

An Introduction To Graphical User Interfaces

You will learn about the event-driven model and how to create simple graphical user interfaces (GUI's) in Java

James Tam

Note: GUI Code Cannot Be Run Through A Text- Only Connection: SSH

```
[csb exampleTwo 45 ]> ls  
Driver.class*  Driver.java  MyListener.class*  MyListener.java
```

```
[csb exampleTwo 46 ]> java Driver
```

```
Exception in thread "main" java.lang.InternalError: Can't connect to X11 window server using  
' :0.0' as the value of the DISPLAY variable.
```

```
    at sun.awt.X11GraphicsEnvironment.initDisplay(Native Method)  
    at sun.awt.X11GraphicsEnvironment.<clinit>(X11GraphicsEnvironment.java:125)  
    at java.lang.Class.forName0(Native Method)  
    at java.lang.Class.forName(Class.java:140)  
    at  
    java.awt.GraphicsEnvironment.getLocalGraphicsEnvironment(GraphicsEnvironment.java:62)  
    at java.awt.Window.init(Window.java:223)  
    at java.awt.Window.<init>(Window.java:267)  
    at java.awt.Frame.<init>(Frame.java:398)  
    at java.awt.Frame.<init>(Frame.java:363)  
    at Driver.main(Driver.java:7)
```

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Components

- They are many types of graphical controls and displays available:
 - JButton, JFrame, JLabel, JList, JTextArea, Window
- A graphical component is also known as “widgets”
- For Sun’s online documentation refer to the url:
 - <http://download.oracle.com/javase/7/docs/api/> (especially java.awt.event, javax.swing.event, and javax.swing).

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Containers

- A special type of component that is used to hold/contain the components (subclass of the basic component class).
- Can be used to group components on the screen (i.e., one container holds another container which in turn groups a number of controls).
- You must have at least one container object for your GUI:
 - JPanel, JWindow, JDialog, JFrame
- Components which have been added to a container will appear/disappear and be garbage collected along with the container.

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Containers

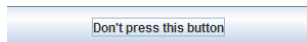
- You must have at least one container object for your GUI:
 - JPanel, JWindow, JDialog, JFrame



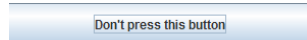
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Some Relevant Java GUI libraries

1. Java classes for the components and containers
 - e.g., JButton class
 - javax.swing (import javax.swing.* or import javax.swing.<class name>)



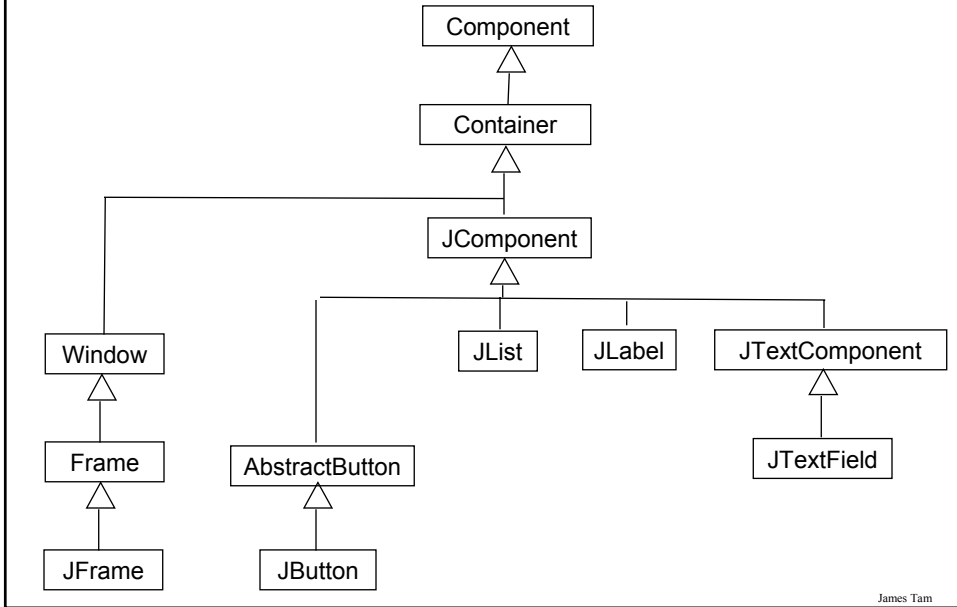
2. Java classes with the code to react to user-initiated events
 - e.g., code that executes when a button is pressed
 - java.awt.event (import java.awt.event.*, import javax.swing.event.*)



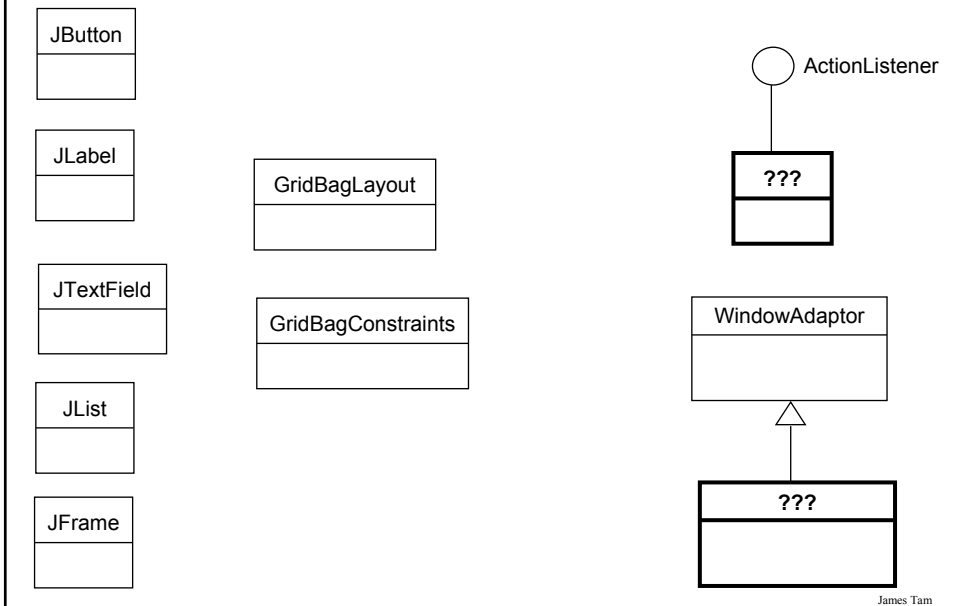
```
class ButtonListener implements ActionListener
{
    public void actionPerformed(ActionEvent e)
    {
        :       :       :
    }
}
```

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Hierarchy: Important Widget Classes



Some Relevant Java GUI Classes For This Section



Traditional Software

- Program control is largely determined by the program through a series of sequential statements.

Example

```

:
if (num >= 0)
{
    // Statements for the body of the if
}
else
{
    // Statements for the body of the else
}

```

When num is non-negative

Num is negative

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Traditional Software

- The user can only interact with the program at places that are specified by the program (e.g., when an input statement is encountered).

Example

```

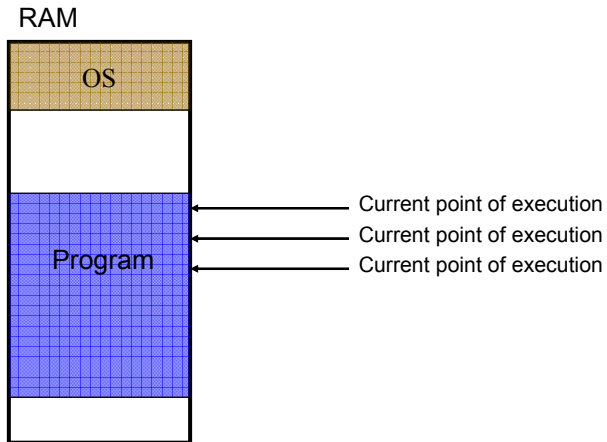
Scanner aScanner = new Scanner (System.in);
System.out.print("Enter student ID number: ");
id = aScanner.nextInt ();

```

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Event-Driven Software

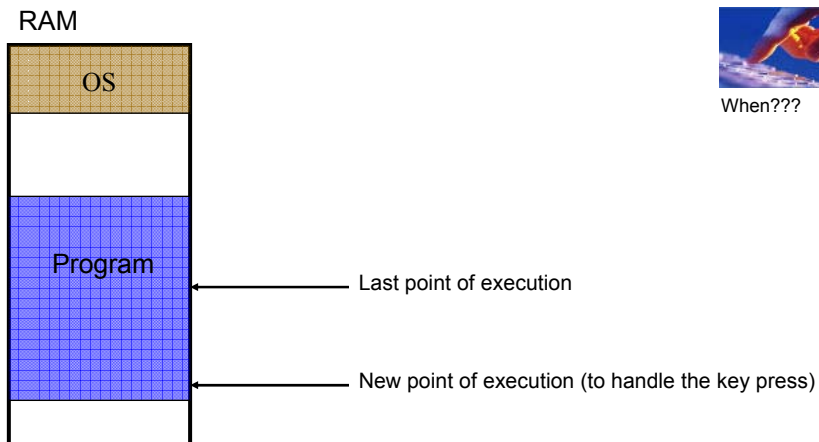
- Program control can also be sequential



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Event-Driven Software

- In addition program control *can also* be determined by events



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Characteristics Of Event Driven Software

- Program control can be determined by events as well as standard program control statements.
- A typical source of these events is the user.
- These events can occur at any time.

