RAMAIAH
Institute of Technology

Object Oriented Programming

Lecture Notes – Module 5

Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model, Adapter Classes, Inner Classes.

Swing: Introducing Swing.

Lambda Expressions: Fundamentals, Block Lambda expressions, Passing Lambda Expressions as Argument, Lambda Expressions and Exceptions, Method References.

Text Books:

1. Object-Oriented Analysis And Design With applications, Grady Booch, Robert A Maksimchuk, Michael W Eagle, Bobbi J Young, 3rd Edition, 2013, Pearson education, ISBN :978-81-317-2287-93. 20
2. The Complete Reference - Java, Herbert Schildt 10th Edition, 2017, TMH Publications, ISBN: 9789387432291.

Reference Book:

1. Head First Java, Kathy Sierra and Bert Bates, 2nd Edition, 2014, Oreilly Publication , ISBN : 978817366602

Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model, Adapter Classes, Inner Classes.

Delegation Event Model in Java

- The Delegation Event model is defined to handle events in GUI programming languages. The GUI stands for Graphical User Interface, where a user graphically/visually interacts with the system.
- The GUI programming is inherently event-driven; whenever a user initiates an activity such as a mouse activity, clicks, scrolling, etc., each is known as an event that is mapped to a code to respond to functionality to the user. This is known as event handling.
- In this section, we will discuss event processing and how to implement the delegation event model in Java. We will also discuss the different components of an Event Model.

Basically, an Event Model is based on the following three components:

- Events
- Events Sources
- Events Listeners

Events

- The Events are the objects that define state change in a source. An event can be generated as a reaction of a user while interacting with GUI elements. Some of the event generation activities are moving the mouse pointer, clicking on a button, pressing the keyboard key, selecting an item from the list, and so on. We can also consider many other user operations as events.
- The Events may also occur that may be not related to user interaction, such as a timer expires, counter exceeded, system failures, or a task is completed, etc. We can define events for any of the applied actions.

Event Sources

A source is an object that causes and generates an event. It generates an event when the internal state of the object is changed. The sources are allowed to generate several different types of events.

A source must register a listener to receive notifications for a specific event. Each event contains its registration method. Below is an example:

public void addTypeListener (TypeListener e1)

From the above syntax, the Type is the name of the event, and e1 is a reference to the event listener. For example, for a keyboard event listener, the method will be called as addKeyListener(). For the mouse event listener, the method will be called as addMouseMotionListener(). When an event is triggered using the respected source, all the events will be notified to registered listeners and receive the event object. This process is known as event multicasting. In few cases, the event notification will only be sent to listeners that register to receive them.

Some listeners allow only one listener to register. Below is an example:

public void addTypeListener(TypeListener e2) throws java.util.TooMany ListenersException

From the above syntax, the Type is the name of the event, and e2 is the event listener's reference. When the specified event occurs, it will be notified to the registered listener. This process is known as unicasting events.

A source should contain a method that unregisters a specific type of event from the listener if not needed. Below is an example of the method that will remove the event from the listener.

public void removeTypeListener(TypeListener e2?)

From the above syntax, the Type is an event name, and e2 is the reference of the listener. For example, to remove the keyboard listener, the removeKeyListener() method will be called.

The source provides the methods to add or remove listeners that generate the events. For example, the Component class contains the methods to operate on the different types of events, such as adding or removing them from the listener.

Event Listeners

An event listener is an object that is invoked when an event triggers. The listeners require two things; first, it must be registered with a source; however, it can be registered with several resources to receive notification about the events. Second, it must implement the methods to receive and process the received notifications.

The methods that deal with the events are defined in a set of interfaces. These interfaces can be found in the java.awt.event package.

For example, the MouseMotionListener interface provides two methods when the mouse is dragged and moved. Any object can receive and process these events if it implements the MouseMotionListener interface.

Event Classes

At the root of the Java event class hierarchy is **EventObject**, which is in **java.util**. It is the superclass for all events. Its one constructor is shown here:

EventObject(Object *src*)

Here, *src* is the object that generates this event.

EventObject contains two methods: **getSource( )** and **toString( )**. The **getSource( )** method returns the source of the event. Its general form is shown here: Object getSource( )

As expected, **toString( )** returns the string equivalent of 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.

ActionEvent has these three constructors:

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*)

Here, *src* is a reference to the object that generated this event. The type of the event is specified by *type,* and its command string is *cmd.* The argument *modifiers* indicates which modifier keys (ALT, CTRL, META, and/or SHIFT) were pressed when the event was generated. The *when* parameter specifies when the event occurred.

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.

The AdjustmentEvent Class

An **AdjustmentEvent** is generated by a scroll bar. There are five types of adjustment events. The **AdjustmentEvent** class defines integer constants that can be used to identify them. The constants and their meanings are shown here:

BLOCK_DECREMENT	The user clicked inside the scroll bar to decrease its value.
BLOCK_INCREMENT	The user clicked inside the scroll bar to increase its value.
TRACK	The slider was dragged.
UNIT_DECREMENT	The button at the end of the scroll bar was clicked to decrease its value.
UNIT_INCREMENT	The button at the end of the scroll bar was clicked to increase its value.

In addition, there is an integer constant, **ADJUSTMENT_VALUE_CHANGED**, that indicates that a change has occurred. Here is one **AdjustmentEvent** constructor:

AdjustmentEvent(Adjustable *src*, int *id*, int *type*, int *data*)

Here, *src* is a reference to the object that generated this event. The *id* specifies the event. The type of the adjustment is specified by *type,* and its associated data is *data.*

The ComponentEvent Class

A **ComponentEvent** is generated when the size, position, or visibility of a component is changed. There are four types of component events. The

ComponentEvent class defines integer constants that can be used to identify them. The constants and their meanings are shown here:

COMPONENT_HIDDEN	The component was hidden.
COMPONENT_MOVED	The component was moved.
COMPONENT_RESIZED	The component was resized.
COMPONENT_SHOWN	The component became visible.

