MODULE 5

The Delegation Event Model
Events are handled in Java using a ***delegation event model***.

Definition : ***EVENT***
An *event* in Java is an object that is created, when changes are experienced in a graphical user interface.
Changes such as
a user clicks on a button,
clicks on a combo box, or
types characters into a text field, etc.,
then an event triggers, creating the relevant event object.

This behavior is part of Java's Event Handling mechanism
(other properties of Java are
Java is capable of handling Exceptions
Java is capable of handling Garbage Collection
etc.,)

Event handling is integral to the creation of swings and AWT type of GUI-based programs.

Events are supported by a number of packages, including java.util, java.awt and java.awt.event.

Words to ponder in DELEGATION-EVENT MODEL: EVENT, EVENT SOURCE, EVENT LISTENER

Delegation Event Model:

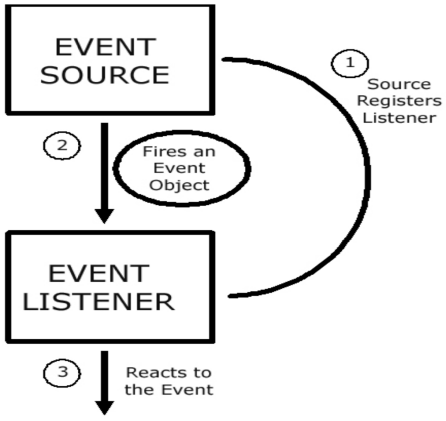
"An ***event source (GUI components) generates an event*** *and sends it to one or more* ***event listeners.***
Listener waits until it receives an event.
Once an event is received, the listener processes the event and then returns the result."

Advantage of this "DELEGATION-EVENT MODEL" is that the **"application logic"** that **"processes events"** is clearly separated from the **"user interface logic"** that **"generates those events"**.

A user interface element (GUI) is able to "delegate" the processing of an event to a separate piece of code.

In the delegation event model, **listeners must register with a source** in order to receive an **event notification**.

Event notifications are sent only to listeners that have registered with the event source.
(callback interfaces)



Events

In the delegation model, an *event* is represented in the form of an object that describes a state change in a source (specifically a GUI application).

Ex: After typing google.com in a web browser, text box of google web page will be empty. (Event is yet to be generated).

As soon as the user types the keywords and press enter, an object containing all the necessary information, regarding the keyword search, including the keywords will be generated and passed to the nearest server.

Event is generated as a consequence of an user interacting with the elements in a GU interface.

Events may also occur that are **not directly caused by interactions with a user interface**.

Ex: an event may be generated when a timer expires, a counter exceeds a value, a software or hardware failure occurs, or an operation is completed.

Event Sources

Event source in a programming perspective is an object that holds all the necessary information about an event. This occurs when the internal state of that object changes in some way.

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. Here is the general form:

public void add<*Type*>Listener(<*Type*>Listener *el*)

Here, *Type* is the name of the event, and *el* is a reference to the event listener.

Ex: The method that registers a keyboard event listener is called **addKeyListener( )**.

The method that registers a mouse motion listener is called **addMouseMotionListener( )**.

When an event occurs, all registered listeners are notified and receive a copy of the "event object". This is known as ***multicasting*** the event.

Notifications are sent only to listeners that register to receive them.

Some sources will allow only one listener to register.
GF:
public void add<*Type*>Listener(<*Type*>Listener *el*) throws
java.util.TooManyListenersException

Here, *Type* is the name of the event, and *el* is a reference to the event listener.

When such an event occurs, the registered listener is notified. This is known as ***unicasting*** the event.

/*
*A source will also provide a method that **allows a listener to unregister an interest in a specific type of event**.*
*GF: **public void remove<Type>Listener(<Type>Listener el)***
Here, Type is the name of the event, and el is a reference to the event listener.

*For example, to remove a keyboard listener, you would call **removeKeyListener( )**.*
*/

Methods that add or remove listeners are provided by the source that generates events.

Below table lists some of the **user interface components/graphical user interface elements that can generate the events**.

Event Source	Description
Button	Generates action events when the button is pressed.
Check box	Generates item events when the check box is selected or deselected.
Choice	Generates item events when the choice is changed.
List	Generates action events when an item is double-clicked; generates item events when an item is selected or deselected.
Menu Item	Generates action events when a menu item is selected; generates item events when a checkable menu item is selected or deselected.
Scroll bar	Generates adjustment events when the scroll bar is manipulated.
Text components	Generates text events when the user enters a character.
Window	Generates window events when a window is activated, closed, deactivated, deiconified, iconified, opened, or quit.

TABLE 22-2 Event Source Examples

Event Classes
When an event occurs, all its information will be encapsulated within an instance of Event class type.

Classes that represent events are at the core of Java's event handling mechanism.

Most widely used events are defined by the AWT(Abstract Window Toolkit) and Swing.

/*
*At the root of the Java event class hierarchy is **EventObject**, which is in **java.util**. It is the superclass for all events.*

***EventObject** class contains these methods:*

```
Object    getSource( );  //returns the source of the event.
String    toString();    //returns the string equivalent of the event.
int       getID();       //returns event type
```

*Class **AWTEvent**, defined within the **java.awt** package, is a subclass of **EventObject**.*

***AWTEvent** is the superclass (either directly or indirectly) of all AWT-based events used by the delegation event model.*

To summarize:

- ***EventObject** is a superclass of all events.*
- ***AWTEvent** is a superclass of all AWT events that are handled by the delegation event model.*

*/

The package **java.awt.event** defines many types of events that are generated by various user interface elements.

Event Class	Description
ActionEvent	Generated when a button is pressed, a list item is double-clicked, or a menu item is selected.
AdjustmentEvent	Generated when a scroll bar is manipulated.
ComponentEvent	Generated when a component is hidden, moved, resized, or becomes visible.
ContainerEvent	Generated when a component is added to or removed from a container.
FocusEvent	Generated when a component gains or loses keyboard focus.
InputEvent	Abstract superclass for all component input event classes.
ItemEvent	Generated when a check box or list item is clicked; also occurs when a choice selection is made or a checkable menu item is selected or deselected.
KeyEvent	Generated when input is received from the keyboard.
MouseEvent	Generated when the mouse is dragged, moved, clicked, pressed, or released; also generated when the mouse enters or exits a component.
MouseWheelEvent	Generated when the mouse wheel is moved.
TextEvent	Generated when the value of a text area or text field is changed.
WindowEvent	Generated when a window is activated, closed, deactivated, deiconified, iconified, opened, or quit.

TABLE 22-1 Main Event Classes in **java.awt.event**

An instance of above classes will be generated by event source automatically and passed to event listeners.

Programmers need not worry about generating instances of these classes, it will be done automatically by JVM.

The Programmer's job will be to register a method as a listener and provide the necessary background logical actions for the event.

The ActionEvent Class
An **ActionEvent** is generated when **a button is pressed, a list item is double-clicked**, or **a menu item is selected**.

The **ActionEvent** class defines four integer constants that can be used to identify any modifiers associated with an action event: **ALT_MASK**, **CTRL_MASK**, **META_MASK**, and **SHIFT_MASK**.

In addition, there is an integer constant, **ACTION_ PERFORMED**, which can be used to identify action events.

Constructors of ActionEvent class **// used only by event source** ActionEvent(Object *src*, int *type*, String *cmd*) ActionEvent(Object *src*, int *type*, String *cmd*, int *modifiers*) ActionEvent(Object *src*, int *type*, String *cmd*, long *when*, int *modifiers*) *src :* is a reference to the object that generated this event. *type :* type of the event is specified by type. *modifier :* indicates which modifier keys such as ALT, CTRL, META and/or SHIFT were pressed when the event was generated. *when:* parameter specifies when the event occurred.
String getActionCommand( ) //used by event listeners returns Command name for the invoking ActionEvent object Ex: when a button is pressed, an action event is generated that has a command name equal to the label on that button.
int getModifiers( ) //used by event listeners returns a value that indicates which modifier keys (ALT, CTRL,META, and/or SHIFT) were pressed when the event was generated.
long getWhen( ) //used by event listeners returns the time at which the event took place. This is called theevent's *timestamp.*

The AdjustmentEvent Class
The ComponentEvent Class
The ContainerEvent Class
The FocusEvent Class
The InputEvent Class
The ItemEvent Class
The KeyEvent Class
The MouseEvent Class
The MouseWheelEvent Class
The TextEvent Class
The WindowEvent Class

Event Listeners

/*

Definition : EVENT LISTENER

*An **event listener** is a **procedure** or **function** in a computer program that waits for an event to occur. The listener is programmed to react to an input or signal by calling the event's handler.*

*/

An *Event listener* is an object that is notified when an event occurs.
(Remember even *Event source* is an object, which generates events)

It has two major requirements.

First, it must have been registered with one or more sources to receive notifications about specific types of events.

Second, it must implement methods to process these notifications/requests, which will logically modify the received data from the event source.

The methods that receive and process events are defined in a set of interfaces found in **java.awt.event**. Ex: **MouseMotionListener** interface defines two methods to receive notifications when the mouse is dragged or moved. Any object may receive and process one or both of these events if it provides an implementation of this interface.

Event Listener Interfaces

Delegation event model has two parts: **source and listener.**

Listeners are created by implementing one or more of the interfaces defined by the **java.awt.event** package.

When an event occurs, the event source invokes the appropriate method defined by the listener and provides an event object as its argument.

Table lists commonly used listener interfaces and provides a brief description of the methods that they define.

Interface	Description
ActionListener	Defines one method to receive action events.
AdjustmentListener	Defines one method to receive adjustment events.
ComponentListener	Defines four methods to recognize when a component is hidden, moved, resized, or shown.
ContainerListener	Defines two methods to recognize when a component is added to or removed from a container.
FocusListener	Defines two methods to recognize when a component gains or loses keyboard focus.
ItemListener	Defines one method to recognize when the state of an item changes.
KeyListener	Defines three methods to recognize when a key is pressed, released, or typed.
MouseListener	Defines five methods to recognize when the mouse is clicked, enters a component, exits a component, is pressed, or is released.
MouseMotionListener	Defines two methods to recognize when the mouse is dragged or moved.
MouseWheelListener	Defines one method to recognize when the mouse wheel is moved.
TextListener	Defines one method to recognize when a text value changes.
WindowFocusListener	Defines two methods to recognize when a window gains or loses input focus.
WindowListener	Defines seven methods to recognize when a window is activated, closed, deactivated, deiconified, iconified, opened, or quit.

