("JTextField Demo");
        setSize(300, 100);

setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setVisible(true);
    }

    public static void main(String[] args) {
        SwingUtilities.invokeLater(() -> new
JTextFieldDemo());
    }
}
```

Swing Buttons



- The button text can be read and written via:
  - String getText( )
  - void setText(String str)
- A button generates an action event when it is pressed

JButton

- A push button
- Constructors
  - JButton(Icon icon)
  - JButton(String str)
  - JButton(String str, Icon icon)
- When the button is pressed, an ActionEvent is generated.
- Using the ActionEvent object passed to the actionPerformed( ) method of the registered ActionListener, the action command string can be obtained.
- We can set the action command by calling setActionCommand( ) on the button.
- We can obtain the action command by calling getActionCommand( ) on the event object.
  - String getActionCommand( )

Example : JButton

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

public class JButtonDemo extends JFrame implements ActionListener {
    JLabel jlab;

    JButtonDemo() {
        setLayout(new FlowLayout());

        ImageIcon apple = new ImageIcon("apple.png");
        JButton jb = new JButton(apple);
        jb.setActionCommand("Apple");
        jb.addActionListener(this);
        add(jb);

        ImageIcon fb = new ImageIcon("fb.png");
        jb = new JButton(fb);
        jb.setActionCommand("Facebook");
        jb.addActionListener(this);
        add(jb);
```

Example : JButton(2)

```
ImageIcon ms = new ImageIcon("ms4.png");
        jb = new JButton(ms);
        jb.setActionCommand("Microsoft");
        jb.addActionListener(this);
        add(jb);

        jlab = new JLabel("Choose an Image");
        add(jlab);

        setTitle("JButton Demo");
        setSize(300, 400);
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setVisible(true);
    }

    // Handle button events
    public void actionPerformed(ActionEvent ae) {
        jlab.setText("You selected " + ae.getActionCommand());
    }

    public static void main(String[] args) {
        SwingUtilities.invokeLater(() -> new JButtonDemo());
    }
}
```

Check Boxes

- The JCheckBox class provides the functionality of a check box.
- Its immediate superclass is JToggleButton, which provides support for two-state buttons.
- JcheckBox defines several constructors: one is
  - JCheckBox(String str)
  - It creates a check box that has the text specified by str as a label.
- On selection or deselection (checked or unchecked) a check box, an **ItemEvent** is generated.
- A reference to the **JCheckBox** that generated the event by calling **getItem( )** on the ItemEvent passed to the itemStateChanged( ) method defined by ItemListener.
- To determine the selected state of a check box is to call **isSelected( )** on the JcheckBox instance.

Example: JCheckbox

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

public class JCheckBoxDemo extends JFrame implements ItemListener {
    JLabel jlab;

    JCheckBoxDemo() {
        setLayout(new FlowLayout());

        // Create and add check boxes
        JCheckBox cb = new JCheckBox("C");
        cb.addItemListener(this);
        add(cb);

        cb = new JCheckBox("C++");
        cb.addItemListener(this);
        add(cb);

        cb = new JCheckBox("Java");
        cb.addItemListener(this);
        add(cb);

        cb = new JCheckBox("Perl");
        cb.addItemListener(this);
        add(cb);
```

Example: JCheckbox(2)

```
// Label to show selection status
        jlab = new JLabel("Select languages");
        add(jlab);

        // Frame settings
        setTitle("JCheckBox Demo");
        setSize(300, 120);
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setVisible(true);
    }

    // Handle item events for the check boxes
    public void itemStateChanged(ItemEvent ie) {
        JCheckBox cb = (JCheckBox) ie.getItem();
        if (cb.isSelected())
            jlab.setText(cb.getText() + " is selected");
        else
            jlab.setText(cb.getText() + " is cleared");
    }

    // Entry point
    public static void main(String[] args) {
        SwingUtilities.invokeLater(() -> new JCheckBoxDemo());
    }
}
```

JTabbedPane

- Encapsulates a tabbed pane
- It manages a set of components by linking them with tabs.
- JTabbedPane uses the SingleSelectionModel model.
- Tabs are added by calling addTab( ):
  - void addTab(String name, Component comp)
  - Here, name is the name for the tab, and comp is the component that should be added to the tab.
  - Often, a JPanel is added as component
- Generic Steps
  - Create an instance of JTabbedPane.
  - Add each tab by calling addTab( ).
  - Add the tabbed pane to the content pane

Example: JtabbedPane p1

```
import javax.swing.*;

public class JTabbedPaneDemo extends JFrame {

    public JTabbedPaneDemo() {
        // Create a tabbed pane
        JTabbedPane jtp = new JTabbedPane();

        // Add tabs with their respective panels
        jtp.addTab("Cities", new CitiesPanel());
        jtp.addTab("Colors", new ColorsPanel());
        jtp.addTab("Flavors", new FlavorsPanel());

        // Add the tabbed pane to the frame
        add(jtp);

        // Basic frame settings
        setTitle("JTabbedPane Demo");
        setSize(400, 200);
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setVisible(true);
    }

    public static void main(String[] args) {
        SwingUtilities.invokeLater(() -> new JTabbedPaneDemo());
    }
}
```

Example: JtabbedPane p2