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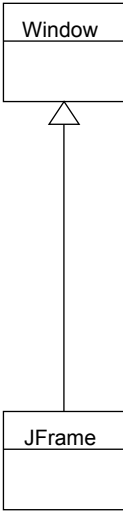
Most Components Can Trigger Events

- Graphical objects can be manipulated by the user to trigger events.
- Each graphical object can have 0, 1 or many events that can be triggered.



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Window Classes



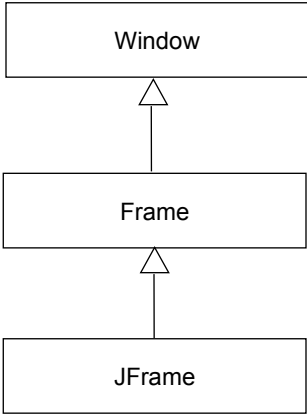
```
04/01/2004 09:00 PM (DIR) exampleSeven
04/01/2004 04:03 PM (DIR) exampleSix
03/31/2004 04:03 PM (DIR) exampleThree
11/19/2003 07:17 PM 737 FileIO.class
import java 11/20/2003 06:22 PM 1,186 FileIO.java
11/19/2003 06:00 PM 20F TextFieldListener.class
11/20/2003 03:18 PM 787 TextFieldListener.java
3 File(s) 13,378 bytes
7 Dir(s) 8,309,465,888 bytes free

location: class Driver
Window w = new Window ();
```



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The Window Class Hierarchy



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Class JFrame

- For full details look at the online API:
 - <http://download.oracle.com/javase/7/docs/api/javafx/swing/JFrame.html>
- Some of the more pertinent methods:
 - JFrame (“<Text on the title bar>”)
 - setSize (<pixel width>, <pixel height>)
 - setVisible (<true/false>)
 - setDefaultCloseOperation (<class constants>¹)

¹ DISPOSE_ON_CLOSE, HIDE_ON_CLOSE, DO_NOTHING_ON_CLOSE

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Example: Creating A Frame That Can Close (And Cleanup Memory After Itself)

- Location of the example:
 - /home/233/examples/gui/first_frame
 - OR
 - www.cpsc.ucalgary.ca/~tamj/233/examples/gui



James Tam

Example: Creating A Frame That Can Close (And Cleanup Memory After Itself)

```
import javax.swing.*;
public class Driver
{
    public static void main (String [] args)
    {
        JFrame mf = new JFrame ("Insert title here");
        mf.setSize (300,200);
        mf.setDefaultCloseOperation(JFrame.DISPOSE_ON_CLOSE);
        mf.setVisible(true);
    }
}
```

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Pitfall 1: Showing Too Early

- When a container holds a number of components the components must be added to the container (later examples).
- To be on the safe side the call to the “setVisible()” method should be done after the contents of the container have already been created and added.

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Window Events

- The basic JFrame class provides basic capabilities for common windowing operations: minimize, maximize, resize, close.
- However if a program needs to perform other actions (i.e., your own custom code) when these events occur the built in approach won't be sufficient.
 - E.g., the program is to automatically save your work to a file when you close the window.

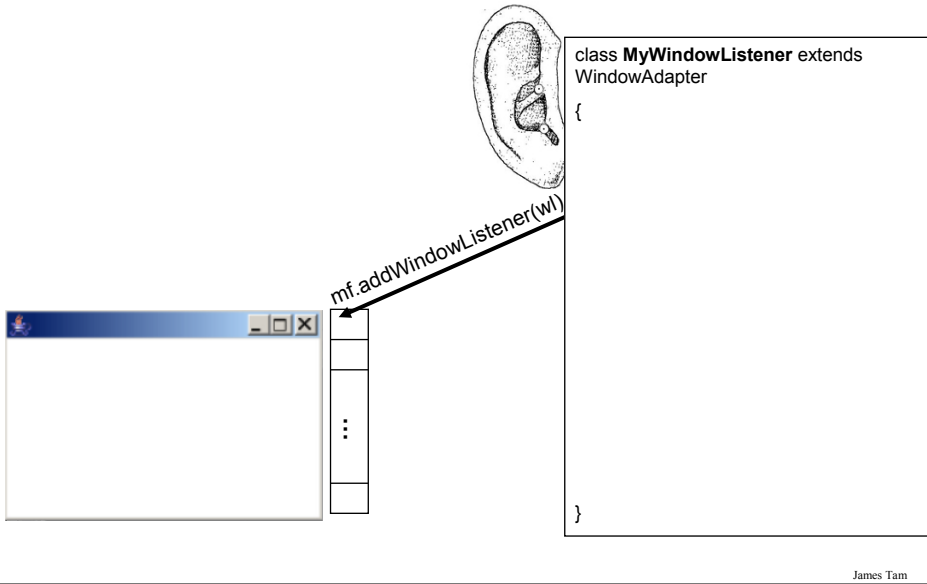
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Steps In The Event Model For Handling A Frame Event: Window Closing

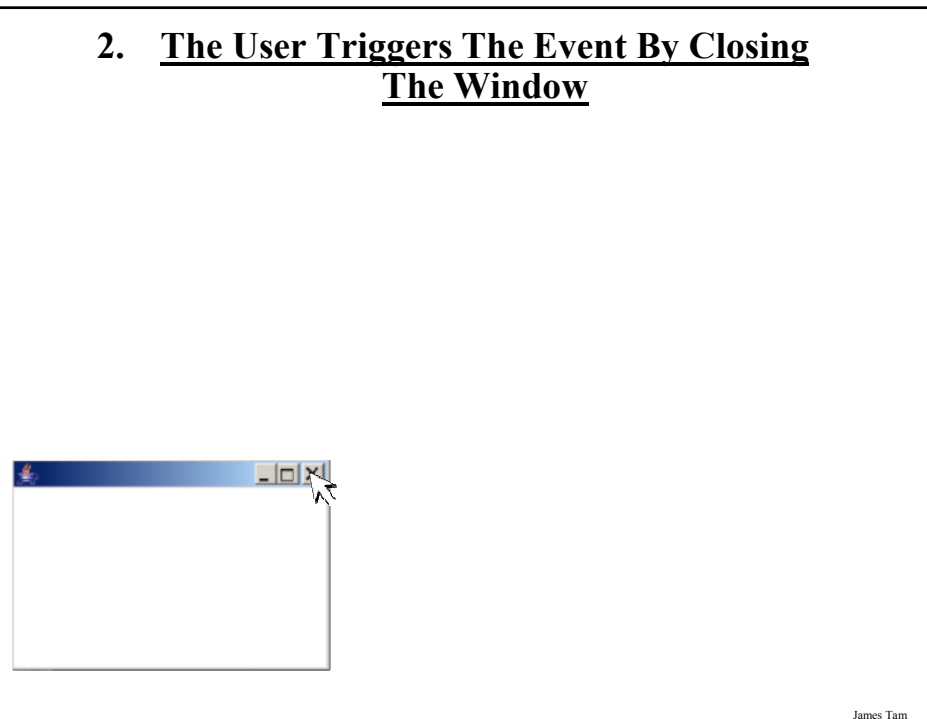
- 1) The frame must register all interested event listeners.
- 2) The user triggers the event by closing the window
- 3) The window sends a message to all listeners of that event.
- 4) The window event listener runs the code to handle the event (e.g., save information to a file).