TABLE 22-3 Commonly Used Event Listener Interfaces

ActionListener Interface

defines the **actionPerformed( )** method that is invoked when an action event occurs.

void actionPerformed (ActionEvent *ae*)

AdjustmentListener Interface

defines the **adjustmentValueChanged( )** method that is invoked when an adjustment event occurs.

void adjustmentValueChanged (AdjustmentEvent *ae*)

…..

KeyListener Interface

defines three methods. The keyPressed( ) and keyReleased( ) methods are invoked when a key is pressed and released, respectively.

The keyTyped( ) method is invoked when a character has been entered.

For example, if a user presses and releases the A key, three events are generated in sequence: key pressed, typed, and released.

If a user presses and releases the HOME key, two key events are generated in sequence: key pressed and released.

void keyPressed (KeyEvent *ke*)
void keyReleased (KeyEvent *ke*)
void keyTyped (KeyEvent *ke*)

MouseListener Interface

defines five methods.

If the mouse is pressed and released at the same point, mouseClicked( ) is invoked.
When the mouse enters a component, the mouseEntered( )method is called.
When it leaves, mouseExited( ) is called.
The mousePressed( ) and mouseReleased( ) methods are invoked when the mouse is pressed and released, respectively.

void mouseClicked (MouseEvent *me*)
void mouseEntered (MouseEvent *me*)
void mouseExited (MouseEvent *me*)
void mousePressed (MouseEvent *me*)
void mouseReleased (MouseEvent *me*)

MouseMotionListener Interface
This interface defines two methods.

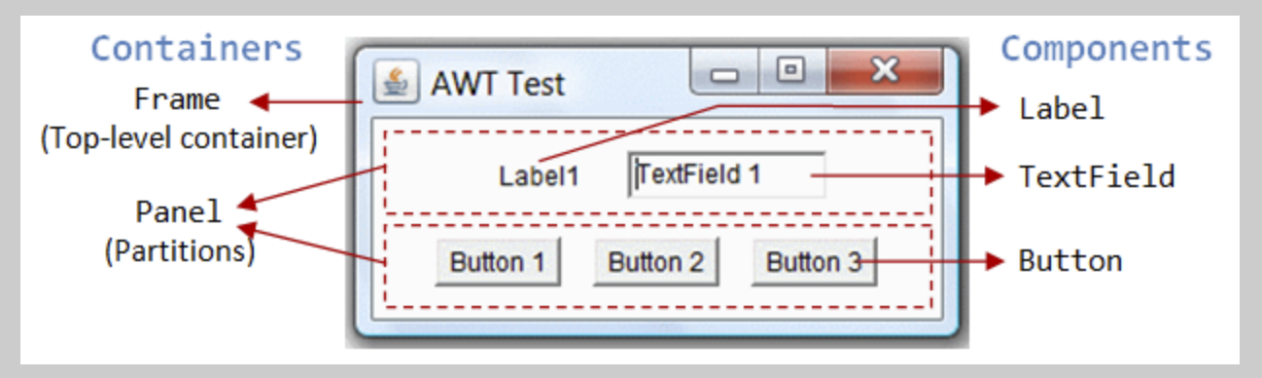
void mouseDragged (MouseEvent *me*)
void mouseMoved (MouseEvent *me*)

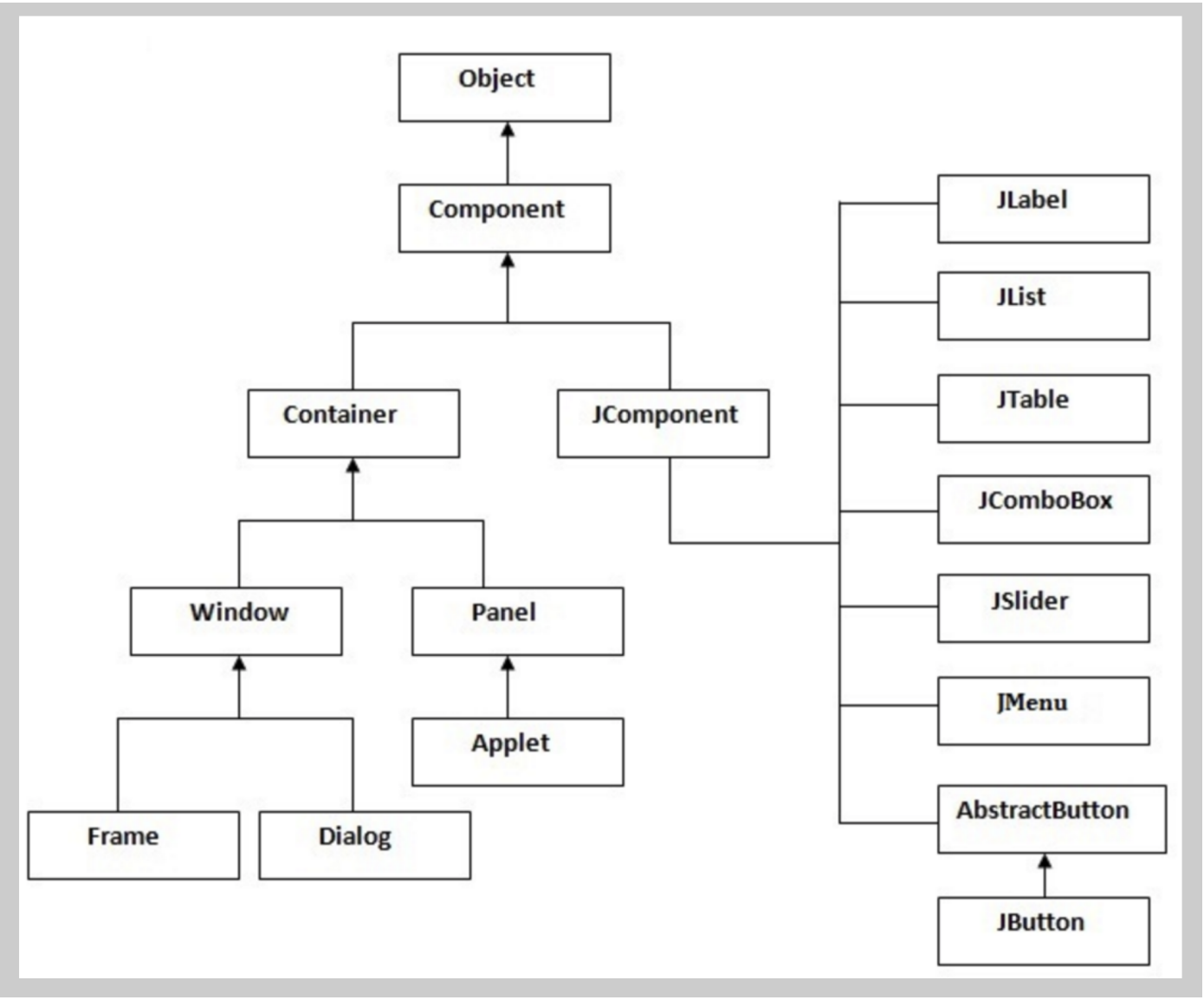
The mouseDragged( ) method is called multiple times as the mouse is dragged.
The mouseMoved( ) method is called multiple times as the mouse is moved.

/* **POINTS TO PONDER**
A single GUI component like button, or text box or label will be part of a container like Frame

GUI components like buttons, textbox or labeLs are Event sources.

But since, these components are stored or added to a container **Frame acts as both an event source and an event listener.***/




Object
Component
Container
JComponent
Window
Panel
Frame
Dialog
Applet
JLabel
JList
JTable
JComboBox
JSlider
JMenu
AbstractButton
JButton

Ex: HANDLING MOUSE EVENTS

```
import java.awt.*;  //1
import java.awt.event.*;  //2
//GUI is both event source and event listener
public class GUI extends Frame implements MouseListener, MouseMotionListener
{
   Label l; //3
   Label l1,l2;

   int mx=0,my=0;

   GUI(){
      addMouseListener(this);  //4
      addMouseMotionListener(this); //4

      l=new Label();
      l.setBounds(10,10,100,150); //5
      add(l);  //6


      l1 = new Label();
      l1.setBounds(10,90,100,150);
      add(l1);

      l2 = new Label();
      l2.setBounds(10,180,100,150);
      add(l2);

      setSize(400,400);  //7
      setLayout(null);  //8
      setVisible(true); //9
   }
```

```
// All these methods are called implicitly by the event source.
    public void mouseClicked(MouseEvent e)
    {
        l.setText("Mouse Clicked" );
        System.out.println(e.getX()+ " "+e.getY());
    }
    public void mouseEntered(MouseEvent e) {
        l.setText("Mouse Entered");
    }
    public void mouseExited(MouseEvent e) {
        l.setText("Mouse Exited");
    }
    public void mousePressed(MouseEvent e) {
        l.setText("Mouse Pressed");
    }
    public void mouseReleased(MouseEvent e) {
       l2.setText("Mouse Released");
    }
    public void mouseDragged(MouseEvent e){
            l1.setText("Mouse Dragged");
    }
    public void mouseMoved(MouseEvent e) {
            l1.setText("Mouse Moved");
    }
public static void main(String[] args) {
    new GUI();
}   }
/*
```

1. adds only those classes that are present in awt sub-directory.

2. event is a sub-package and all the classes in event is added to the program

3.The object of Label class, which is a GUI component for placing text in a container.
It is used to display a single line of read only text.
The text can be changed by an application but a user cannot edit it directly.