```
// ---------- Supporting Panels ----------

class CitiesPanel extends JPanel {
    public CitiesPanel() {
        add(new JButton("New York"));
        add(new JButton("London"));
        add(new JButton("Hong Kong"));
        add(new JButton("Tokyo"));
    }
}

class ColorsPanel extends JPanel {
    public ColorsPanel() {
        add(new JCheckBox("Red"));
        add(new JCheckBox("Green"));
        add(new JCheckBox("Blue"));
    }
}

class FlavorsPanel extends JPanel {
    public FlavorsPanel() {
        JComboBox<String> jcb = new JComboBox<>();
        jcb.addItem("Vanilla");
        jcb.addItem("Chocolate");
        jcb.addItem("Strawberry");
        add(jcb);
    }
}
```

JList

- supports the selection of one or more items from a list.
- A list of just about any object that can be displayed (mostly found to be string)
- JList provides several constructors:
  - JList(Object[ ] items)
- JList is based on two models:
  - ListModel
  - ListSelectionModel interface
- Most of the time you will wrap a Jlist inside a JScrollPane (makes long lists will automatically be scrollable)

JList(2)

- A JList generates a **ListSelectionEvent** when the user makes or changes or deselects a selection.
- It is handled by implementing ListSelectionListener.
  - void valueChanged(ListSelectionEvent le)
  - Here, le is a reference to the object that generated the event.
- Normally, the JList object is interrogate to determine what has occurred.
- By default, a JList allows the user to select multiple ranges of items within the list
- This behavior can be changed by calling setSelectionMode( )
  - void setSelectionMode(int mode)
  - mode (SINGLE_SELECTION, SINGLE_INTERVAL_SELECTION, and MULTIPLE_INTERVAL_SELECTION)

JList(3)

- The index of the first item selected can also be obtained by calling getSelectedIndex( )
  - int getSelectedIndex( )
- If no item is selected, –1 is returned.
- We can obtain the value associated with the selection by calling getSelectedValue( ):
  - Object getSelectedValue( )
- It returns a reference to the first selected value.
- If no value has been selected, it returns null.

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

public class JListDemo extends JFrame {
    JList<String> jlst;
    JLabel jlab;
    JScrollPane jscrlp;

    // Create an array of cities
    String[] Cities = {
        "New York", "Chicago", "Houston", "Denver", "Los Angeles", "Seattle",
        "London", "Paris", "New Delhi", "Hong Kong", "Tokyo", "Sydney"
    };


    public JListDemo() {
        setLayout(new FlowLayout());

        // Create the JList
        jlst = new JList<>(Cities);
        jlst.setSelectionMode(ListSelectionModel.SINGLE_SELECTION);

        jscrlp = new JScrollPane(jlst);
        jscrlp.setPreferredSize(new Dimension(120, 90));

        // Create label for showing selection
        jlab = new JLabel("Choose a City");

        // Add selection listener
        jlst.addListSelectionListener(new ListSelectionListener() {
            public void valueChanged(ListSelectionEvent le) {
                int idx = jlst.getSelectedIndex();
                if (idx != -1)
                    jlab.setText("Current selection: " + Cities[idx]);
                else
                    jlab.setText("Choose a City");
            }
        });

        // Add components to frame
            add(jscrlp);
            add(jlab);

            // Frame settings
            setTitle("JList Demo");
            setSize(250, 200);

    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
            setVisible(true);
        }

        // Entry point (replaces applet <applet> tag)
        public static void main(String[] args) {
            SwingUtilities.invokeLater(() -> new JListDemo());
        }
    }
```

Multiple Jpanel

```
import java.awt.*;
import javax.swing.*;
public class MultiJPanel extends JFrame {
   private JPanel mainPanel, subPanel1, subPanel2, subPanel3;
   public MultiJPanel() {
      setTitle("MultiPanel Demonstration");
      mainPanel = new JPanel(); // main panel
      mainPanel.setLayout(new GridLayout(1, 4));
      mainPanel.add(new JLabel("Main Panel", SwingConstants.CENTER));
      mainPanel.setBackground(Color.white);
      mainPanel.setBorder(BorderFactory.createLineBorder(Color.black, 1));
      subPanel1 = new JPanel();
      subPanel1.add(new JLabel("Panel One", SwingConstants.CENTER));
      subPanel1.setBackground(Color.red);
      subPanel2 = new JPanel();
      subPanel2.setBackground(Color.blue);
      subPanel2.add(new JLabel("Panel Two", SwingConstants.CENTER));
      subPanel3 = new JPanel();
      subPanel3.setBackground(Color.green);
      subPanel3.add(new JLabel("Panel Three"));
```

```
      mainPanel.add(subPanel1);
      mainPanel.add(subPanel2);
      mainPanel.add(subPanel3);
      add(mainPanel);
      setSize(400, 300);
      setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      setLocationRelativeTo(null);
      setVisible(true);
   }
   public static void main(String[] args) {
      new MultiJPanel();
   }  }
```

Self Study

- JRadioButton
- JScrollPane
- JComboBox
- JTable