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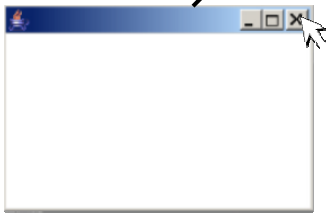
1. The Frame Must Register All Interested Event Listeners.



2. The User Triggers The Event By Closing The Window



3. The Window Sends A Message To All Listeners Of That Event.



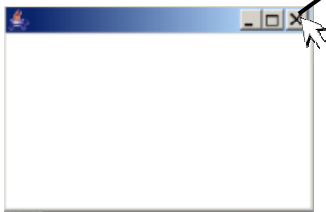
```
public class MyWindowListener extends WindowAdapter
{
    public void windowClosing (WindowEvent e)
    {

    }

}
```

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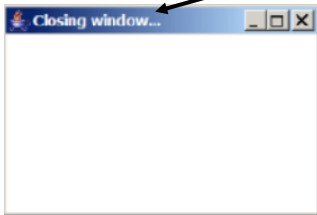
4. The Event Listener Runs The Code To Handle The Event.



```
public class MyWindowListener extends WindowAdapter
{
    public void windowClosing (WindowEvent e)
    {
        /* Code to react to event */
        JFrame aFrame = (JFrame) e.getWindow();
        aFrame.setTitle("Closing window...");
        // Pause program so user can see the message.
        aFrame.setVisible(false);
        aFrame.dispose();
    }
}
```

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4. The Event Listener Runs The Code To Handle The Event.



```
public class MyWindowListener extends WindowAdapter
{
    public void windowClosing (WindowEvent e)
    {
        /* Code to react to event */
        JFrame aFrame = (JFrame) e.getWindow();
        aFrame.setTitle("Closing window...");
        // Pause program so user can see the message.
        aFrame.setVisible(false);
        aFrame.dispose();
    }
}
```

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An Example Of Handling A Frame Event

- Location of the example:

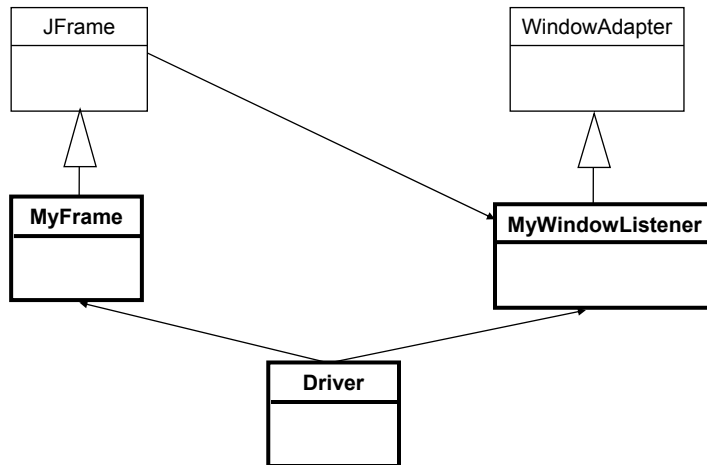
/home/233/examples/gui/second_window_events

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/second_window_events

James Tam

An Example Of Handling A Frame Event (2)



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The Driver Class

```
import javax.swing.JFrame;

public class Driver
{
    public static final int WIDTH = 300;
    public static final int HEIGHT = 200;
    public static void main (String [] args)
    {
        JFrame aFrame = new JFrame ();
        MyWindowListener aListener = new MyWindowListener();
        aFrame.addWindowListener(aListener);
        aFrame.setSize (WIDTH,HEIGHT);
        aFrame.setVisible(true);
    }
}
```

James Tam

Class MyFrame

```
import javax.swing.JFrame;

public class MyFrame extends JFrame
{
    // More code will be added in later examples.
}
```

James Tam

Class MyWindowListener

```
import java.awt.event.WindowAdapter;
import java.awt.event.WindowEvent;
import javax.swing.JFrame;

public class MyWindowListener extends WindowAdapter {
    public void windowClosing (WindowEvent e) {
        JFrame aFrame = (JFrame) e.getWindow();
        aFrame.setTitle("Closing window...");
        try
            Thread.sleep(3000);
        catch (InterruptedException ex)
            System.out.println("Pausing of program was interrupted");
        aFrame.setVisible(false);
        aFrame.dispose();
    }
}
```

James Tam

Callback

- The code that handles the event (the code that is called when a GUI event such as a window closing occurs) is commonly referred to as a “callback”.
 - An old IBM IDE (VisualAge) used to refer to these as ‘event to code’.
 - Evaluation copy:
http://download.cnet.com/IBM-VisualAge-for-Java/3000-2247_4-18868.html
 - IBM page:
<http://www-142.ibm.com/software/products/us/en/atoz>

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Callback (2)

- Example callbacks:

```
// Window event callback (you have already seen this example)
public void windowClosing (WindowEvent e) {
    << Called when window event occurs >>
}
```

```
// Button event callback (you haven't yet seen this example)
public void actionPerformed (ActionEvent e) {
    << Called when button event occurs >>
}
```

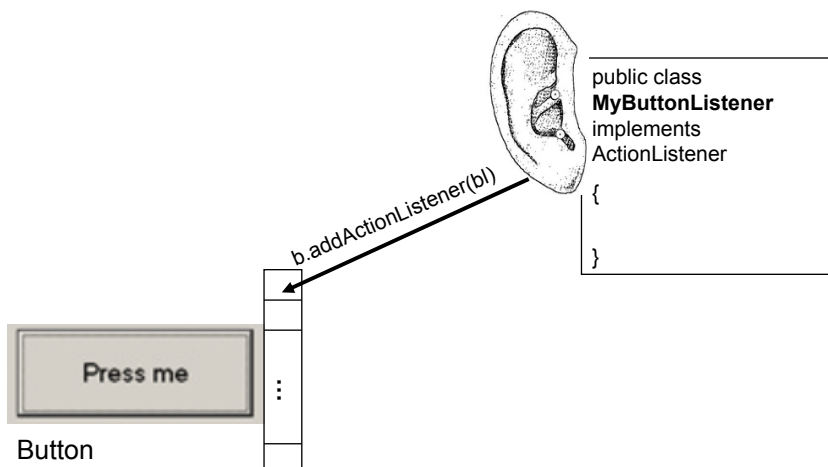
James Tam

Steps In The Event Model For Handling A Button Event

- 1) The button must register all interested event listeners.
- 2) The user triggers an event by pressing a button.
- 3) The button sends a message to all listeners of the button press event.
- 4) The button listener runs the code to handle the button press event.

James Tam

1. The Graphical Component Must Register All Interested Event Listeners.



James Tam

2. The User Triggers An Event By Pressing The Button



James Tam

3. The Component Sends A Message To All Registered Listeners For That Event

```
public class MyButtonListener implements  
ActionListener  
{  
    public void actionPerformed (ActionEvent e)  
    {  
    }  
}
```



James Tam

3. The Component Sends A Message To All Registered Listeners For That Event

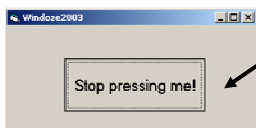
```
public class MyButtonListener implements  
ActionListener  
{  
    public void actionPerformed (ActionEvent e)  
    {  
        JButton b = (JButton) e.getSource();  
        b.setLabel("Stop pressing me!");  
    }  
}
```



James Tam

4. The Event Listener Runs The Code To Handle The Event

```
public class MyButtonListener implements  
ActionListener  
{  
    public void actionPerformed (ActionEvent e)  
    {  
        JButton b = (JButton) e.getSource();  
        b.setLabel("Stop pressing me!");  
    }  
}
```



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An Example Of Handling A Button Event

- Location of the example:

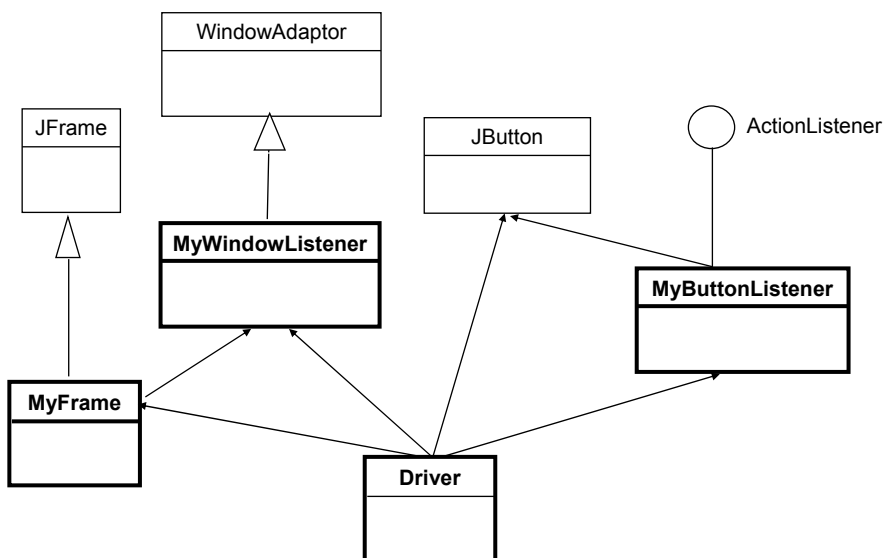
/home/233/examples/gui/three_button_events