ComponentEvent has this constructor:

ComponentEvent(Component *src*, int *type*)

Here, *src* is a reference to the object that generated this event. The type of the event is specified by *type.*

The ContainerEvent Class

A**ContainerEvent** is generated when a component is added to or removed from a container. There are two types of container events. The **ContainerEvent** class defines **int** constants that can be used to identify them: **COMPONENT_ADDED** and **COMPONENT_REMOVED**.

They indicate that a component has been added to or removed from the container.

ContainerEvent is a subclass of **ComponentEvent** and has this constructor:

ContainerEvent(Component *src*, int *type*, Component *comp*)

Here, *src* is a reference to the container that generated this event. The type of the event is specified by *type,* and the component that has been added to or removed from the container is *comp.* You can obtain a reference to the container that generated this event by using the **getContainer( )** method, shown here:

The FocusEvent Class

A **FocusEvent** is generated when a component gains or loses input focus. These events are identified by the integer constants **FOCUS_GAINED** and **FOCUS_LOST**.

FocusEvent is a subclass of **ComponentEvent** and has these constructors:

FocusEvent(Component *src*, int *type*)

FocusEvent(Component *src*, int *type*, boolean *temporaryFlag*)

FocusEvent(Component *src*, int *type*, boolean *temporaryFlag*, Component *other*)

Here, *src* is a reference to the component that generated this event. The type of the event is specified by *type.* The argument *temporaryFlag* is set to **true** if the focus event is temporary. Otherwise, it is set to **false**. (A temporary focus event occurs as a result of another user interface operation. For example, assume that the focus is in a text field. If the user moves the mouse to adjust a scroll bar, the focus is temporarily lost.)

The InputEvent Class

The abstract class **InputEvent** is a subclass of **ComponentEvent** and is the superclass for component input events. Its subclasses are **KeyEvent** and **MouseEvent**. **InputEvent** defines several integer constants that represent any modifiers, such as the control key being pressed, that might be associated with the event. Originally, the **InputEvent** class defined the following eight values to represent the modifiers:

ALT_MASK	BUTTON2_MASK	META_MASK
ALT_GRAPH_MASK	BUTTON3_MASK	SHIFT_MASK
BUTTON1_MASK	CTRL_MASK	

However, because of possible conflicts between the modifiers used by keyboard events and mouse events, and other issues, the following extended modifier values were added:

ALT_DOWN_MASK	BUTTON2_DOWN_MASK	META_DOWN_MASK
ALT_GRAPH_DOWN_MASK	BUTTON3_DOWN_MASK	SHIFT_DOWN_MASK
BUTTON1_DOWN_MASK	CTRL_DOWN_MASK	

The ItemEvent Class

An **ItemEvent** is generated when a check box or a list item is clicked or when a checkable menu item is selected or deselected. There are two types of item events, which are identified by the following integer constants:

DESELECTED	The user deselected an item.
SELECTED	The user selected an item.

In addition, **ItemEvent** defines one integer constant, **ITEM_STATE_CHANGED**, that signifies a change of state.

ItemEvent has this constructor:

ItemEvent(ItemSelectable *src*, int *type*, Object *entry*, int *state*)

Here, *src* is a reference to the component that generated this event. For example, this might be a list or choice element. The type of the event is specified by *type.* The specific item that generated the item event is passed in *entry.* The current state of that item is in *state.*

The KeyEvent Class

A **KeyEvent** is generated when keyboard input occurs. There are three types of key events, which are identified by these integer constants: **KEY_PRESSED**, **KEY_RELEASED**, and **KEY_TYPED**. The first two events are generated when any key is pressed or released. The last event occurs only when a character is generated. Remember, not all keypresses result in characters. For example, pressing SHIFT does not generate a character.

There are many other integer constants that are defined by **KeyEvent**. For example, **VK_0** through **VK_9** and **VK_A** through **VK_Z** define the ASCII equivalents of the numbers and letters. Here are some others:

VK_ALT	VK_DOWN	VK_LEFT	VK_RIGHT
VK_CANCEL	VK_ENTER	VK_PAGE_DOWN	VK_SHIFT
VK_CONTROL	VK_ESCAPE	VK_PAGE_UP	VK_UP

The **VK** constants specify *virtual key codes* and are independent of any modifiers, such as control, shift, or alt.

KeyEvent is a subclass of **InputEvent**. Here is one of its constructors:

KeyEvent(Component *src*, int *type*, long *when*, int *modifiers*, int *code*, char *ch*)

Here, *src* is a reference to the component that generated the event. The type of the event is specified by *type.* The system time at which the key was pressed is passed in *when.* The *modifiers* argument indicates which modifiers were pressed when this key event occurred. The virtual key code, such as **VK_UP**, **VK_A**, and so forth, is passed in *code.* The character equivalent (if one exists) is passed in *ch.* If no valid character exists, then *ch* contains **CHAR_UNDEFINED**. For **KEY_TYPED** events, *code* will contain **VK_UNDEFINED**.

The MouseEvent Class

There are eight types of mouse events. The **MouseEvent** class defines the following integer constants that can be used to identify them:

MOUSE_CLICKED	The user clicked the mouse.
MOUSE_DRAGGED	The user dragged the mouse.
MOUSE_ENTERED	The mouse entered a component.
MOUSE_EXITED	The mouse exited from a component.
MOUSE_MOVED	The mouse moved.
MOUSE_PRESSED	The mouse was pressed.
MOUSE_RELEASED	The mouse was released.
MOUSE_WHEEL	The mouse wheel was moved.