(IH of Label)
java.lang.Object
    java.awt.Component
        java.awt.Label   //Label is derived class of Component

4. **Frame is both the source and the listener for these events.**

the Frame registers itself as a listener for mouse events.

This is done by using addMouseListener( ) and addMouseMotionListener( ),

which are members of Component.

```
void    addMouseListener          (MouseListener ml)
void    addMouseMotionListener  (MouseMotionListener mml)
```

5. public void setBounds(int x, int y, int width, int height)

Moves and resizes this component. The new location from

top-left corner is specified by x and y, and

the new size is specified by width and height.

6. public Component add(Component comp)

Appends the specified component to the end of this container.

Parameters:

comp - the component to be added

Returns:

the component argument

Throws:

NullPointerException - if comp is null

Class Frame

INHERITANCE HIERARCHY

****

java.lang.Object

java.awt.Component // add(Component comp) method belongs to this class

java.awt.Container

java.awt.Window

java.awt.Frame

7. public void setSize(int w, int h) belongs to Component class

Resizes this component so that it has width w and height h.

Parameters:

w - the new width of this component in pixels

h - the new height of this component in pixels

User defined class GUI does not have setSize method but its base class Frame has it, which is inherited by Component class.

8. java.awt.Container contains setLayout method

The Layout managers enable programmer to control the way in which visual components are arranged in the GUI forms by determining the size and position of components within the containers.
There are different built-in classes for layout managers in java.

9. public void setVisible(boolean b) java.awt.Window class contains this method
Shows or hides this Window depending on the value of parameter b.
*/

Ex: HANDLING KEYBOARD EVENTS

```
import java.awt.*;
import java.awt.event.*;
public class GUI extends Frame implements KeyListener
{
   Label l,l1;
   String msg ="";

 GUI(){
       addKeyListener(this);

       l=new Label();
       l.setBounds(10,10,100,150);
       add(l);


       l1 = new Label();
       l1.setBounds(10,90,200,400);
       add(l1);

       setSize(400,400);
       setLayout(null);
       setVisible(true);
   }

   public void keyPressed(KeyEvent ke) {
       l.setText("Key Down");
       int key = ke.getKeyCode();
       switch(key) {
         case KeyEvent.VK_F1:
 //Virtual key codes present in KeyEvent class Pg no. 645 text book
```

```
            msg += "<F1>";
            break;
          case KeyEvent.VK_F2:
            msg += "<F2>";
            break;
          case KeyEvent.VK_F3:
            msg += "<F3>";
            break;
          case KeyEvent.VK_PAGE_DOWN:
            msg += "<PgDn>";
            break;
          case KeyEvent.VK_PAGE_UP:
            msg += "<PgUp>";
            break;
          case KeyEvent.VK_LEFT:
            msg += "<Left Arrow>";
            break;
          case KeyEvent.VK_RIGHT:
            msg += "<Right Arrow>";
       break; }
        l1.setText(msg);
    }

    public void keyReleased(KeyEvent ke) {
        l.setText("KeyReleased");
    }

    public void keyTyped(KeyEvent ke) {
        msg = msg + ke.getKeyChar();
          l1.setText(msg);
    }

public static void main(String[] args) {
    new GUI();
}
}
```

Adapter Classes

Adapter classes are used to simplify the creation task of event handlers.

Ex: GUI class is an Event handler it has registered for KeyListener. Since, it has registered for KeyListener, it has to implement all the methods that are declared in the KeyListener interface. After implementing KeyListener, if GUI class wants to implement only KeyTyped method it is not

allowed.

An adapter class provides **an empty implementation** for all the methods in an event listener interface.

Adapter classes are useful only when some of the events are supposed to be received and processed by a particular event listener interface.

Adapter classes can be inherited by the event handler classes (like GUI) and only those methods that are required can be implemented.

Ex:

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

class frame extends Frame      //Event Source
{
  protected Label l; // Label is G-component.     Frame is a container

 frame(){
       l=new Label();
       l.setBounds(10,10,100,150);
       add(l);

       //Event register method
       addMouseMotionListener(new GUI(this));  //1


       setSize(400,400);
       setLayout(null);
       setVisible(true);
   }
}
//GUI is considered as listener class
public class GUI extends MouseMotionAdapter   // Event Listener
{
          frame fr;
          GUI(frame f){
                    fr = f;
          }

   public void mouseDragged(MouseEvent me) {
            fr.l.setText("Mouse Dragged");
```

```
    }

    public static void main(String[] args) {
            new frame();
    }
}
/*
```

1. Since, java allows only one class to extend, both Frame and MouseMotionAdapter cannot be extended to a single class.

   "frame" class extends Frame and "GUI" extends MouseMotionAdapter class.

   Frame is the component which generates an event and also the component which responds to the event (Event listener).

   Registering for the event listener has to be done in frame class only.

   GUI class implements mouseDragged method hence addMouseMotionListener is passed as an instance of GUI.

   addMouseMotionListener cannot be called in GUI class because it is present in Component class whose properties are inherited by Frame class and MouseMotionAdapter has not inherited properties of the Component class.

   public abstract class MouseMotionAdapter extends Object
   implements MouseMotionListener

```
*/
```

TABLE 22-4 Commonly Used Listener Interfaces Implemented by Adapter Classes

Adapter Class	Listener Interface
ComponentAdapter	ComponentListener
ContainerAdapter	ContainerListener
FocusAdapter	FocusListener
KeyAdapter	KeyListener
MouseAdapter	MouseListener
MouseMotionAdapter	MouseMotionListener
WindowAdapter	WindowListener

All adapter classes are by default abstract classes, in which the methods of respective interfaces are null defined. The methods in this class are empty.

public abstract class MouseMotionAdapter extends Object

implements MouseMotionListener

In other words definitions of compulsory/mandatory methods of implemented interface will not have any statements within it.

Inner Classes

"inner class" is a class defined within another class, or even within an expression.

Use of inner class will simplify the code using event adapter classes.

Ex:

```
import java.awt.*;
import java.awt.event.*;
 class frame extends Frame //Event source
{
  protected Label l;

   frame(){
      l=new Label();
      l.setBounds(10,10,100,150);
      add(l);

      //Event register method
      addMouseMotionListener(new gui());

      setSize(400,400);
      setLayout(null);
      setVisible(true);
   }
   class gui extends MouseMotionAdapter  // INNER CLASS event listener
   {
         public void mouseDragged(MouseEvent me)
         {
               l.setText("Mouse Dragged");
         }
   }// end of class gui
} // end of class frame
public class GUI
```