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/three_button_events

James Tam

An Example Of Handling A Button Event (2)



James Tam

An Example Of Handling A Button Event: The Driver Class

```
import javax.swing.JButton;

public class Driver
{
    public static final int WIDTH = 300;
    public static final int HEIGHT = 200;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        MyWindowListener aWindowListener = new MyWindowListener();
        aFrame.addWindowListener(aWindowListener);
        aFrame.setSize (WIDTH,HEIGHT);
    }
}
```

James Tam

An Example Of Handling A Button Event: The Driver Class (2)

```
JButton aButton = new JButton("Press me.");
MyButtonListener aButtonListener = new
MyButtonListener();
aButton.addActionListener(aButtonListener);
aFrame.add (aButton);
aFrame.setVisible(true);
}
}
```

James Tam

An Example Of Handling A Button Event: The ButtonListener Class

```
import javax.swing.JButton;  
import java.awt.event.ActionEvent;  
import java.awt.event.ActionListener;  
  
public class MyButtonListener implements ActionListener  
{  
    public void actionPerformed (ActionEvent e)  
    {  
        JButton aButton = (JButton) e.getSource();  
        aButton.setText("Stop pressing me!");  
    }  
}
```

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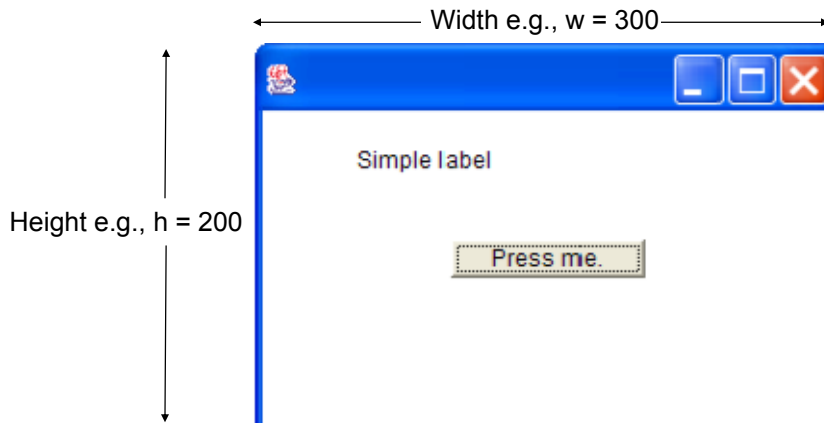
How To Handle The Layout Of Components

1. Manually set the coordinates yourself
2. Use one of Java's built-in layout manager classes

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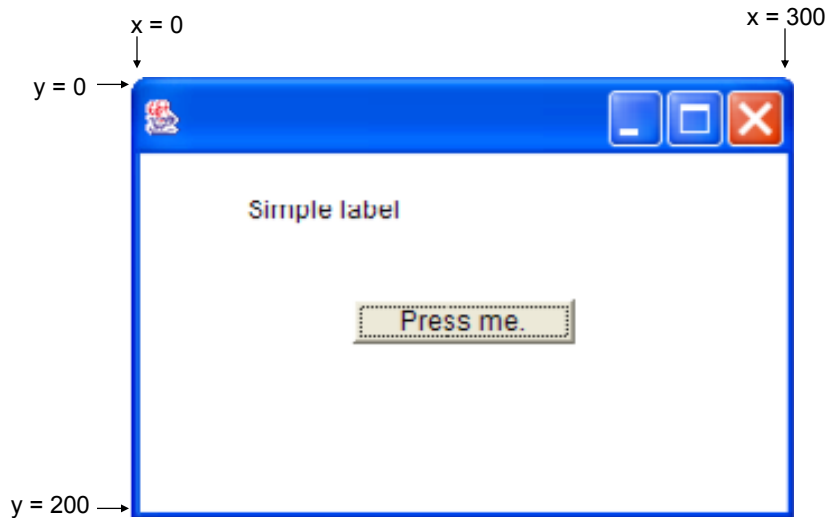
Layout Is Based On Spatial Coordinates

e.g. `MyFrame my = new MyFrame ();`
`my.setSize(300,200);`



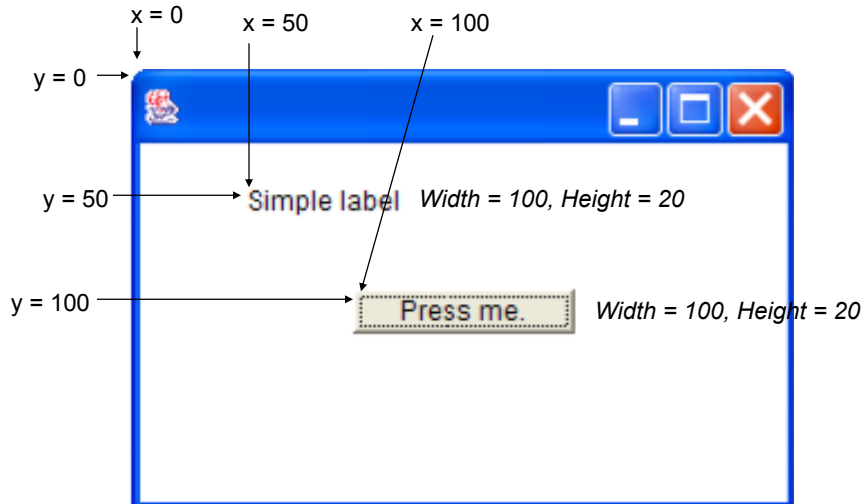
James Tam

Layout Is Based On Spatial Coordinates



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Coordinates Of Components: Relative To The Container



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Pitfall 2: Invisible Component

- Don't forget that coordinates (0,0) are covered by the title bar of the frame.
- Components added at this location may be partially or totally hidden by the title bar.

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A Example Showing Manual Layout

- Location of the example:

/home/233/examples/gui/fourth_manual_layout

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/fourth_manual_layout

James Tam

An Example Showing Manual Layout: The Driver Class

```
import javax.swing.JButton;  
import javax.swing.JLabel;  
import javax.swing.JFrame;
```

```
public class Driver
```

```
{
```

```
    public static final int WIDTH_FRAME = 300;  
    public static final int HEIGHT_FRAME = 300;  
    public static final int X_COORD_BUTTON = 100;  
    public static final int Y_COORD_BUTTON = 100;  
    public static final int WIDTH_BUTTON = 100;  
    public static final int HEIGHT_BUTTON = 20;  
    public static final int X_COORD_LABEL = 50;  
    public static final int Y_COORD_LABEL = 50;  
    public static final int WIDTH_LABEL = 100;  
    public static final int HEIGHT_LABEL = 20;
```

James Tam

An Example Showing Manual Layout: The Driver Class (2)

```
public static void main (String [] args) {  
    JFrame aFrame = new JFrame ();  
    aFrame.setLayout(null);  
    aFrame.setSize (WIDTH_FRAME,HEIGHT_FRAME);  
    JButton aButton = new JButton("Press me.");  
    aButton.setBounds(X_COORD_BUTTON,  
                    Y_COORD_BUTTON,  
                    WIDTH_BUTTON,  
                    HEIGHT_BUTTON);  
    JLabel aLabel = new JLabel ("Simple label");  
    aLabel.setBounds(X_COORD_LABEL,  
                   Y_COORD_LABEL,  
                   WIDTH_LABEL,  
                   HEIGHT_LABEL);  
    aFrame.add(aButton);  
    aFrame.add(aLabel);  
    aFrame.setVisible(true);  
    }  
}
```