MouseEvent is a subclass of **InputEvent**. Here is one of its constructors:

MouseEvent(Component *src*, int *type*, long *when*, int *modifiers*, int *x*, int *y*, int *clicks*, boolean *triggersPopup*)

Here, *src* is a reference to the component that generated the event. The type of the event is specified by *type.* The system time at which the mouse event occurred is passed in *when.* The *modifiers* argument indicates which modifiers were pressed when a mouse event occurred.

The coordinates of the mouse are passed in *x* and *y.* The click count is passed in *clicks.* The *triggersPopup* flag indicates if this event causes a pop-up menu to appear on this platform.

The MouseWheelEvent Class

The **MouseWheelEvent** class encapsulates a mouse wheel event. It is a subclass of **MouseEvent**. Not all mice have wheels. If a mouse has a wheel, it is located between the left and right buttons. Mouse wheels are used for scrolling. **MouseWheelEvent** defines these two integer constants:

WHEEL_BLOCK_SCROLL	A page-up or page-down scroll event occurred.
WHEEL_UNIT_SCROLL	A line-up or line-down scroll event occurred.

Here is one of the constructors defined by **MouseWheelEvent**:

MouseWheelEvent(Component *src*, int *type*, long *when*, int *modifiers*, int *x*, int *y*, int *clicks*, boolean *triggersPopup*, int *scrollHow*, int *amount*, int *count*)

Here, *src* is a reference to the object that generated the event. The type of the event is specified by *type.* The system time at which the mouse event occurred is passed in *when.* The *modifiers* argument indicates which modifiers were pressed when the event occurred. The coordinates of the mouse are passed in *x* and *y.* The number of clicks the wheel has rotated is passed in *clicks.* The *triggersPopup* flag indicates if this event causes a pop-up menu to appear on this platform. The *scrollHow* value must be either **WHEEL_UNIT_SCROLL** or **WHEEL_BLOCK_SCROLL**. The number of units to scroll is passed in *amount.* The *count* parameter indicates the number of rotational units that the wheel moved.

The TextEvent Class

Instances of this class describe text events. These are generated by text fields and text areas when characters are entered by a user or program. **TextEvent** defines the integer constant **TEXT_VALUE_CHANGED**.

The one constructor for this class is shown here:

TextEvent(Object *src*, int *type*)

Here, *src* is a reference to the object that generated this event. The type of the event is specified by *type.*

The WindowEvent Class

There are ten types of window events. The**WindowEvent** class defines integer constants that can be used to identify them. The constants and their meanings are shown here:

WINDOW_ACTIVATED	The window was activated.
WINDOW_CLOSED	The window has been closed.
WINDOW_CLOSING	The user requested that the window be closed.
WINDOW_DEACTIVATED	The window was deactivated.
WINDOW_DEICONIFIED	The window was deiconified.
WINDOW_GAINED_FOCUS	The window gained input focus.
WINDOW_ICONIFIED	The window was iconified.
WINDOW_LOST_FOCUS	The window lost input focus.
WINDOW_OPENED	The window was opened.
WINDOW_STATE_CHANGED	The state of the window changed.

Sources of 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.

Event Listener Interfaces

The ActionListener Interface

This interface defines the **actionPerformed( )** method that is invoked when an action event occurs. Its general form is shown here:

void actionPerformed(ActionEvent *ae*)

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.

The AdjustmentListener Interface

This interface defines the **adjustmentValueChanged( )** method that is invoked when an adjustment event occurs. Its general form is shown here:

void adjustmentValueChanged(AdjustmentEvent *ae*)

The ComponentListener Interface

This interface defines four methods that are invoked when a component is resized, moved, shown, or hidden. Their general forms are shown here:

void componentResized(ComponentEvent *ce*)

void componentMoved(ComponentEvent *ce*)

void componentShown(ComponentEvent *ce*)

void componentHidden(ComponentEvent *ce*)

The ContainerListener Interface

This interface contains two methods. When a component is added to a container, **componentAdded( )** is invoked. When a component is removed from a container, **componentRemoved( )** is invoked. Their general forms are shown here:

void componentAdded(ContainerEvent *ce*)

void componentRemoved(ContainerEvent *ce*)

The FocusListener Interface

This interface defines two methods. When a component obtains keyboard focus, **focusGained( )** is invoked. When a component loses keyboard focus, **focusLost( )** is called. Their general forms are shown here:

void focusGained(FocusEvent *fe*)

void focusLost(FocusEvent *fe*)

The ItemListener Interface

This interface defines the **itemStateChanged( )** method that is invoked when the state of an item changes. Its general form is shown here:

void itemStateChanged(ItemEvent *ie*)

The KeyListener Interface

This 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.

The general forms of these methods are shown here:

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

The MouseListener Interface

This 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. The general forms of these methods are shown here:

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

The MouseMotionListener Interface

This interface defines two methods. The **mouseDragged( )** method is called multiple times as the mouse is dragged. The **mouseMoved( )** method is called multiple times as the mouse is moved. Their general forms are shown here:

```
void mouseDragged(MouseEvent me)
void mouseMoved(MouseEvent me)
```

The MouseWheelListener Interface

This interface defines the **mouseWheelMoved( )** method that is invoked when the mouse wheel is moved. Its general form is shown here:

void mouseWheelMoved(MouseWheelEvent *mwe*)

The TextListener Interface

This interface defines the **textChanged( )** method that is invoked when a change occurs in a text area or text field. Its general form is shown here:

void textChanged(TextEvent *te*)

The WindowFocusListener Interface

This interface defines two methods: **windowGainedFocus( )** and **windowLostFocus( )**. These are called when a window gains or loses input focus. Their general forms are shown here:

void windowGainedFocus(WindowEvent *we*)

void windowLostFocus(WindowEvent *we*)