```
{
        public static void main(String[] args) {
           new frame();
        }
}
```

Swings (GUI components in swings are not thread safe)

Swing is a set of classes that provides more powerful and flexible GUI components than AWT.

AWT graphical components are considered as *heavy weight components.*

*/**
AWT Graphical components look and feel is fixed. Look and feel of a component is defined by the platform.
**/*

Swing eliminates a number of the limitations inherent in the AWT.

Swing is built on the foundation of the AWT.

Swing also uses the same event handling mechanism as the AWT.

Two Key Swing Features

Lightweight components and

Pluggable look and feel.

"Look" *refers to the appearance of GUI widgets and* ***"feel"*** *refers to the way the widgets behave.*
"Pluggable" *the look and feel that can be changed during runtime.*

Swing Components Are Lightweight

Swing components are written entirely in Java and do not map directly to platform-specific peers.

Because lightweight components are rendered using graphics primitives (like line drawing, circle drawing and different graphical drawing algorithms), they can be transparent, which enables non rectangular shapes.
"Non-rectangular shapes" *: Normally Dialog Boxes are rectangular in shape. Various methods can be adopted to make them non-rectangular in shape.*

Hence, lightweight components are more efficient and more flexible.

Furthermore, because lightweight components do not translate into native peers, the look and feel of each component is determined by Swing, not by the underlying operating system.

This means that each component will work in a consistent manner across all platforms.

/
Swing Supports a Pluggable Look and Feel (PLAF)
Since, each Swing component is rendered by Java code rather than by native code, the look and feel of a component is ***under the control of Swing****.*

Swing separates the look and feel of a component from the logic of the component.

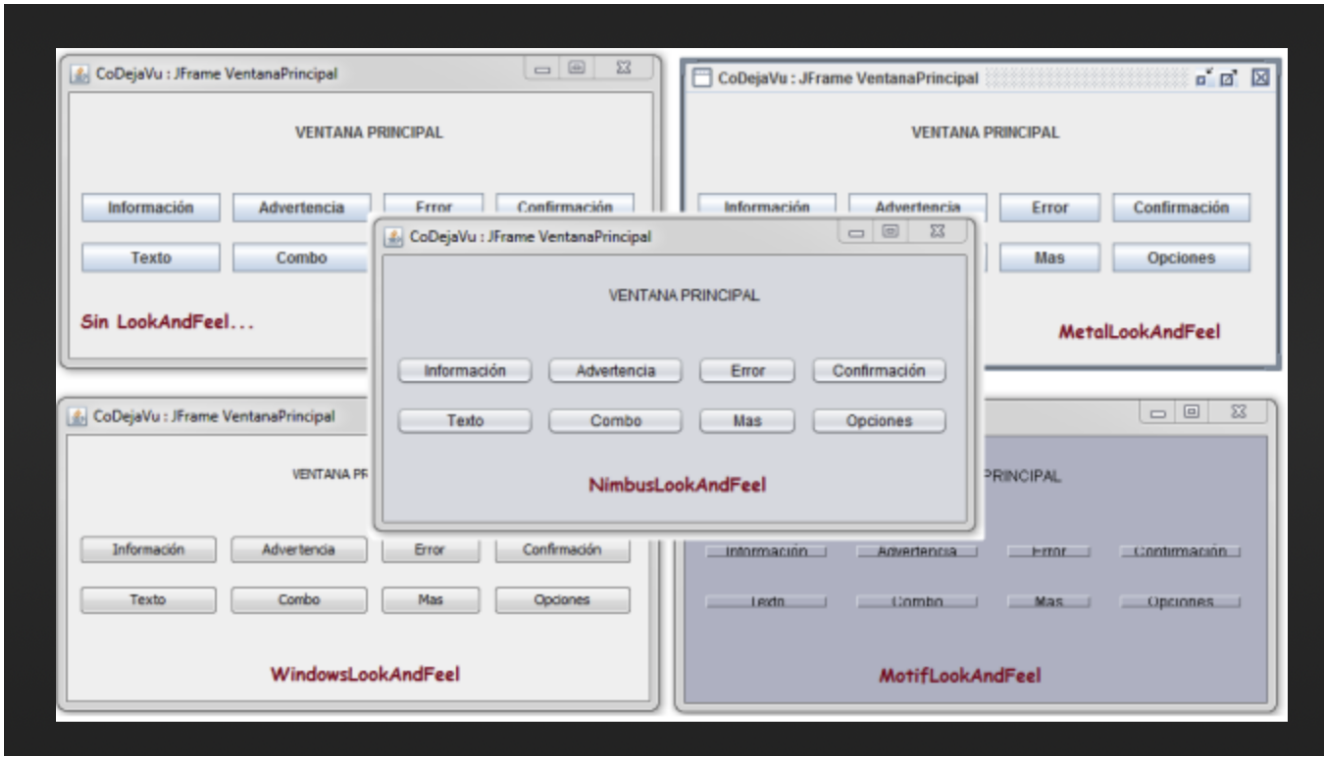
Since, swing separates the look and feel of a component, it is possible to change the way that a component is rendered without affecting any of its other aspects.

Pluggable look-and-feels offer several important advantages. It is possible to define a look and feel that is consistent across all platforms.

Conversely, it is possible to create a look and feel that acts wrt a specific platform.
Ex: if an application will be running only in a Windows environment, it is possible to specify the Windows look and feel.
**/*

The look and feel can be changed dynamically at run time.

Java SE 6 provides look-and-feels, such as **metal** and **Motif**, that are available to all Swing users.
The metal look and feel is also called the *Java look and feel*.
It is platform-independent and available in all Java execution environments. It is also the default look and feel.



For the Swing program metal look-and-feel will be considered since it is platform independent.

The MVC Connection

In general, a visual/Graphical component is a composite of three distinct aspects:

The way that the **component looks** when rendered on the screen

The way that the **component reacts** to the user

The **state information** associated with the component

MVC means the "**logic that interacts with data"** and "**user interface that represent data"** must be separate entities.

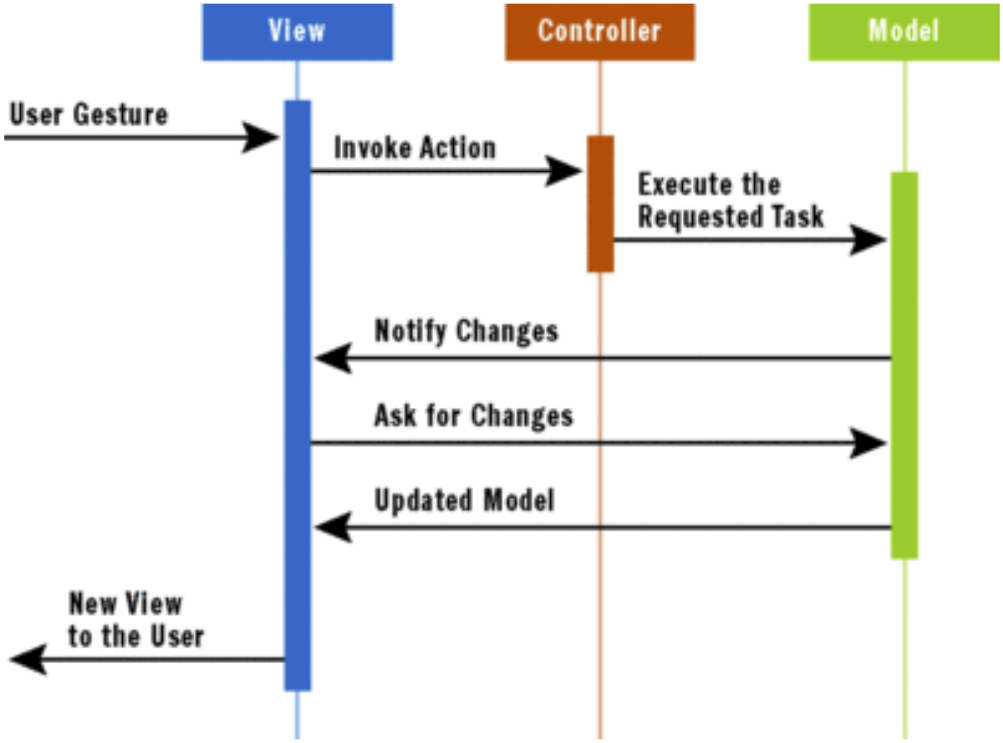
In MVC terminology, the ***model*** corresponds to the state information associated with the component.

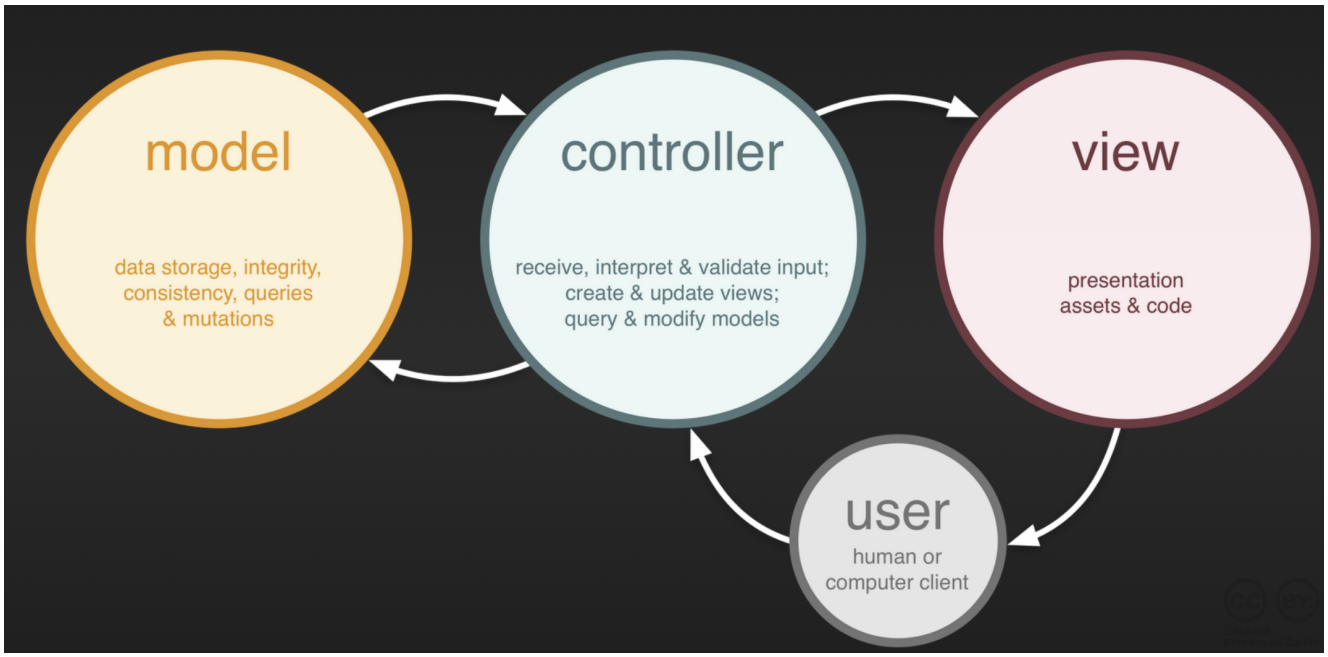
Ex: in case of a check box, the model contains a field/data member that indicates if the box is checked or unchecked.

View determines how the component is displayed on the screen.

C***ontroller*** determines how the component reacts to the user.

Ex: when the user clicks a checkbox, the controller reacts by changing the model to reflect the user's choice (checked or unchecked). Which then results in the view being updated.





Ex:
In restaurant example, customer is the view, waiter is the controller and the chef is the model.
Data in this case is equal to the ingredients of the food.
Chef or the cook has to prepare them, just like the model retrieves and processes data from persistent storage.
Waiter is not going to prepare the food like the controller does not communicate with the database (also both the controller and the view), in restaurant example the waiter and customer doesn't know anything about the process of the cook.

Swing uses a modified version of MVC that **combines** the **view** and the **controller into a single logical entity** called the ***UI delegate***.

Hence, Swings are termed as **MODEL-DELEGATE / SEPARABLE MODE**L architecture.

To support the Model-Delegate architecture, most **Swing components contain two objects**.
First represents the model.
Second represents UI delegate.

Models are defined by interfaces. (Models are similar to listeners)
Ex: model for a button is defined by the **ButtonModel** interface.

UI delegates are classes that inherit **ComponentUI**.
Ex: UI delegate for a button is **ButtonUI**.

Difference between AWT and Swing

Java AWT	Java Swing
AWT components are platform-dependent	Swing components are platform-independent
AWT components are heavy weight	Swing components are lightweight
AWT does not provide pluggable look and feel	Swing supports pluggable look and feel
AWT provides less GUI components than swing	Swing provides more number of GUI components
AWT does not follow MVC (Model View Controller) Where model represents data View represents presentation Controller acts as an interface between model and view	Swing follows MVC

Components and Containers

A Swing GUI consists of two key items: *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 that is designed to hold other components.

Further, 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.

Containers are also considered as components, a container can also hold other containers.

Swing defines a *containment hierarchy*, at the top of which must be a *top-level container*.
Ex: JFrame, JApplet, JDialog etc.,

Components

Swing components are derived from the **JComponent** class.

JComponent provides the functionality that is common to all components.

All of Swing's components are represented by classes defined within the package **javax.swing**.

JApplet	JButton	JCheckBox	JCheckBoxMenuItem
JColorChooser	JComboBox	JComponent	JDesktopPane
JDialog	JEditorPane	JFileChooser	JFormattedTextField
JFrame	JInternalFrame	JLabel	JLayeredPane
JList	JMenu	JMenuBar	JMenuItem
JOptionPane	JPanel	JPasswordField	JPopupMenu
JProgressBar	JRadioButton	JRadioButtonMenuItem	JRootPane
JScrollBar	JScrollPane	JSeparator	JSlider
JSpinner	JSplitPane	JTabbedPane	JTable
JTextArea	JTextField	JTextPane	JTogglebutton
JToolBar	JToolTip	JTree	JViewport
JWindow			

Table: Swing Components and Containers.

/*Containers
Swing defines two types of containers.

***The first** are top-level containers: **JFrame**, **JApplet**,**JWindow**, and **JDialog** (heavy weight).*
*These containers do not inherit **JComponent**.*
*They inherit the AWT classes **Component** and **Container**.*

As the name implies, a top-level container must be at the top of a containment hierarchy.

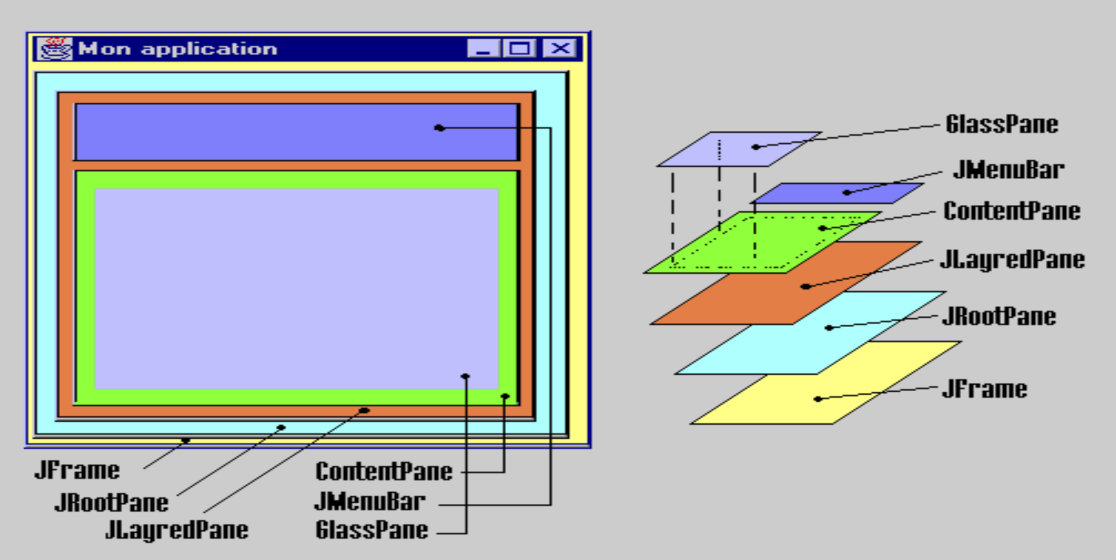
A top-level container is not contained within any other container.
*Ex: most commonly used container for applications is **JFrame**.*

***The second** type of containers supported by Swing are lightweight containers.*
*Lightweight containers do inherit **JComponent**.*

*An example of a lightweight container is **JPanel**, which is a general-purpose container. Lightweight containers are often used to organize and manage groups of related components because a lightweight container can be contained within another container.*

*Thus, **JPanel** is used to create subgroups of related controls that are contained within an outer container.*/*

The Top-Level Container Panes



The pane with which application will interact the most is the content pane, because this is the pane to which visual components will be added.
Ex: when a component, such as a button is added, to a top-level container, it will be added to the content pane. By default, the content pane is an instance of **JPanel**.

A SIMPLE SWING APPLICATIONS