James Tam

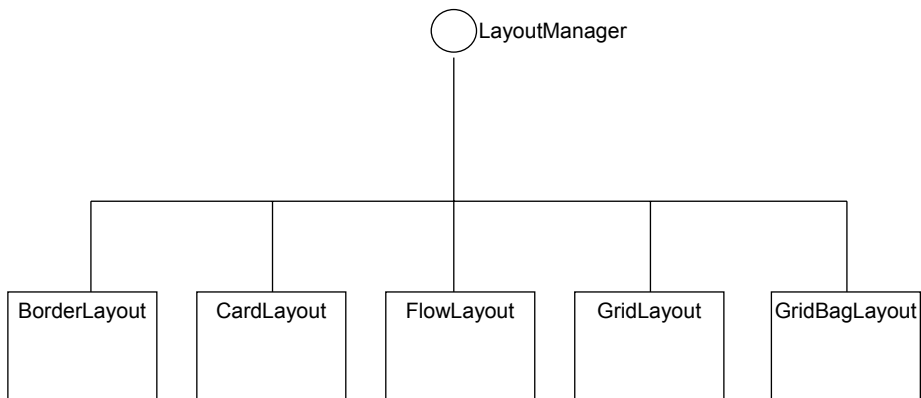
How To Handle The Layout Of Components

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- 2. Use one of Java's built-in layout manager classes**

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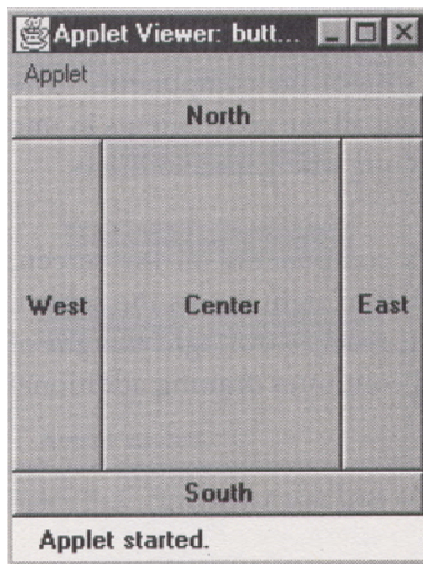
Java Layout Classes

- There are many implementations (this diagram only includes the original classes that were implemented by Sun).



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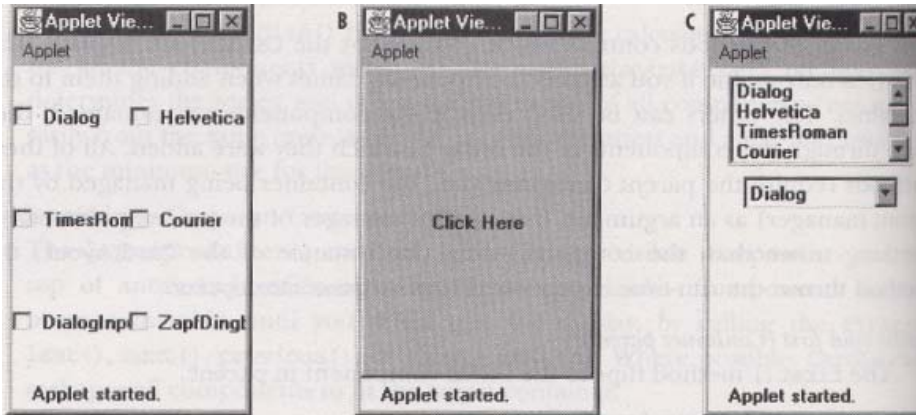
BorderLayout



From Java: AWT Reference p. 256

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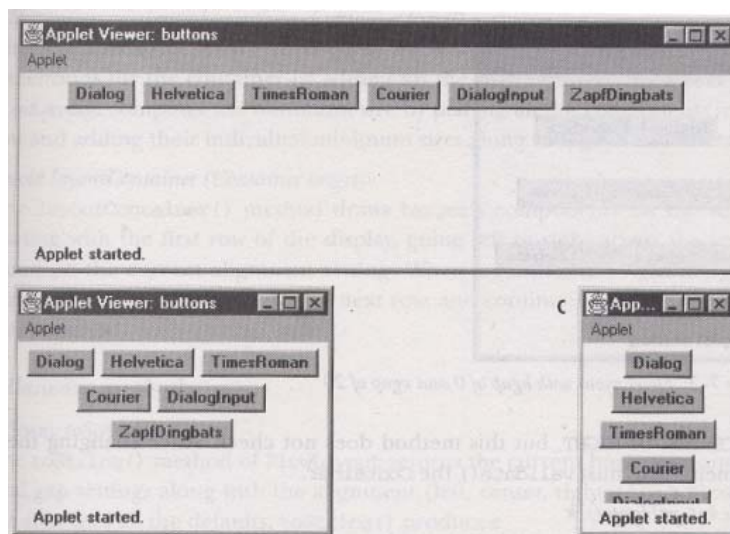
CardLayout



From Java: AWT Reference p. 264

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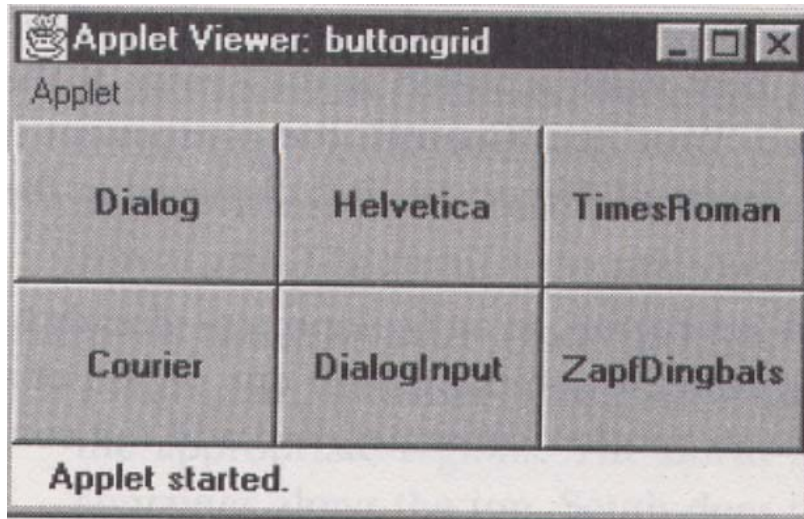
FlowLayout



From Java: AWT Reference p. 253

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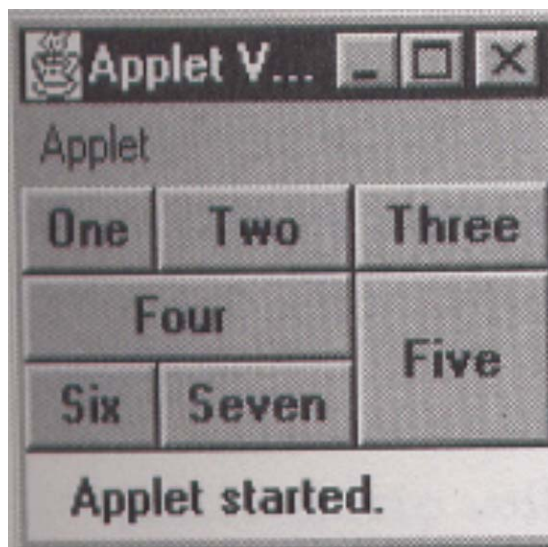
GridLayout



From Java: AWT Reference p. 260

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GridBagLayout

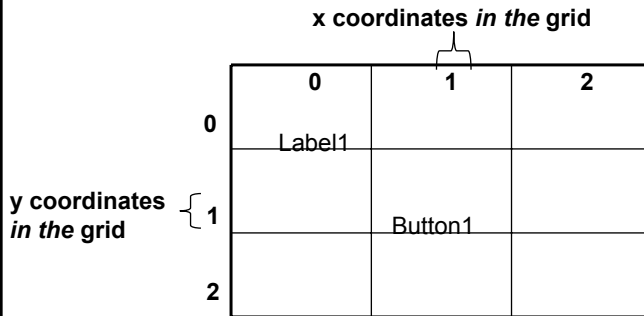


From Java: AWT Reference p. 269

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Designing A GUI When Using The GridBagLayout

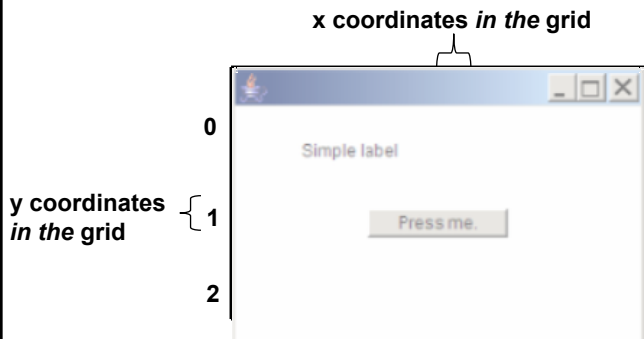
- Use graph paper or draw out a table.