The WindowListener Interface

This interface defines seven methods. The **windowActivated( )** and **windowDeactivated( )** methods are invoked when a window is activated or deactivated, respectively. If a window is iconified, the **windowIconified( )** method is called. When a window is deiconified, the **windowDeiconified( )** method is called. When a window is opened or closed, the **windowOpened( )** or **windowClosed( )** methods are called, respectively. The **windowClosing( )** method is called when a window is being closed. The general forms of these methods are:

void windowActivated(WindowEvent *we*)

void windowClosed(WindowEvent *we*)

void windowClosing(WindowEvent *we*)

void windowDeactivated(WindowEvent *we*)

void windowDeiconified(WindowEvent *we*)

void windowIconified(WindowEvent *we*)

void windowOpened(WindowEvent *we*)

Using the Delegation Event Model

Now that you have learned the theory behind the delegation event model and have had an overview of its various components, it is time to see it in practice. Using the delegation event model is actually quite easy. Just follow these two steps:

1. Implement the appropriate interface in the listener so that it will receive the type of event desired.
2. Implement code to register and unregister (if necessary) the listener as a recipient for the event notifications.

Handling Mouse Events

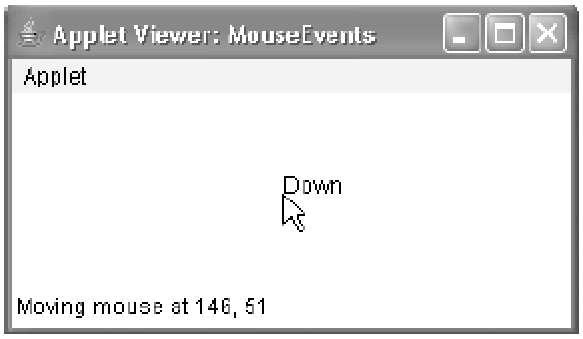
To handle mouse events, you must implement the **MouseListener** and the **MouseMotionListener** interfaces.

```
// Demonstrate the mouse event handlers.
import java.awt.*;
import java.awt.event.*;
import java.applet.*;
/*
<applet code="MouseEvents" width=300 height=100>
</applet>
*/
public class MouseEvents extends Applet
implements MouseListener, MouseMotionListener {
String msg = "";
int mouseX = 0, mouseY = 0; // coordinates of mouse
public void init() {
addMouseListener(this);
addMouseMotionListener(this);
}
// Handle mouse clicked.
public void mouseClicked(MouseEvent me) {
// save coordinates
mouseX = 0;
```

```
mouseY = 10;
msg = "Mouse clicked.";
repaint();
}
// Handle mouse entered.
public void mouseEntered(MouseEvent me) {
// save coordinates
mouseX = 0;
mouseY = 10;
msg = "Mouse entered.";
repaint();
}
// Handle mouse exited.
public void mouseExited(MouseEvent me) {
// save coordinates
mouseX = 0;
mouseY = 10;
msg = "Mouse exited.";
repaint();
}
// Handle button pressed.
public void mousePressed(MouseEvent me) {
// save coordinates
mouseX = me.getX();
mouseY = me.getY();
msg = "Down";
repaint();
}
// Handle button released.
public void mouseReleased(MouseEvent me) {
// save coordinates
mouseX = me.getX();
```

```
mouseY = me.getY();
msg = "Up";
repaint();
}
// Handle mouse dragged.
public void mouseDragged(MouseEvent me) {
// save coordinates
mouseX = me.getX();
mouseY = me.getY();
msg = "*";
showStatus("Dragging mouse at " + mouseX + ", " + mouseY);
repaint();
}
// Handle mouse moved.
public void mouseMoved(MouseEvent me) {
// show status
showStatus("Moving mouse at " + me.getX() + ", " + me.getY());
}
// Display msg in applet window at current X,Y location.
public void paint(Graphics g) {
g.drawString(msg, mouseX, mouseY);
}
}
```

Sample output from this program is shown here:



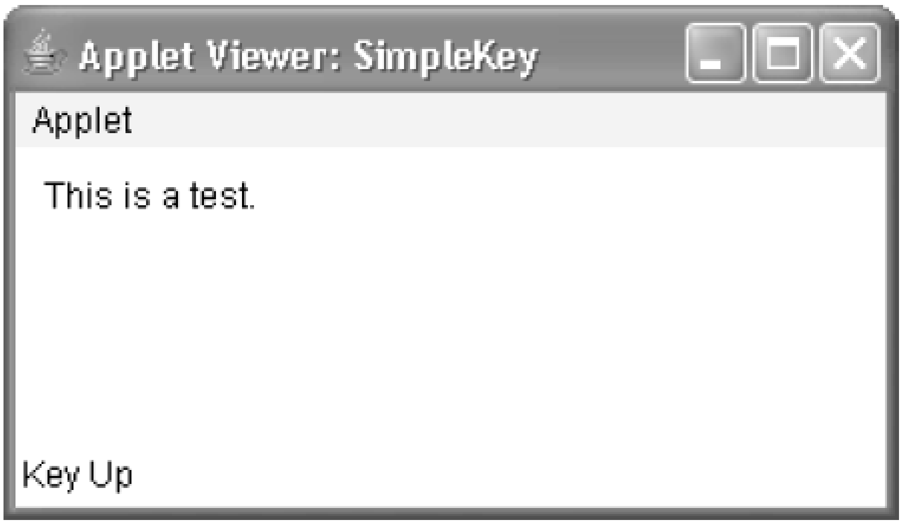
```
Down
Moving mouse at 146, 51
```

Handling Keyboard Events

To handle keyboard events, you use the same general architecture as that shown in the mouse event example in the preceding section. The difference, of course, is that you will be implementing the **KeyListener** interface.

```
// Demonstrate the key event handlers.
import java.awt.*;
import java.awt.event.*;
import java.applet.*;
/*
<applet code="SimpleKey" width=300 height=100>
</applet>
*/
public class SimpleKey extends Applet
implements KeyListener {
String msg = "";
int X = 10, Y = 20; // output coordinates
public void init() {
addKeyListener(this);
}
public void keyPressed(KeyEvent ke) {
showStatus("Key Down");
}
public void keyReleased(KeyEvent ke) {
showStatus("Key Up");
}
public void keyTyped(KeyEvent ke) {
msg += ke.getKeyChar();
repaint();
}
// Display keystrokes.
public void paint(Graphics g) {
g.drawString(msg, X, Y);
}
}
```

Sample output is shown here:



This is a test.