```
import javax.swing.*;
class SwingDemo {
  SwingDemo() {

        JFrame jfrm = new JFrame("A Simple Swing Application");

        jfrm.setSize(275, 100);

        jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        JLabel jlab = new JLabel(" Swing means powerful GUIs.");

        jfrm.add(jlab);

        jfrm.setVisible(true);
  }
```

```
public static void main(String args[]) {
     SwingUtilities.invokeLater(new Runnable()     {
    public void run()
    {
      new SwingDemo();
    }
   }   // end of anonymous class
   );// end of creation of instance
}}
```

Output of the program

The program imports javax.swing, which contains components and models defined by Swing.
Ex: javax.swing defines classes that implement labels, buttons, text controls, and menus.

It will be included in all programs that use Swing.

First statement is constructor of "SwingDemo" user defined class is

JFrame jfrm = new JFrame("A Simple Swing Application");

This creates a **container** called jfrm that defines a rectangular window complete with a
title bar;
close,
minimize,
maximize, and
restore buttons; and
a system menu.

It creates a standard, top-level window. **The title of the window is passed to the constructor.**

Next, the window is sized using this statement:
jfrm.setSize(275, 100); //void setSize(int *width*, int *height*)

setSize( ) method (which is inherited by JFrame from the AWT class Component) sets the dimensions of the window, which are specified in pixels.

By default, when a top-level window is closed (such as when the user clicks the close box), the window is removed from the screen, but the application is not terminated, which is the default behavior.

In some situations, when a top level window is closed the entire application has to terminate, which is done by calling setDefaultCloseOperation( ) as shown.

jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

Since, the above statement is used in the program closing the window causes the entire application to terminate.

GF: **void setDefaultCloseOperation(int *what*)**
The value passed in *what* determines what happens when the window is closed.
JFrame.EXIT_ON_CLOSE
JFrame.DISPOSE_ON_CLOSE
JFrame.HIDE_ON_CLOSE
JFrame.DO_NOTHING_ON_CLOSE

The next statement creates a Swing JLabel component:
JLabel jlab = new JLabel("Swing means powerful GUIs.");

JLabel displays information, which can consist of text, an icon, or a combination of the two.
The label created by the program contains only text, which is passed to its constructor.

Next statement is
jfrm.add(jlab); //Component add(Component *comp*)

*All **top-level containers** have a **content pane** in which **components are stored**.*

Adding a component to a frame's content pane is done by calling **add( )** on **JFrame** reference i.e **jfrm**.

The last statement is: **jfrm.setVisible(true);**

If its argument is **true**, the window will be displayed. Otherwise, it will be hidden.

Anonymous inner class
https://docs.oracle.com/javase/tutorial/java/javaOO/anonymousclasses.html

Inside **main( )**, a **SwingDemo** object is created, which causes the window and the label to be displayed.

```
SwingUtilities.invokeLater(new Runnable()
                {
                    public void run()
                    {
                        new SwingDemo();
                    }

                }
            );
```

This sequence causes a **SwingDemo** object to be created on the ***event dispatching thread*** rather than on the ***main thread of the application***.

Swing programs are event-driven.
Ex: when a user interacts with a component, an event is generated.

An event is passed to the application by calling an event handler defined by the application.

Event handler is executed on the **"event dispatching thread (EDT)"** provided by Swing and not on the main thread of the application.

//Below URL's answers why swing components must be executed in EDT
https://docs.oracle.com/javase/tutorial/uiswing/concurrency/dispatch.html

https://javarevisited.blogspot.com/2013/08/why-swing-is-not-thread-safe-in-java-Swingworker-Event-thread.html
Below lines are available in the above link.
"Since EDT thread is most important in Swing and responsible for listening event and updating GUI, you must not do any time consuming task on it, otherwise, you risk your application to become unresponsive or frozen. Another key thing to note, while using multi-threading in Swing development is that, not only GUI components but there model e.g. TableModel for JTable, must be updated in Event Dispatcher thread. One of the crucial difference between AWT and Swing is that AWT components are thread-safe."

(***)To execute GUI code on the **event dispatching thread**, one of the two methods that are defined by the **SwingUtilities** class, are supposed to be called.

static void invokeLater(Runnable *obj*)

static void invokeAndWait(Runnable *obj*) throws InterruptedException, InvocationTargetException

obj is a **Runnable** object that will have its **run( )** method called by the event dispatching thread.

The difference between the two methods is that **invokeLater( )** returns immediately, but **invokeAndWait( )** waits until **obj.run( )** returns.

*/**
*invokeAndWait() method in swing is **synchronous**.*
It blocks until the Runnable task is complete.

*InvokeLater() method in swing is **asynchronous**.*
It posts an action event to the event queue and returns immediately. It will not wait for the task to complete
**/*

Ex: Same program written using an intermediate class

```
import javax.swing.*;
class gui {
  gui() {

          JFrame jfrm = new JFrame("A Simple Swing Application");

          jfrm.setSize(275, 100);

          jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

         JLabel jlab = new JLabel(" Swing means powerful GUIs.");

          jfrm.add(jlab);

          jfrm.setVisible(true);
  }
}

class inter implements Runnable
{
        Thread t = new Thread(this);

        public inter()
        {   t.start();   }

        public void run()
        {   new gui();   }
}

class test {
public static void main(String args[]) {
    new inter();
        OR
SwingUtilities.invokeLater(new inter() );
  }   }
```

Event Handling

The following program handles the event generated by a Swing push button.