James Tam

Designing A GUI When Using The GridBagLayout

- Use graph paper or draw out a table.



James Tam

GridBagConstraints

- Goes with the GridBagLayout class.
- Because the GridBagLayout doesn't know 'how' to display components you also need GridBagConstraints to constrain things (determine the layout).
- GridBagConstraints indicates how components should be displayed within the GridBag.
- For more complete information see:
- <http://java.sun.com/javase/7/docs/api/java/awt/GridBagConstraints.html>

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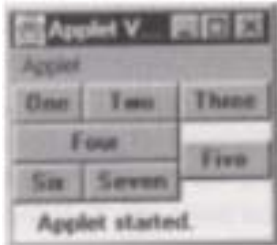
Some Important Parts Of The GridBagConstraints Class

```
public class GridBagConstraints
{
    // Used in conjunction with the constants below to determine the resize policy
    // of the component
    public int fill;

    // Apply only if there is available space.
    // Determine in which direction (if any) that the component expands to fill the
    // space.
    public final static int NONE;
    public final static int BOTH;
    public final static int HORIZONTAL;
    public final static int VERTICAL;
```

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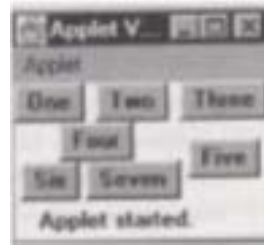
GridBagConstraints: Fill Values



Horizontal



Vertical



None

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Some Important Parts Of The GridBagConstraints Class (2)

// Position within the grid

```
public int gridx;
```

```
public int gridy;
```

// Number of grid squares occupied by a component

```
public int gridwidth;
```

```
public int gridheight;
```

James Tam

Some Important Parts Of The GridBagConstraints Class (3)

```
// Used in conjunction with the constants below to determine that the
// component drift if the space available is larger than the component.
public int anchor;

// Apply only if the component is smaller than the available space.
// Determine in which direction that the component will be anchored there
public final static int CENTER;
public final static int EAST;
public final static int NORTH;
public final static int NORTHEAST;
public final static int NORTHWEST;
public final static int SOUTH;
public final static int SOUTHEAST;
public final static int SOUTHWEST;
public final static int WEST;
```

James Tam

An Example Using The GridBagLayout

- Location of the example:

/home/233/examples/gui/fifth_gridbaglayout

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/fifth_gridbaglayout

James Tam

An Example Using The GridBagLayout: The Driver Class

```
public class Driver
{
    public static final int WIDTH = 400;
    public static final int HEIGHT = 300;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        aFrame.setSize(WIDTH,HEIGHT);
        aFrame.setVisible(true);
    }
}
```

James Tam

An Example Using The GridBagLayout: Class MyFrame

```
public class MyFrame extends JFrame
{
    private JButton aButton;
    private JLabel aLabel;
    private GridBagConstraints aLayout;
    GridBagConstraints aConstraint;

    public MyFrame ()
    {
        MyWindowListener aWindowListener = new MyWindowListener ();
        addWindowListener(aWindowListener); // Calling method of super class.
        aConstraint = new GridBagConstraints();
        aButton = new JButton("Press me");
        MyButtonListener aButtonListener = new MyButtonListener();
        aButton.addActionListener (aButtonListener);
    }
}
```

James Tam

An Example Using The GridBagLayout: Class MyFrame (2)

```
aLabel = new JLabel("Simple label");  
aLayout = new GridBagLayout();  
setLayout(aLayout); // Calling method of super class.  
addWidget(aLabel, 0, 0, 1, 1);  
addWidget(aButton, 2, 2, 1, 1);  
} // End constructor
```

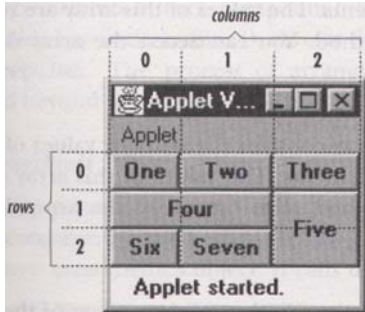
James Tam

An Example Using The GridBagLayout: Class MyFrame (3)

```
public void addWidget (Component widget, int x, int y, int w, int h)  
{  
    aConstraint.gridx = x;  
    aConstraint.gridy = y;  
    aConstraint.gridwidth = w;  
    aConstraint.gridheight = h;  
    aLayout.setConstraints (widget, aConstraint);  
    addWidget(); // Calling method of super class.  
}  
} // End of definition for class MyFrame
```

James Tam

Advanced Uses Of GridBagLayout



From Java: AWT Reference p. 269

Button	gridx (col)	gridy (row)	grid-width	grid-height
One	0	0	1	1
Two	1	0	1	1
Three	2	0	1	1
Four	0	1	2	1
Five	2	1	1	2
Six	0	2	1	1
Seven	1	2	1	1

James Tam

Layout Of GUI Components

- JT's note (and opinion): learning how to layout GUI components manually will teach you "how things work".
 - That's because you have to handle many details yourself (either manually or by using a layout class).
 - Except when writing small programs with a simple GUI (assignment) doing things manually is just too much of a hassle.
 - The programmer focuses on the wrong details (how do I get the programming language to 'do stuff' as opposed to how do I create a GUI that is 'user-friendly').
 - In other cases ('real life programs') an IDE is used.
 - Some examples:
 - Sun's NetBeans IDE: <http://docs.oracle.com/javase/tutorial/uiswing/learn/index.html>
 - IBM's Eclipse IDE: <http://www.ibm.com/developerworks/opensource/library/os-ecvisual/>

James Tam

Components Effecting The State Of Other Components

- Location of the example:

/home/233/examples/gui/sixth_controls_affect_controls

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/sixth_controls_affect_controls

James Tam

Components Effecting The State Of Other Components: The Driver Class

```
public class Driver
{
    public static final int WIDTH = 400;
    public static final int HEIGHT = 300;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        aFrame.setSize(WIDTH,HEIGHT);
        aFrame.setVisible(true);
    }
}
```

James Tam

Components Effecting The State Of Other Components: Class MyFrame

```
public class MyFrame extends JFrame
{
    private JLabel aLabel;
    private GridBagLayout aLayout;
    private GridBagConstraints aConstraint;
    private JButton himButton;
    private JButton herButton;
    private MyButtonListener aButtonListener;
```

James Tam

Components Effecting The State Of Other Components: Class MyFrame (2)

```
public MyFrame ()
{
    MyWindowListener aWindowListener = new MyWindowListener ();
    addWindowListener(aWindowListener); // Calling method of super class.
    aConstraint = new GridBagConstraints();
    aButtonListener = new MyButtonListener();

    himButton = new JButton("HIM: Press her not me.");
    himButton.setActionCommand("him");
    himButton.setBackground(Color.lightGray);
    himButton.addActionListener(aButtonListener);

    herButton = new JButton("HER: Press him not me");
    herButton.setActionCommand("her");
    herButton.setBackground(Color.lightGray);
    herButton.addActionListener(aButtonListener);
```

James Tam

Components Effecting The State Of Other Components: Class MyFrame (3)

```
aLabel = new JLabel("Simple label");
aLayout = new GridBagLayout();
setLayout(aLayout);    // Calling method of super class.
addWidget(aLabel, 0, 0, 1, 1);
addWidget(himButton, 0, 1, 1, 1);
addWidget(herButton, 0, 2, 1, 1);
}
```

James Tam

Components Effecting The State Of Other Components: Class MyFrame (4)

```
public void addWidget (Component widget, int x, int y, int w, int h)
{
    aConstraint.gridx = x;
    aConstraint.gridy = y;
    aConstraint.gridwidth = w;
    aConstraint.gridheight = h;
    aLayout.setConstraints (widget, aConstraint);
    add(widget);    // Calling method of super class.
}

public JButton getHerButton () { return herButton; }
public JButton getHimButton () { return himButton; }
```