Key Up

Adapter Classes

Java provides a special feature, called an *adapter class,* that can simplify the creation of event handlers in certain situations. An adapter class provides an empty implementation of all methods in an event listener interface. Adapter classes are useful when you want to receive and process only some of the events that are handled by a particular event listener interface.

You can define a new class to act as an event listener by extending one of the adapter classes and implementing only those events in which you are interested. For example, the **MouseMotionAdapter** class has two methods, **mouseDragged( )** and **mouseMoved( )**, which are the methods defined by the **MouseMotionListener** interface. If you were interested in only mouse drag events, then you could simply extend **MouseMotionAdapter** and override **mouseDragged( )**. The empty implementation of **mouseMoved( )** would handle the mouse motion events for you.

Table below lists the commonly used adapter classes in **java.awt.event** and notes the interface that each implements.

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

```
// Demonstrate an adapter.
import java.awt.*;
import java.awt.event.*;
import java.applet.*;
/*
<applet code="AdapterDemo" width=300 height=100>
</applet>
*/
public class AdapterDemo extends Applet {
public void init() {
addMouseListener(new MyMouseAdapter(this));
addMouseMotionListener(new MyMouseMotionAdapter(this));
}
}
class MyMouseAdapter extends MouseAdapter {
AdapterDemo adapterDemo;
public MyMouseAdapter(AdapterDemo adapterDemo) {
this.adapterDemo = adapterDemo;
}
// Handle mouse clicked.
public void mouseClicked(MouseEvent me) {
adapterDemo.showStatus("Mouse clicked");
}
}
```

```
class MyMouseMotionAdapter extends MouseMotionAdapter {
AdapterDemo adapterDemo;
public MyMouseMotionAdapter(AdapterDemo adapterDemo) {
this.adapterDemo = adapterDemo;
}
// Handle mouse dragged.
public void mouseDragged(MouseEvent me) {
adapterDemo.showStatus("Mouse dragged");
}
}
```

Inner Classes

To understand the benefit provided by inner classes, consider the applet shown in the following listing. It *does not* use an inner class. Its goal is to display the string "Mouse Pressed" in the status bar of the applet viewer or browser when the mouse is pressed. There are two top-level classes in this program. **MousePressedDemo** extends **Applet**, and **MyMouseAdapter** extends **MouseAdapter**. The **init( )** method of **MousePressedDemo** instantiates **MyMouseAdapter** and provides this object as an argument to the **addMouseListener( )** method.

Notice that a reference to the applet is supplied as an argument to the **MyMouseAdapter** constructor. This reference is stored in an instance variable for later use by the **mousePressed( )** method. When the mouse is pressed, it invokes the **showStatus( )** method of the applet through the stored applet reference. In other words, **showStatus( )** is invoked relative to the applet reference stored by **MyMouseAdapter**.

```
// This applet does NOT use an inner class.
import java.applet.*;
import java.awt.event.*;
/*
<applet code="MousePressedDemo" width=200 height=100>
</applet>
*/
public class MousePressedDemo extends Applet {
```

```
public void init() {
addMouseListener(new MyMouseAdapter(this));
}
}
class MyMouseAdapter extends MouseAdapter {
MousePressedDemo mousePressedDemo;
public MyMouseAdapter(MousePressedDemo mousePressedDemo) {
this.mousePressedDemo = mousePressedDemo;
}
public void mousePressed(MouseEvent me) {
mousePressedDemo.showStatus("Mouse Pressed.");
}
}
```

The following listing shows how the preceding program can be improved by using an inner class. Here, **InnerClassDemo** is a top-level class that extends **Applet**. **MyMouseAdapter** is an inner class that extends **MouseAdapter**. Because **MyMouseAdapter** is defined within the scope of **InnerClassDemo**, it has access to all of the variables and methods within the scope of that class. Therefore, the **mousePressed( )** method can call the **showStatus( )** method directly. It no longer needs to do this via a stored reference to the applet. Thus, it is no longer necessary to pass **MyMouseAdapter( )** a reference to the invoking object.