```
//Handle an event in a Swing program.
import java.awt.*;  // because "FlowLayout" is present in this package
import java.awt.event.*;
import javax.swing.*;
class EventDemo {
JLabel jlab;
   EventDemo() {
        // Create a new JFrame container.
        JFrame jfrm = new JFrame("An Event Example");
        // Specify FlowLayout for the layout manager.
        jfrm.setLayout(new FlowLayout());
/*
https://docs.oracle.com/javase/7/docs/api/java/awt/FlowLayout.html
Reg why FlowLayout is necessary is explained in the above url
*/
        // Give the frame an initial size.
        jfrm.setSize(220, 90);

         // Terminate the program when the user closes the application.
        jfrm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        // Make two buttons.
        JButton jbtnAlpha = new JButton("Alpha");
        JButton jbtnBeta = new JButton("Beta");
```

```
        // Add action listener for Alpha.
        //https://docs.oracle.com/javase/7/docs/api/java/awt/event/ActionListener.html
        /*
        Adds the specified action listener to receive action events from this button. Action events occur
        when a user presses or releases the mouse over this button
        */
         jbtnAlpha.addActionListener (new ActionListener()
                {
                        public void actionPerformed(ActionEvent ae) {
                                jlab.setText("Alpha was pressed.");
                        }
                } );

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

        // Add the buttons to the content pane.
        jfrm.add(jbtnAlpha);
        jfrm.add(jbtnBeta);

         // Create a text-based label.
         jlab = new JLabel("Press a button.");

        // 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 EventDemo();
```

```
    }
  });
  } }
```

The **java.awt** package is needed because it contains the **FlowLayout** class, which supports the standard flow layout manager used to lay out components in a frame.

The **java.awt.event** package is needed because it has an **ActionListener** interface and **ActionEvent** class.

The **EventDemo** constructor begins by creating a **JFrame** called **jfrm**. It then sets the layout manager for the content pane of **jfrm** to **FlowLayout**.

Then**, EventDemo( )** creates two push buttons, as shown here:

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

Swing push buttons are instances of **JButton**. **JButton** supplies several constructors. The one used here is

JButton(String *msg*)

The *msg* parameter specifies the string that will be displayed inside the button.

When a push button is pressed, it generates an **ActionEvent** instance.
JButton provides the **addActionListener( )** method, which is used to add an action listener.

ActionListener interface defines only one method:

void actionPerformed(ActionEvent *ae*)

This method is called when a button is pressed. In other words, it is the event handler that is called when a button press event has occurred.

Next, event listeners for the button's action events are added by the code shown here:

```
   // Add action listener for Alpha.
    jbtnAlpha.addActionListener(new ActionListener() {

     public void actionPerformed(ActionEvent ae)
    {
       jlab.setText("Alpha was pressed.");

    }
});

// Add action listener for Beta.
    jbtnBeta.addActionListener(new ActionListener() {

     public void actionPerformed(ActionEvent ae)
     {
       jlab.setText("Beta was pressed.");

      }
});
```

Anonymous inner classes are used to provide the event handlers for the two buttons.
Each time a button is pressed, the string displayed in the jlab is changed to reflect which button was pressed.

Next, the buttons are added to the content pane of **jfrm**:jfrm.add(jbtnAlpha);
jfrm.add(jbtnBeta);

Finally, **jlab** is added to the content pane and window is made visible.
When the program is executed, each time a button is pressed, a message is displayed in the label that indicates which button was pressed.

IMP: All event handlers, such as actionPerformed( ), are called on the event dispatching thread. Therefore, an event handler must return quickly in order to avoid slowing down the application. If the application needs to do something time consuming as the result of an event, it must use a separate thread.

Create a Swing Applet

Applet definition
https://docs.oracle.com/javase/tutorial/deployment/applet/index.html
And
Life cycle of the applet
https://docs.oracle.com/javase/tutorial/deployment/applet/lifeCycle.html

Swing-based applets are similar to AWT-based applets, but with an important difference:
A Swing applet extends **JApplet** rather than **Applet**.
JApplet is derived from **Applet**.

Swing applets use four lifecycle methods: **init( )**, **start( )**, **stop( )**, and **destroy( )**.
Only the required methods will be overridden in the application program.

Ex:

```
//A simple Swing-based applet
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;
/* THIS HTML CODE IS NEEDED IF THIS PROGRAM IS EXECUTED IN TERMINAL MODE.
<object code="MySwingApplet" width=220 height=90>
</object>
*/
public class Test extends JApplet {
        JButton jbtnAlpha;
        JButton jbtnBeta;
        JLabel jlab;
        // Initialize the applet.
        @Override
        public void init() {
                try {
                        SwingUtilities.invokeAndWait(new Runnable ()
                        {
                                public void run()
                                {
                                        makeGUI(); // initialize the GUI
                                }
                        });
                } catch(Exception exc) {
                        System.out.println("Can't create because of "+ exc);
        } }
```

```
// This applet does not need to override start(), stop(),or destroy().
// Set up and initialize the GUI.
private void makeGUI()   {
        // Set the applet to use flow layout.
        setLayout(new FlowLayout());
        // Make two buttons.
        jbtnAlpha = new JButton("Alpha");
        jbtnBeta = new JButton("Beta");

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

        });

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


        // Add the buttons to the content pane.
        add(jbtnAlpha);
        add(jbtnBeta);
        // Create a text-based label.
        jlab = new JLabel("Press a button.");
        // Add the label to the content pane.
        add(jlab);
        }
}
```

Test extends **JApplet**. All Swing-based applets extend **JApplet** rather than **Applet**.

init( ) method initializes the Swing components on the event dispatching thread by setting up a call to **makeGUI( )**. This is accomplished through the use of **invokeAndWait( )** rather than **invokeLater( )**.

Applets must use **invokeAndWait( )** because the **init( )** method must not return until the entire initialization process has been completed.

Inside **makeGUI( )**, the two buttons and label are created, and the action listeners are added to the buttons. Finally, the components are added to the content pane.

Exploring Swings

Two types of programs can be created using Swings in java
1. Swing application
2. Swing Applet

Swing Component classes are as follows.

JButton	JCheckBox	JComboBox	JLabel
JList	JRadioButton	JScrollPane	JTabbedPane
JTable	JTextField	JToggleButton	JTree

These components are all lightweight, and they are all derived from **JComponent.**

The Swing components are used in Swing applets rather than swing applications.

JLabel and ImageIcon
JLabel creates a label.

JLabel can be used to display text and/or an icon.

It is a passive component in that it does not respond to user input.

JLabel defines several constructors.
JLabel(Icon *icon*)
JLabel(String *str*)
JLabel(String *str*, Icon *icon*, int *align*)
str and *icon* are the text and icon used for the label.

align argument specifies the horizontal alignment of the text and/or icon within the dimensions of the label.
a*lign* value must be one of the following values: LEFT, RIGHT, CENTER, LEADING, or TRAILING.

Icons are specified by objects of type Icon, which is an interface defined by Swing.

ImageIcon class can be used to obtain an icon. **ImageIcon** implements **Icon** and encapsulates an image. Thus, an object of type ImageIcon can be passed as an argument to the Icon parameter of JLabel's constructor.

There are several ways to provide the image, including reading it from a file or downloading it from a URL. ImageIcon constructor is as follows

ImageIcon(String *filename*)

It obtains the image in the file named *filename.*

The icon and text associated with the label can be obtained by the following methods:

Icon getIcon( )

String getText( )

The icon and text associated with a label can be set by these methods:

void setIcon(Icon *icon*)

void setText(String *str*)

Here, *icon* and *str* are the icon and text, respectively.

Therefore, using setText( ) it is possible to change the text inside a label during program execution.

Ex:

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

//JApplet is depricated
public class Test 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() {

 // Create an icon.
 ImageIcon ii = new
          ImageIcon("/Users/hemanth//eclipse-workspace//hellot//src//hello//india.gif");

 // Create a label.
 JLabel jl = new JLabel("India", ii, JLabel.CENTER);

 // Add the label to the content pane.
add(jl); }
}
```

JTextField
How to use Text fields in swings in java
https://docs.oracle.com/javase/tutorial/uiswing/components/textfield.html

https://docs.oracle.com/javase/8/docs/api/javax/swing/JTextField.html
"..... VK_ENTER results in the listeners getting an ActionEvent, and the VK_ENTER event is consumed. This is compatible with how AWT text fields handle VK_ENTER events."

JTextField allows users to edit one line of text.
It is derived from **JTextComponent**, which provides the basic functionality common to Swing text components.

Three of **JTextField**'s constructors are shown here:
JTextField(int *cols*)
JTextField(String *str*, int *cols*)
JTextField(String *str*)
str is the string to be initially presented *cols* is the number of columns in the text field.
If no string is specified, the text field is initially empty.
If the number of columns is not specified, the text field is sized to fit the specified string.

JTextField generates events in response to user interaction.
ActionEvent is fired when the user presses ENTER.
CaretEvent is fired each time the caret (i.e., the cursor) changes position.

To obtain the text currently in the text field, call **getText( )**.

Ex:
```
import java.awt.*;
import javax.swing.*;

//Demonstrate JTextField.
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class Test extends JApplet {
        JTextField jtf;
        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() {
 // Change to flow layout.
 setLayout(new FlowLayout());

 // Add text field to content pane.
 jtf = new JTextField(15);

add(jtf);

jtf.addActionListener(new ActionListener() {
   public void actionPerformed(ActionEvent ae) {
     // Show text when user presses ENTER.
     showStatus(jtf.getText());
} });
```

https://docs.oracle.com/javase/8/docs/api/javax/swing/event/CaretListener.html#caretUpdate-javax.swing.event.CaretEvent-

```
jtf.addCaretListener(new CaretListener() {
    public void caretUpdate(CaretEvent e)
    {
            System.out.println(e.getDot());
    }
});

} }
```

Output:

The Swing Buttons
Swing defines four types of buttons: **JButton**, **JToggleButton**, **JCheckBox**, and **JRadioButton**.

All are subclasses of the **AbstractButton** class, which extends **JComponent**. Thus, all buttons share a set of common traits.

AbstractButton contains many methods that allow programmers to control the behavior of buttons. For example, different icons can be displayed for the button when it is disabled, pressed, or selected. Another icon can be used as a *rollover* icon, which is displayed when the mouse is positioned over a button. The following methods set these icons:

void setDisabledIcon (Icon *di*)
void setPressedIcon (Icon *pi*)
void setSelectedIcon (Icon *si*)
void setRolloverIcon (Icon *ri*)

Here, *di, pi, si,* and *ri* are the icons to be used for the indicated purpose.

The text associated with a button can be read and written via the following methods:

String getText ( )
void setText (String *str*)

str is the text to be associated with the button.

JButton
JButton class provides the functionality of a push button.

JButton allows an icon, a string, or both to be associated with the push button.