James Tam

Components Effecting The State Of Other Components: Class MyFrame (5)

```
public class MyWindowListener extends WindowAdapter
{
    public void windowClosing (WindowEvent e)
    {
        JFrame f = (JFrame) e.getWindow();
        f.setTitle("Closing window...");
        try {
            Thread.sleep(3000);
        }
        catch (InterruptedException ex) {
            System.out.println("Pausing of program was interrupted");
        }
        f.setVisible(false);
        f.dispose();
    }
}
```

James Tam

Components Effecting The State Of Other Components: Class ButtonListener

```
public class MyButtonListener implements ActionListener
{
    public void actionPerformed (ActionEvent e)
    {
        JButton aButton = (JButton) e.getSource();
        String s = e.getActionCommand();
        MyFrame aFrame = (MyFrame) aButton.getRootPane().getParent();
    }
}
```

James Tam

Components Effecting The State Of Other Components: Class ButtonListener (2)

```
if (s.equals("her"))
{
    JButton himButton = aFrame.getHimButton();
    String title = aFrame.getTitle();
    aFrame.setTitle(himButton.getText());
    himButton.setBackground(Color.green);
    aButton.setBackground(Color.lightGray);
    timeDelay();
    aFrame.setTitle(title);
}
```

James Tam

Components Effecting The State Of Other Components: Class ButtonListener (3)

```
else if (s.equals("him")) {
    JButton herButton = aFrame.getHerButton();
    String title = aFrame.getTitle();
    aFrame.setTitle(herButton.getText());
    herButton.setBackground(Color.green);
    aButton.setBackground(Color.lightGray);
    timeDelay();
    aFrame.setTitle(title);
}
else {
    :
}
}
```

James Tam

Components Effecting The State Of Other Components: Class ButtonListener (4)

```
private void timeDelay ()
{
    try
    {
        Thread.sleep(3000);
    }
    catch (InterruptedException e)
    {
        System.out.println("Problem with pasuing of the program");
    }
}
}
```

James Tam

Last Example: Critique

- There was one method handles events for all the buttons.
- Inside that method there was a need to ‘identify’ the source of the event.
 - The method is rather long even though there are only 2 sources (2 buttons).
 - What if the GUI has dozens of buttons!

```
public void actionPerformed (ActionEvent e)
{
    String s = e.getActionCommand();
    if (s.equals("her")) {

    }
    if (s.equals("him")) {

    }
}
}
```

James Tam

Anonymous Objects/Anonymous Class

- If an object needs to be created but never directly referenced then it may be candidate for being created as an anonymous object.
- An example of where an anonymous object may be created is an event listener.
- Creating an anonymous object:

```
    JButton aButton = new JButton("Press me.");
    aButton.addActionListener (new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            JButton aButton = (JButton) e.getSource();
            aButton.setText("Stop pressing me!");
        }
    });
```

Awkward if complex programming is required.

No reference name

One advantage: code for widget and event handler are in the same place.

James Tam

Revised Example Using Anonymous Class And Object

- Location of the example:

/home/233/examples/gui/seventh_controls_affect_controls_anonymousObjectClass

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/_seventh_controls_affect_controls_anonymousObjectClass

James Tam

Driver Class

```
public class Driver
{
    public static final int WIDTH = 400;
    public static final int HEIGHT = 300;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        aFrame.setSize(WIDTH,HEIGHT);
        aFrame.setVisible(true);
    }
}
```

James Tam

Class MyFrame

```
public class MyFrame extends JFrame
{
    private JLabel aLabel;
    private GridBagLayout aLayout;
    private GridBagConstraints aConstraint;
    private JButton himButton;
    private JButton herButton;
    private MyButtonListener aButtonListener;
```

James Tam

Class MyFrame (2)

```
public MyFrame ()
{
    MyWindowListener aWindowListener = new MyWindowListener ();
    addWindowListener(aWindowListener); // Calling method of super class.
    aConstraint = new GridBagConstraints();

    himButton = new JButton("HIM: Press her not me.");
    himButton.setBackground(Color.lightGray);

    herButton = new JButton("HER: Press him not me");
    herButton.setBackground(Color.lightGray);
}
```

James Tam

Class MyFrame (3): Callback for HimButton

```
himButton.addActionListener(
    new ActionListener()
    {
        public void actionPerformed(ActionEvent e)
        {
            JButton himButton = (JButton) e.getSource();
            MyFrame aFrame = (MyFrame) himButton.getRootPane().getParent();
            String title = aFrame.getTitle();
            JButton herButton = aFrame.getHerButton();
            aFrame.setTitle(herButton.getText());
            herButton.setBackground(Color.green);
            himButton.setBackground(Color.lightGray);
            timeDelay();
            aFrame.setTitle(title);
        } // Close: defining method actionPerformed (himButton callback)
    } // Close: define a new anonymous class that implements ActionListener
); // Close: for parameter list of call to method addActionListener
```

James Tam

Class MyFrame (4): Callback for HerButton

```
herButton.addActionListener(  
    new ActionListener()  
    {  
        public void actionPerformed(ActionEvent e)  
        {  
            JButton herButton = (JButton) e.getSource();  
            MyFrame aFrame = (MyFrame) herButton.getRootPane().getParent();  
            String title = aFrame.getTitle();  
            JButton himButton = aFrame.getHimButton();  
            aFrame.setTitle(himButton.getText());  
            himButton.setBackground(Color.green);  
            herButton.setBackground(Color.lightGray);  
            timeDelay();  
            aFrame.setTitle(title);  
        } // Close: defining method actionPerformed (herButton callback)  
    } // Close: define a new anonymous class that implements ActionListener  
); // Close: for parameter list of call to method addActionListener
```

James Tam

Class MyFrame (5)

```
// MyFrame constructor continued  
aLabel = new JLabel("Simple label");  
aLayout = new GridBagLayout();  
setLayout(aLayout); // Calling method of super class.  
addWidget(aLabel, 0, 0, 1, 1);  
addWidget(himButton, 0, 1, 1, 1);  
addWidget(herButton, 0, 2, 1, 1);  
} // End constructor  
  
private void timeDelay () {  
    try {  
        Thread.sleep(3000);  
    }  
    catch (InterruptedException e) {  
        System.out.println("Problem with pasuing of the program");  
    }  
}
```

James Tam

Class MyFrame (6)

```
public void addWidget (Component widget, int x, int y, int w, int h)
{
    aConstraint.gridx = x;
    aConstraint.gridy = y;
    aConstraint.gridwidth = w;
    aConstraint.gridheight = h;
    aLayout.setConstraints (widget, aConstraint);
    add(widget);    // Calling method of super class.
}

public JButton getHerButton () { return herButton; }
public JButton getHimButton () { return himButton; }

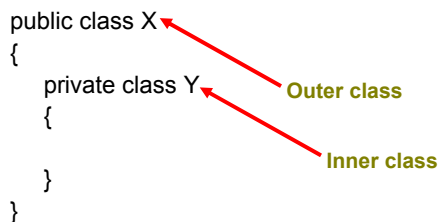
}
```

James Tam

Nested/Inner Classes

- Occurs when one class is defined inside of another class:

```
public class X
{
    private class Y
    {
    }
}
```



- Why nest class definitions¹:
 - It is a way of logically grouping classes that are only used in one place.
 - Nested classes can lead to more readable and maintainable code.
 - It increases encapsulation (inner class hidden from all classes except the outer class).
- Similar to declaring anonymous objects, nesting classes may be used when creating event listeners.