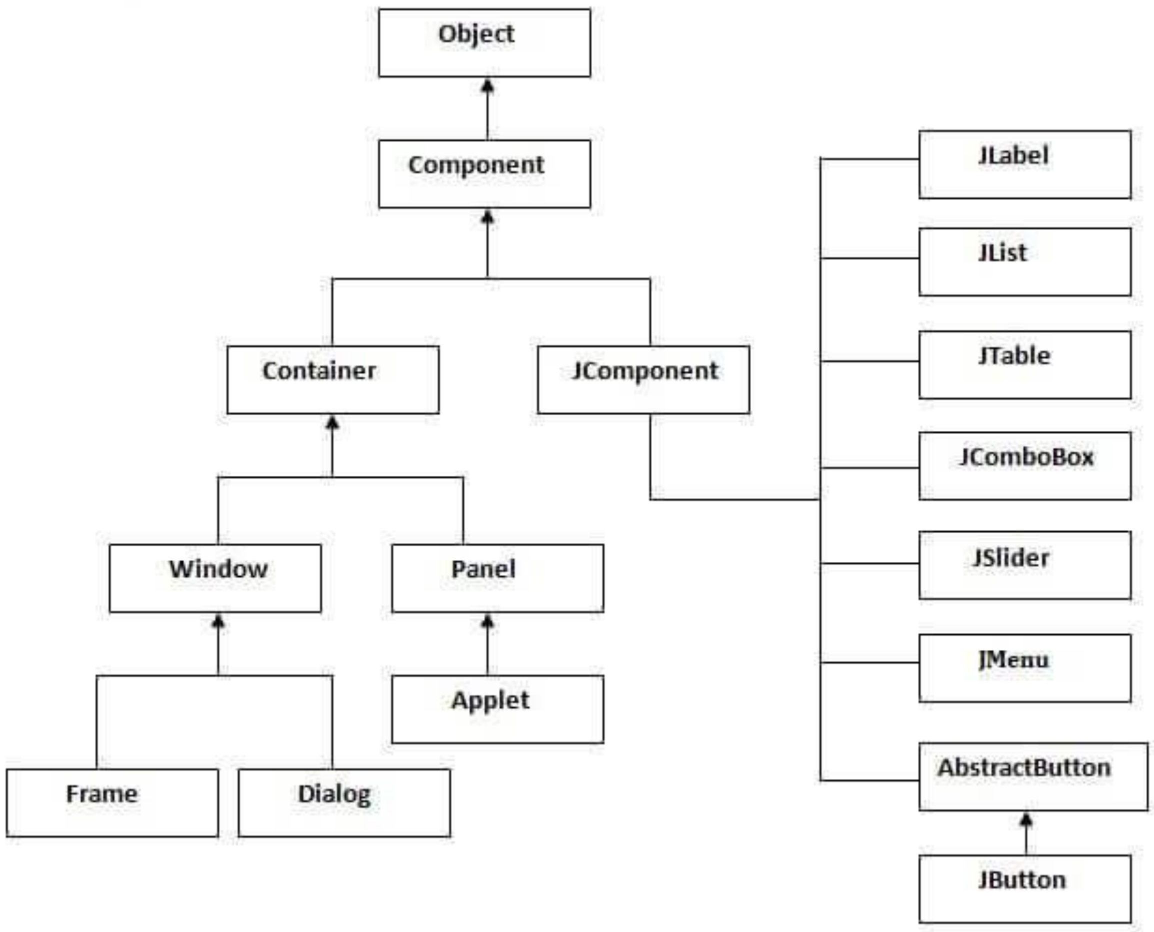
```
// Inner class demo.
import java.applet.*;
import java.awt.event.*;
/*
<applet code="InnerClassDemo" width=200 height=100>
</applet>
*/
public class InnerClassDemo extends Applet {
public void init() {
addMouseListener(new MyMouseAdapter());
}
class MyMouseAdapter extends MouseAdapter {
public void mousePressed(MouseEvent me) {
showStatus("Mouse Pressed");
}
}
}
```

Java Swing

Unlike AWT, Java Swing provides platform-independent and lightweight components. The javax.swing package provides classes for java swing API such as JButton, JTextField, JTextArea, JRadioButton, JCheckbox, JMenu, JColorChooser etc.

Hierarchy of Java Swing classes

The hierarchy of java swing API is given below.



Commonly used Methods of Component class

The methods of Component class are widely used in java swing that are given below.

Method	**Description**
public void add(Component c)	add a component on another component.
public void setSize(int width,int height)	sets size of the component.
public void setLayout(LayoutManager m)	sets the layout manager for the component.

public void setVisible(boolean b)	sets the visibility of the component. It is by default false.

Java Swing Examples

There are two ways to create a frame:

- By creating the object of Frame class (association)
- By extending Frame class (inheritance)

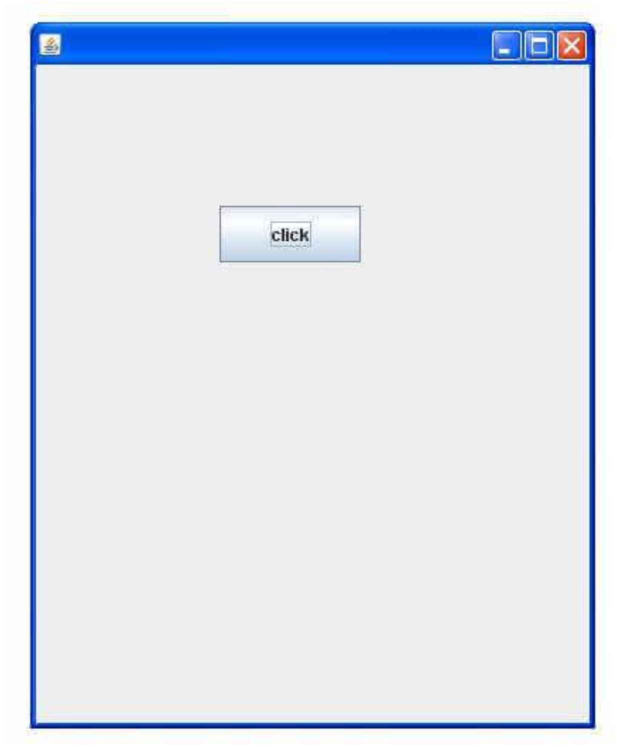
We can write the code of swing inside the main(), constructor or any other method.

Simple Java Swing Example

Let's see a simple swing example where we are creating one button and adding it on the JFrame object inside the main() method.