Three of its constructors are shown here:

JButton(Icon *icon*)
JButton(String *str*)
JButton(String *str*, Icon *icon*)

Here, *str* and *icon* are the string and icon used for the button.
str is the string which can be used to identify the button, which is also termed as ***"Action Command String"***

When the button is pressed, an **ActionEvent** is generated.

Using the **ActionEvent** object passed to the **actionPerformed( )** method of the registered **ActionListener**, *action command* string associated with the button can be obtained.

By default, this is the string displayed inside the button.

Action command can be set by calling **setActionCommand( )** on the button.
Action command can be obtained by calling **getActionCommand( )** on the event object.

String getActionCommand( )

Thus, when using two or more buttons within the same application, the action command gives an easy way to determine which button was pressed.

Ex:

```
//Demonstrate an icon-based JButton.
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;
public class Test extends JApplet implements ActionListener {
        JLabel jlab;
        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() {
        // Change to flow layout.
        setLayout(new FlowLayout());

        // Add buttons to content pane.
        ImageIcon india = new
                        ImageIcon("/Users/hemanth/eclipse-workspace/mergesort/src/mergesort/india.gif");
        JButton jb = new JButton("India",india);
        //jb.setActionCommand("India");
/*
   The string "India" passed to the constructor of JButton itself will act as Action Command String.
   The same action command string can also be set by invoking setActionCommand( ) method of
   JButton.

   The string passed during the constructor call will be displayed as a part of the button.
   But, the string passed by setActionCommand will not be displayed as a part of the button.
*/
         jb.addActionListener(this);
/*  Above function call has "this" in its parameter list because the class Test is implementing
    ActionListener as part of the code, which in turn makes the class Test as both event source and
    event listener.   */
```

```
        add(jb);

        ImageIcon usa = new
                ImageIcon("/Users/hemanth/eclipse-workspace/mergesort/src/mergesort/usa.jpeg");
        jb = new JButton(usa);
        jb.setActionCommand("USA");
        jb.addActionListener(this);
        add(jb);


        ImageIcon aus = new
                ImageIcon("/Users/hemanth/eclipse-workspace/mergesort/src/mergesort/aus.jpeg");
        jb = new JButton(aus);
        jb.setActionCommand("Australia");
        jb.addActionListener(this);
        add(jb);


        ImageIcon japan = new
                ImageIcon("/Users/hemanth/eclipse-workspace/mergesort/src/mergesort/japan.jpeg");
        jb = new JButton(japan);
        jb.setActionCommand("Japan");
        jb.addActionListener(this);
        add(jb);

        // Create and add the label to content pane.
        jlab = new JLabel("Choose a Flag");
        add(jlab);
}
// Handle button events.
public void actionPerformed(ActionEvent ae) {
        jlab.setText("You selected " + ae.getActionCommand());
    }
}
```

Check Boxes
The **JCheckBox** class provides the functionality of a check box.

JCheckBoxdefines several constructors.

JCheckBox (String *str*)

It creates a check box that has the text specified by *str* as a label.
Other constructors let you specify the initial selection state of the button and specify an icon.

When the user selects or deselects a checkbox, an **ItemEvent** is generated.

A reference to the **JCheckBox** that generated the event can be obtained by calling **getItem( )** on the **ItemEvent** passed to the **itemStateChanged( )** method defined by **ItemListener**.

```
interface ItemListener
{
    void itemStateChanged(ItemEvent e);
/*Invoked when an item has been selected or deselected by the user. The code written for this method performs the operations that need to occur when an item is selected (or deselected).*/
}
```

The easiest way to determine the selected state of a check box is to call **isSelected( )** on the **JCheckBox** instance.

In addition to supporting the normal check box operation, **JCheckBox** allows programmers to specify the icons that indicate when a checkbox is selected, cleared, and rolled-over.

When user clicks a checkbox, an **ItemEvent** is generated. Inside the **itemStateChanged( )**method, **getItem( )** is called to obtain a reference to the **JCheckBox** object that generated the event. Next, a call to **isSelected( )** determines if the box was selected or cleared. The **getText( )** method gets the text for that check box and uses it to set the text inside the label.

Ex:

```
//Demonstrate JCheckbox.
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class Test extends JApplet implements ItemListener {
JLabel jlab;
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() {
 // Change to flow layout.
setLayout(new FlowLayout());

 // Add check boxes to the content pane.
 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);

// Create the label and add it to the content pane.
```

```
 jlab = new JLabel("Select languages");
 add(jlab);
}
// Handle item events for the check boxes.
public void itemStateChanged(ItemEvent ie) {
/*
Object getItem( ) method belongs to ItemEvent class which is a common base class for many GUI
components in swings, hence return type is generic in nature.
*/
        JCheckBox cb = (JCheckBox)ie.getItem();
        if(cb.isSelected())
                jlab.setText(cb.getText() + " is selected");
        else
                jlab.setText(cb.getText() + " is cleared");
        }
}
```

JTabbedPane

JTabbedPane encapsulates a *tabbed pane*. It manages a set of components by linking them with tabs. Selecting a tab causes the component associated with that tab to come to the forefront.

JTabbedPane defines three constructors. Default constructor is considered, which creates an empty control with the tabs positioned across the top of the pane.

JTabbedPane uses the **SingleSelectionModel** model.

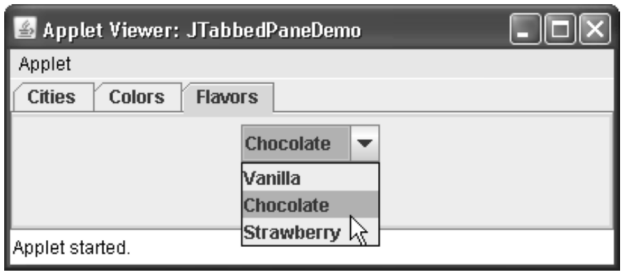
Tabs are added by calling **addTab( )**. Here is one of its forms:

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, the component added to a tab is a **JPanel** that contains a group of related components. This technique allows a tab to hold a set of components.

The general procedure to use a tabbed pane is outlined here:

1. Create an instance of **JTabbedPane**.
2. Add each tab by calling **addTab( )**.
3. Add the tabbed pane to the content pane.



Ex:

```
//Demonstrate JTabbedPane.
import javax.swing.*;

public class Test 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() {
          JTabbedPane jtp = new JTabbedPane();
          jtp.addTab("Cities", new CitiesPanel());
          jtp.addTab("Colors", new ColorsPanel());
          jtp.addTab("Flavors", new FlavorsPanel());
          add(jtp);
}
}//End of class Test
```

```
//Make the panels that will be added to the tabbed pane.
class CitiesPanel extends JPanel {
public CitiesPanel() {
 JButton b1 = new JButton("New York");
 add(b1);
 JButton b2 = new JButton("London");
 add(b2);
 JButton b3 = new JButton("Hong Kong");
 add(b3);
 JButton b4 = new JButton("Tokyo");
 add(b4);
} }


class ColorsPanel extends JPanel {
public ColorsPanel() {
        JCheckBox cb1 = new JCheckBox("Red");
        add(cb1);
        JCheckBox cb2 = new JCheckBox("Green");
        add(cb2);
        JCheckBox cb3 = new JCheckBox("Blue");
        add(cb3);
} }


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

JScrollPane

JScrollPane is a lightweight container that automatically handles the scrolling of another component.

The component being scrolled can either be an individual component, such as a table, or a group of components contained within another lightweight container, such as a **JPanel**.
If the object being scrolled is larger than the viewable area, horizontal and/or vertical scroll bars are automatically provided, and the component can be scrolled through the pane.

The viewable area of a scroll pane is called the *viewport*. It is a window in which the component being scrolled is displayed.

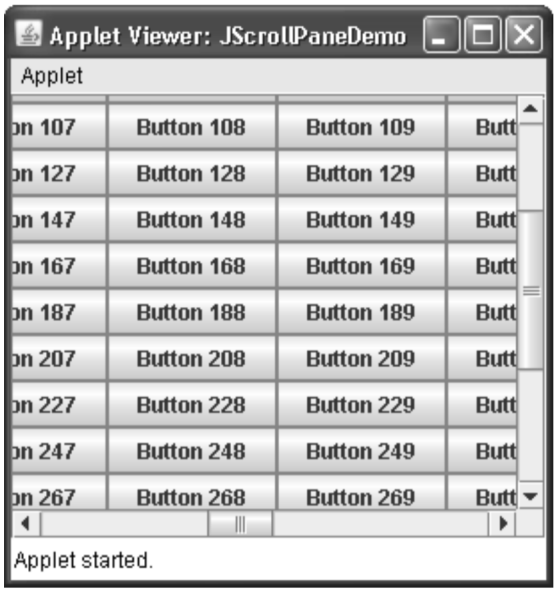
In its default behavior, a **JScrollPane** will dynamically add or remove a scroll bar as needed.
For example, if the component is taller than the viewport, a vertical scroll bar is added. If the component will completely fit within the viewport, the scroll bars are removed.

JScrollPane defines several constructors.

JScrollPane(Component *comp*)

The component to be scrolled is specified by *comp*.

Here are the steps to follow to use a scroll pane:
1. Create the component to be scrolled.
2. Create an instance of **JScrollPane**, passing to it the object to scroll.
3. Add the scroll pane to the content pane.



Ex://Demonstrate JScrollPane.

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

public class Test 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() {
  // Add 400 buttons to a panel.
  JPanel jp = new JPanel();
  jp.setLayout(new GridLayout(20, 20));
  int b = 0;
  for(int i = 0; i < 20; i++)
    for(int j = 0; j < 20; j++)
    {
      jp.add(new JButton("Button " + b));
      ++b;
    }
  // Create the scroll pane.
  JScrollPane jsp = new JScrollPane(jp);
  // Add the scroll pane to the content pane.
  add(jsp);
}
}//End of class Test
```

JList

JList supports the selection of one or more items from a list.

Although the list often consists of strings, it is possible to create a list of just about any object that can be displayed.

JList provides several constructors.

JList(Object[ ] *items*)

This creates a **JList** that contains the items in the array specified by *items*.

Although a JList will work properly by itself, most of the time it will be wrapped inside JScrollPane. This way, long lists will automatically be scrollable, which simplifies GUI design.

A **JList** generates a **ListSelectionEvent** when the user makes or changes a selection. This event is also generated when the user deselects an item. It is handled by implementing **ListSelectionListener**, which

specifies only one method, called **valueChanged( )**, which is shown here:

void valueChanged(ListSelectionEvent *le*)

Here, *le* is a reference to the object that generated the event.

```
interface ListSelectionListener
{
        void valueChanged(ListSelectionEvent le);
}
```

By default, a **JList** allows the user to select multiple ranges of items within the list, but you can change this behavior by calling **setSelectionMode( )**, which is defined by **JList**. It is shown here:

void setSelectionMode(int *mode*)

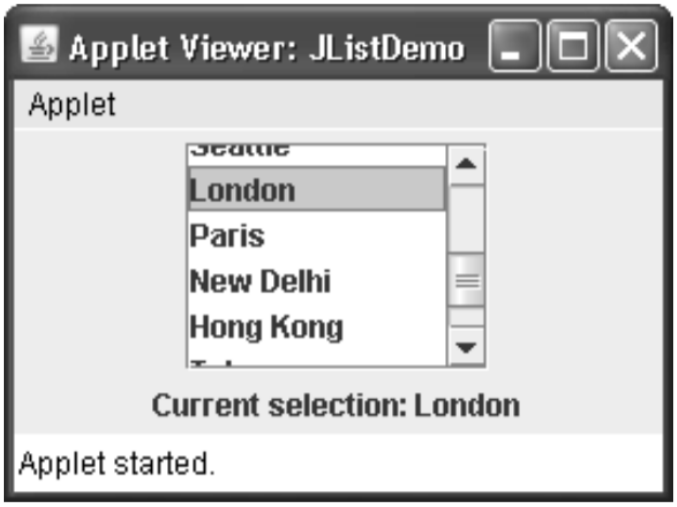
Here, *mode* specifies the selection mode. It must be one of these values defined by **ListSelectionModel**:

SINGLE_SELECTION
SINGLE_INTERVAL_SELECTION
MULTIPLE_INTERVAL_SELECTION

The default, multiple-interval selection, allows the user to select multiple ranges of items within a list.

With single-interval selection, the user can select one range of items.

With single selection, the user can select only a single item.



Ex:

```
//Demonstrate JList.
import javax.swing.*;
import javax.swing.event.*;
import java.awt.*;
import java.awt.event.*;

public class Test extends ~~JApplet~~ {
JList 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 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() {
 // Change to flow layout.
 setLayout(new FlowLayout());

 //Create a JList.
 jlst = new JList(Cities);

 // Set the list selection mode to single selection.
 jlst.setSelectionMode(ListSelectionModel.SINGLE_SELECTION);

 // Add the list to a scroll pane.
 jscrlp = new JScrollPane(jlst);


 // Make a label that displays the selection.
 jlab = new JLabel("Choose a City");

 // Add selection listener for the list.
 jlst.addListSelectionListener(new ListSelectionListener()
    {
        public void valueChanged(ListSelectionEvent le)
        {
                // Get the index of the changed item.
                int idx = jlst.getSelectedIndex();
                // Display selection, if item was selected.
                if(idx != -1)
                        jlab.setText("Current selection: " + Cities[idx]);
                else // Otherwise, reprompt.
                        jlab.setText("Choose a City");
        }
    });
 // Add the list and label to the content pane.
 add(jscrlp);
 add(jlab);    } }
```

JComboBox

Swing provides a *combo box* (a combination of a text field and a drop-down list) through the **JComboBox** class.

A combo box normally displays one entry, but it will also display a drop-down list that allows a user to select a different entry.

A combo box can also be created that lets the user enter a selection into the text field.

JComboBox constructor used by the example is shown here:

JComboBox(Object[ ] *items*)

Here, *items* is an array that initializes the combo box.

JComboBox uses the **ComboBoxModel**.

In addition to passing an array of items to be displayed in the drop-down list, items can be dynamically added to the list of choices via the **addItem( )** method,

void addItem (Object *obj*)

Here, *obj* is the object to be added to the combo box.

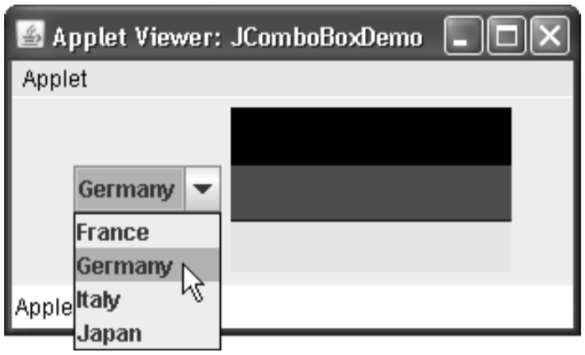
JComboBox generates an **action event** when the user selects an item from the list.

JComboBox also generates an **item event** when the state of selection changes, which occurs when an item is selected or deselected.

To obtain the item selected in the list is to call **getSelectedItem( )** on the combo box.

Object getSelectedItem( )

There is a need to cast the returned value into the type of object stored in the list.



Ex:

```
//Demonstrate JComboBox.
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class Test extends JApplet {
        JLabel jlab;
        ImageIcon france, germany, italy, japan;
        JComboBox jcb;
        String flags[] = { "france", "usa", "aus", "Japan" };
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()
 {
          // Change to flow layout.
          setLayout(new FlowLayout());

          // Instantiate a combo box and add it to the content pane.
          jcb = new JComboBox(flags);
          add(jcb);
```

```
        // Handle selections.
        jcb.addActionListener(new ActionListener()
        {
          public void actionPerformed(ActionEvent ae)
          {
            String s= "/Users/hemanth/eclipse-workspace/mergesort/src/mergesort/";
                s = s + (String) jcb.getSelectedItem();
            jlab.setIcon(new ImageIcon(s + ".jpeg"));
          }
        }
        );

        // Create a label and add it to the content pane.
        jlab = new JLabel(new ImageIcon("france.gif"));
        add(jlab);
}
}
```

JTable

JTable is a component that displays rows and columns of data.

Depending on its configuration, it is also possible to select a row, column, or cell within the table, and to change the data within a cell.

JTable has many classes and interfaces associated with it. These are packaged in **javax.swing.table**.

JTable is a component that consists of one or more columns of information.

At the top of each column is a heading. In addition to describing the data in a column, the heading also provides the mechanism by which the user can change the size of a column or change the location of a column within the table.

JTable does not provide any scrolling capabilities of its own. Instead, you will normally wrap a **JTable** inside a **JScrollPane**.

JTable supplies several constructors.

JTable (Object *data*[ ][ ], Object *colHeads*[ ])

Here, *data* is a two-dimensional array of the information to be presented, and *colHeads* is a one-dimensional array with the column headings.

JTable relies on three models.

The first is the table model, which is defined by the **TableModel** interface. This model defines those things related to displaying data in a two-dimensional format.

The second is the table column model, which is represented by **TableColumnModel**. **JTable** is defined in terms of columns, and it is **TableColumnModel** that specifies the characteristics of a column. These two models are packaged in **javax.swing.table**.

The third model determines how items are selected, and it is specified by the **ListSelectionModel**.

A **JTable** can generate several different events.

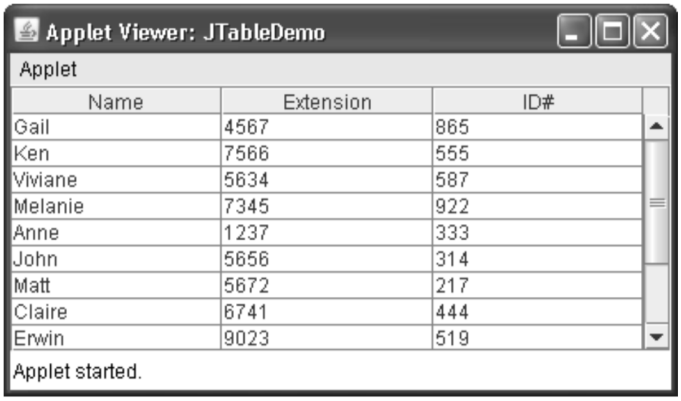
The two most fundamental to a table's operation are **ListSelectionEvent** and **TableModelEvent**.

A **ListSelectionEvent** is generated when the user selects something in the table. By default, **JTable** allows you to select one or more complete rows, but you can change this behavior to allow one or more columns, or one or more individual cells to be selected.

A **TableModelEvent** is fired when that table's data changes in some way.

If **JTable** is used only to display data then it is not necessary to handle events.

Steps required to set up a simple **JTable** which can be used to display data:
1. Create an instance of **JTable**.
2. Create a **JScrollPane** object, specifying the table as the object to scroll.
3. Add the table to the scroll pane.
4. Add the scroll pane to the content pane.



Ex:

```
//Demonstrate JTable.
import java.awt.*;
import javax.swing.*;
```

```
public class Test 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() {
 // Initialize column headings.
 String[] colHeads = { "Name", "Extension", "ID#" };

 // Initialize data.
 Object[][] data = {
   { "Gail", "4567", "865" },
   { "Ken", "7566", "555" },
   { "Viviane", "5634", "587" },
   { "Melanie", "7345", "922" },
   { "Anne", "1237", "333" },
   { "John", "5656", "314" },
   { "Matt", "5672", "217" },
   { "Claire", "6741", "444" },
   { "Erwin", "9023", "519" },
   { "Ellen", "1134", "532" },
   { "Jennifer", "5689", "112" },
   { "Ed", "9030", "133" },
   { "Helen", "6751", "145" }
    };
 // Create the table.
 JTable table = new JTable(data, colHeads);

 // Add the table to a scroll pane.
 JScrollPane jsp = new JScrollPane(table);

 // Add the scroll pane to the content pane.
add(jsp);
}  }
```