File: FirstSwingExample.java

```
import javax.swing.*;
public class FirstSwingExample {
public static void main(String[] args) {
JFrame f=new JFrame();//creating instance of JFrame
JButton b=new JButton("click");//creating instance of JButton
b.setBounds(130,100,100, 40);//x axis, y axis, width, height
f.add(b);//adding button in JFrame
f.setSize(400,500);//400 width and 500 height
f.setLayout(null);//using no layout managers
f.setVisible(true);//making the frame visible
}
}
```



Example of Swing by Association inside constructor

We can also write all the codes of creating JFrame, JButton and method call inside the java constructor.

File: Simple.java

```
import javax.swing.*;
public class Simple {
JFrame f;
Simple(){
f=new JFrame();//creating instance of JFrame

JButton b=new JButton("click");//creating instance of JButton
b.setBounds(130,100,100, 40);

f.add(b);//adding button in JFrame

f.setSize(400,500);//400 width and 500 height
f.setLayout(null);//using no layout managers
f.setVisible(true);//making the frame visible
}

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

The setBounds(int xaxis, int yaxis, int width, int height)is used in the above example that sets the position of the button.

Simple example of Swing by inheritance

We can also inherit the JFrame class, so there is no need to create the instance of JFrame class explicitly.

File: Simple2.java

```
import javax.swing.*;
public class Simple2 extends JFrame{//inheriting JFrame
JFrame f;
Simple2(){
JButton b=new JButton("click");//create button
b.setBounds(130,100,100, 40);

add(b);//adding button on frame
setSize(400,500);
setLayout(null);
setVisible(true);
}
public static void main(String[] args) {
new Simple2();
}}
```

Lambda Expressions: Fundamentals, Block Lambda expressions, Passing Lambda Expressions as Argument, Lambda Expressions and Exceptions, Method References.

- Lambda expression is a new and important feature of Java which was included in Java SE 8. It provides a clear and concise way to represent one method interface using an expression. It is very useful in collection library. It helps to iterate, filter and extract data from collection.
- The Lambda expression is used to provide the implementation of an interface which has functional interface. It saves a lot of code. In case of lambda expression, we don't need to define the method again for providing the implementation. Here, we just write the implementation code.
- Java lambda expression is treated as a function, so compiler does not create .class file.

Functional Interface

Lambda expression provides implementation of *functional interface*. An interface which has only one abstract method is called functional interface. Java provides an anotation @*FunctionalInterface*, which is used to declare an interface as functional interface.

Why use Lambda Expression

1. **To provide the implementation of Functional interface.**
2. **Less coding.**

Java Lambda Expression Syntax

1. **(argument-list) -> {body}**

Java lambda expression is consisted of three components.

1) Argument-list: It can be empty or non-empty as well.

2) Arrow-token: It is used to link arguments-list and body of expression.

3) Body: It contains expressions and statements for lambda expression.

No Parameter Syntax

```
() -> {
//Body of no parameter lambda
}
```

One Parameter Syntax

```
(p1) -> {
//Body of single parameter lambda
}
```

Two Parameter Syntax

```
    (p1,p2) -> {
    //Body of multiple parameter lambda
    }
```

Let's see a scenario where we are not implementing Java lambda expression. Here, we are implementing an interface without using lambda expression.

Without Lambda Expression

```
    interface Drawable{
        public void draw();
    }
    public class LambdaExpressionExample {
        public static void main(String[] args) {
            int width=10;

            //without lambda, Drawable implementation using anonymous class
            Drawable d=new Drawable(){
                public void draw(){System.out.println("Drawing "+width);}
            };
            d.draw();
        }
    }
```

Output:

```
Drawing 10
```

Java Lambda Expression Example

Now, we are going to implement the above example with the help of Java lambda expression.

```
    @FunctionalInterface  //It is optional
    interface Drawable{
        public void draw();
```

```
}

public class LambdaExpressionExample2 {
    public static void main(String[] args) {
        int width=10;

        //with lambda
        Drawable d2=()->{
            System.out.println("Drawing "+width);
        };
        d2.draw();
    }
}
```

Output:

```
Drawing 10
```

A lambda expression can have zero or any number of arguments. Let's see the examples:

Java Lambda Expression Example: No Parameter

```
interface Sayable{
    public String say();
}
public class LambdaExpressionExample3{
public static void main(String[] args) {
    Sayable s=()->{
        return "I have nothing to say.";
    };
    System.out.println(s.say());
}
}
```

Output:

```
I have nothing to say.
```

Java Lambda Expression Example: Single Parameter

```
interface Sayable{
    public String say(String name);
}

public class LambdaExpressionExample4{
    public static void main(String[] args) {

        // Lambda expression with single parameter.
        Sayable s1=(name)->{
            return "Hello, "+name;
        };
        System.out.println(s1.say("Sonoo"));

        // You can omit function parentheses
        Sayable s2= name ->{
            return "Hello, "+name;
        };
        System.out.println(s2.say("Sonoo"));
    }
}
```

Output:

```
Hello, Sonoo
Hello, Sonoo
```

Java Lambda Expression Example: Multiple Parameters

```
interface Addable{
    int add(int a,int b);
}

public class LambdaExpressionExample5{
    public static void main(String[] args) {

        // Multiple parameters in lambda expression
        Addable ad1=(a,b)->(a+b);
        System.out.println(ad1.add(10,20));

        // Multiple parameters with data type in lambda expression
        Addable ad2=(int a,int b)->(a+b);
        System.out.println(ad2.add(100,200));
    }
}
```

Output:

```
30
300
```

Java Lambda Expression Example: with or without return keyword

In Java lambda expression, if there is only one statement, you may or may not use return keyword. You must use return keyword when lambda expression contains multiple statements.

```
    interface Addable{
        int add(int a,int b);
    }

    public class LambdaExpressionExample6 {
        public static void main(String[] args) {

            // Lambda expression without return keyword.
            Addable ad1=(a,b)->(a+b);
            System.out.println(ad1.add(10,20));

            // Lambda expression with return keyword.
            Addable ad2=(int a,int b)->{
```

```
                            return (a+b);
                            };
               System.out.println(ad2.add(100,200));
           }
       }
```

Output:

```
30
300
```

Java Lambda Expression Example: Foreach Loop

```
    import java.util.*;
    public class LambdaExpressionExample7{
        public static void main(String[] args) {

            List<String> list=new ArrayList<String>();
            list.add("ankit");
            list.add("mayank");
            list.add("irfan");
            list.add("jai");

            list.forEach(
                (n)->System.out.println(n)
            );
        }
    }
```

Output:

```
ankit
mayank
irfan
jai
```

Java Lambda Expression Example: Multiple Statements

```
@FunctionalInterface
interface Sayable{
    String say(String message);
}
  public class LambdaExpressionExample8{
    public static void main(String[] args) {

        // You can pass multiple statements in lambda expression
        Sayable person = (message)-> {
            String str1 = "I would like to say, ";
            String str2 = str1 + message;
            return str2;
        };
            System.out.println(person.say("time is precious."));
    }
}
```

Output:

```
I would like to say, time is precious.
```

Java Lambda Expression Example: Creating Thread

You can use lambda expression to run thread. In the following example, we are implementing run method by using lambda expression.

```
public class LambdaExpressionExample9{
    public static void main(String[] args) {

        //Thread Example without lambda
        Runnable r1=new Runnable(){
            public void run(){
                System.out.println("Thread1 is running...");
            }
        };
        Thread t1=new Thread(r1);
        t1.start();
        //Thread Example with lambda
        Runnable r2=()->{
                System.out.println("Thread2 is running...");
        };
        Thread t2=new Thread(r2);
        t2.start();
    }
}
```

Output:

```
Thread1 is running...
Thread2 is running...
```

Java lambda expression can be used in the collection framework. It provides efficient and concise way to iterate, filter and fetch data. Following are some lambda and collection examples provided.

Java Lambda Expression Example: Comparator

```
import java.util.ArrayList;
import java.util.Collections;
import java.util.List;
class Product{
    int id;
    String name;
    float price;
    public Product(int id, String name, float price) {
        super();
        this.id = id;
        this.name = name;
        this.price = price;
    }
}
public class LambdaExpressionExample10{
    public static void main(String[] args) {
        List<Product> list=new ArrayList<Product>();

        //Adding Products
        list.add(new Product(1,"HP Laptop",25000f));
        list.add(new Product(3,"Keyboard",300f));
        list.add(new Product(2,"Dell Mouse",150f));

        System.out.println("Sorting on the basis of name...");

        // implementing lambda expression
        Collections.sort(list,(p1,p2)->{
        return p1.name.compareTo(p2.name);
        });
        for(Product p:list){
            System.out.println(p.id+" "+p.name+" "+p.price);
        }

    }
}
```

Output:

```
Sorting on the basis of name...
2 Dell Mouse 150.0
1 HP Laptop 25000.0
3 Keyboard 300.0
```

Java Lambda Expression Example: Filter Collection Data

```
import java.util.ArrayList;
import java.util.List;
import java.util.stream.Stream;
```

```
class Product{
    int id;
    String name;
    float price;
    public Product(int id, String name, float price) {
        super();
        this.id = id;
        this.name = name;
        this.price = price;
    }
}
public class LambdaExpressionExample11{
    public static void main(String[] args) {
        List<Product> list=new ArrayList<Product>();
        list.add(new Product(1,"Samsung A5",17000f));
        list.add(new Product(3,"Iphone 6S",65000f));
        list.add(new Product(2,"Sony Xperia",25000f));
        list.add(new Product(4,"Nokia Lumia",15000f));
        list.add(new Product(5,"Redmi4 ",26000f));
        list.add(new Product(6,"Lenevo Vibe",19000f));

        // using lambda to filter data
        Stream<Product> filtered_data = list.stream().filter(p -
> p.price > 20000);

        // using lambda to iterate through collection
        filtered_data.forEach(
                product -> System.out.println(product.name+": "+product.price)
        );
    }
}
```

Output:

```
Iphone 6S: 65000.0
Sony Xperia: 25000.0
Redmi4 : 26000.0
```

Java Lambda Expression Example: Event Listener

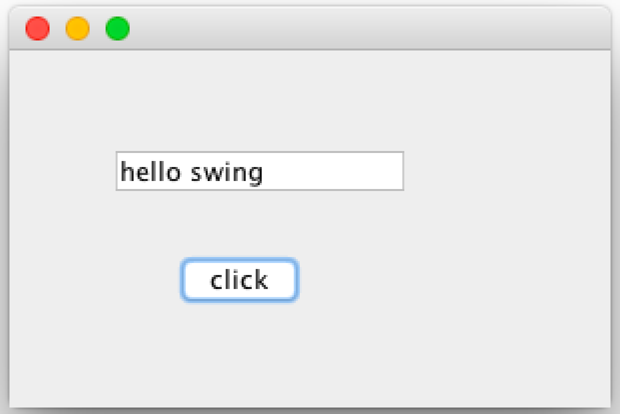
```
    import javax.swing.JButton;
    import javax.swing.JFrame;
    import javax.swing.JTextField;
    public class LambdaEventListenerExample {
        public static void main(String[] args) {
            JTextField tf=new JTextField();
            tf.setBounds(50, 50,150,20);
            JButton b=new JButton("click");
            b.setBounds(80,100,70,30);

            // lambda expression implementing here.
            b.addActionListener(e-> {tf.setText("hello swing");});

            JFrame f=new JFrame();
            f.add(tf);f.add(b);
            f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
            f.setLayout(null);
            f.setSize(300, 20
    0);
            f.setVisible(true);

        }
    }
```

Output:


hello swing
click