¹ For more information: <http://download.oracle.com/javase/tutorial/java/javaOO/nested.html>

James Tam

Example: Inner Classes

•Location Of example:

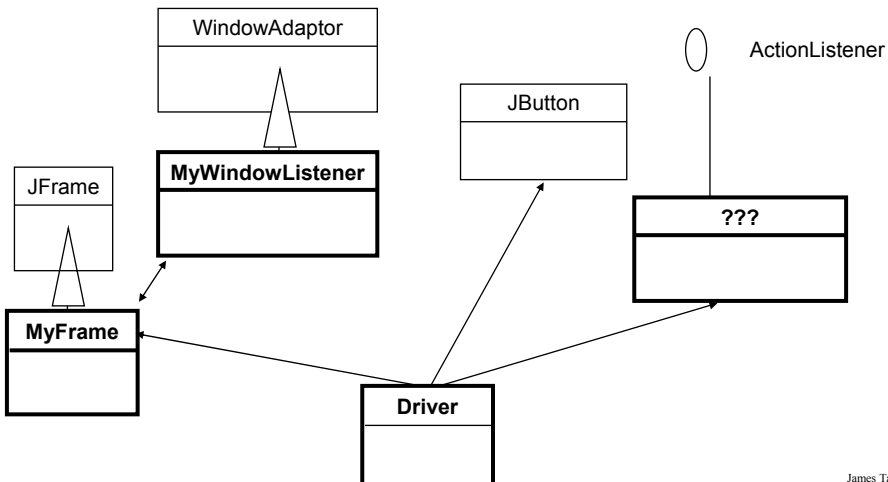
/home/233/examples/gui/eighth_button_alternate

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/eighth_button_alternate

James Tam

Example: Inner Classes (2)



James Tam

The Driver Class

```
import javax.swing.JButton;
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class Driver
{
    public static final int WIDTH = 300;
    public static final int HEIGHT = 200;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        aFrame.setSize (WIDTH,HEIGHT);
        JButton aButton = new JButton("Press me.");
    }
}
```

James Tam

The Driver Class (2)

```
// Anonymous object/class
aButton.addActionListener(
    new ActionListener()
    {
        public void actionPerformed(ActionEvent e)
        {
            JButton aButton = (JButton) e.getSource();
            aButton.setText("Stop pressing me!");
        } // End: Defining method actionPerformed
    } // End: Defining anonymous object/class
); // End: Parameter list for addActionListener

aFrame.add(aButton);
aFrame.setVisible(true);
}
```

James Tam

Class MyFrame: Outline

```
public class MyFrame extends JFrame
{
    // MyFrame's private parts
    public MyFrame ()
    {
        . . .
    }
    // Inner class defined within the MyFrame class.
    // Private because it's only used by the MyFrame class.
    private class MyWindowListener extends WindowAdapter
    {
        public void windowClosing (WindowEvent e)
        {
            : :
        }
    }
}
```

NOTE: The inner class can access the outer class' privates!

Definition of class MyWindowListener entirely within definition of class MyFrame

•Listens for events for that window

James Tam

Class MyFrame (2)

```
import javax.swing.JFrame;
import java.awt.event.WindowAdapter;
import java.awt.event.WindowEvent;

public class MyFrame extends JFrame
{
    public MyFrame ()
    {
        MyWindowListener aWindowListener = new MyWindowListener();
        this.addWindowListener(aWindowListener);
    }
}
```

James Tam

Class MyFrame (3)

```
// Inner class defined within the MyFrame class.  
// Private because it's only used by the MyFrame class.  
private class MyWindowListener extends WindowAdapter {  
    public void windowClosing (WindowEvent e) {  
        JFrame aFrame = (JFrame) e.getWindow();  
        aFrame.setTitle("Closing window...");  
        delay();  
        aFrame.setVisible(false);  
        aFrame.dispose();  
    }  
} // End: Definition of class MyWindowListener
```

Proof that the inner class can access the outer class' privates

```
private void delay() {  
    try {  
        Thread.sleep(3000); }  
    catch (InterruptedException ex) {  
        System.out.println("Pausing of program was interrupted"); }  
}
```

```
} // End: Definition of class MyFrame
```

James Tam

The JList Class

JT's note: why I apparently 'harped' on casting (hierarchies)

- Used to provide a graphical and interactive control for a list.
 - This example will create a list of strings but the data that can be stored in each list element is quite flexible (class Object).
- Scrollbars are NOT automatically included (you need to add a JList reference to the constructor of a class that provides scrolling capabilities).
- For the complete class refer to the url:
 - <http://java.sun.com/javase/7/docs/api/>
- For online tutorials (Sun):
 - <http://download.oracle.com/javase/tutorial/uiswing/components/list.html>

James Tam

Some Important Parts Of The List Class

```
class JList
{
    // The data for the list is stored by another class (some form of ListModel).
    // Returns a reference to the model (needed to add/remove elements).
    ListModel getModel ()

    // Creates a list whose data is an array of objects.
    public ListModel (Object [] listData)

    // Creates an empty list with the data managed by specified model
    public ListModel (ListModel dataModel1)

    // Passes an instance of a class that reacts to list events.
    addListSelectionListener(ListSelectionListener listener)
```

¹ The data model is what manipulates the list data. Common options *DefaultListModel*, *ListModel*

Some Important Parts Of The List Class (2)

```
    // Determines the number of rows that appear..
    setVisibleRowCount (int count)

    // Determine the index of the selected element
    int getSelectedIndex ()

}
```

Adding Scrolling Capability

- As you create an instance of the class that provides scrolling capabilities pass in a reference to the list in the scrolling classes' constructor.
 - E.g., JScrollPane (<reference to the List>)
- Then add an instance of this scrolling class to the Frame (or the appropriate container).
 - E.g., aFrame.add (<reference to the scrolling object>)

James Tam

Adding/Removing Elements

- As previously mentioned the ListModel (and not the list) is responsible for manipulating (adding/removing) the list data.
- In order to change the list's membership you need to first get a reference to the list model.
 - E.g., aModel = aList.getModel ()
- Then you can call the appropriate method of the ListModel.
 - Add: aModel.addElement (<object>)
 - Remove: aModel.removeElementAt (<index or object>)

James Tam

An Example Employing A List

- Location of the example:

/home/233/examples/gui/ninth_JList

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/gui/ninth_JList

James Tam

An Example Employing A List: The Driver Class

```
public class Driver
{
    public static final int WIDTH = 400;
    public static final int HEIGHT = 300;
    public static void main (String [] args)
    {
        MyFrame aFrame = new MyFrame ();
        aFrame.setSize(WIDTH,HEIGHT);
        aFrame.setVisible(true);
    }
}
```

James Tam

An Example Employing A List: Class MyFrame

```
public class MyFrame extends JFrame
{
    private JLabel listLabel;
    private JLabel textLabel;
    private JList aList;
    private GridBagLayout aLayout;
    private GridBagConstraints aConstraint;
    private JTextField aTextField;

    public static final int MAX_VISIBLE_ROWS = 3;
    public static final int MAX_ELEMENTS = 10;
```

James Tam

An Example Employing A List: Class MyFrame (2)

```
public MyFrame ()
{
    MyWindowListener aWindowListener = new MyWindowListener ();
    Object anObject;
    String aString;
    DefaultListModel aModel;
    int size;

    addWindowListener(aWindowListener);
    aConstraint = new GridBagConstraints();
    aList = new JList(new DefaultListModel ());
    initializeList();
    aList.setSelectedIndex(0);
    aTextField = new JTextField ();
    aModel = (DefaultListModel) aList.getModel();
    size = aModel.getSize();
    anObject = aModel.getElementAt(0);
```

James Tam

An Example Employing A List: Class MyFrame (3)

```
if (anObject instanceof String)
{
    aString = (String) anObject;
    aTextField.setText(aString);
}
aList.setVisibleRowCount(MAX_VISIBLE_ROWS);
aList.addListSelectionListener(new MyListListener());
listLabel = new JLabel(Integer.toString(size));
textLabel = new JLabel ("Currently selected item");

aLayout = new GridBagLayout();
setLayout(aLayout); // Calling method of super class.
addWidget(listLabel, 0, 0, 1, 1, GridBagConstraints.NONE);
addWidget(textLabel, 3, 0, 1, 1, GridBagConstraints.NONE);
addWidget(new JScrollPane(aList), 0, 1, 2, 3,
    GridBagConstraints.HORIZONTAL);
addWidget(aTextField, 3, 1, 1, 1, GridBagConstraints.HORIZONTAL);
}
```

James Tam

An Example Employing A List: Class MyFrame (4)

```
public void addWidget (Component widget, int x, int y, int w, int h, int fill)
{
    aConstraint.gridx = x;
    aConstraint.gridy = y;
    aConstraint.gridwidth = w;
    aConstraint.gridheight = h;
    aConstraint.fill = fill;
    aLayout.setConstraints (widget, aConstraint);
    add(widget); // Calling method of super class.
}
```

James Tam

An Example Employing A List: Class MyFrame (5)

```
public void initializeList ()
{
    int i;
    DefaultListModel aModel = (DefaultListModel) aList.getModel ();
    for (i = 1; i <= MAX_ELEMENTS; i++)
        aModel.addElement(new String(Integer.toString(i * 10)));
}

public JTextField getTextField ()
{
    return aTextField;
}
```

James Tam

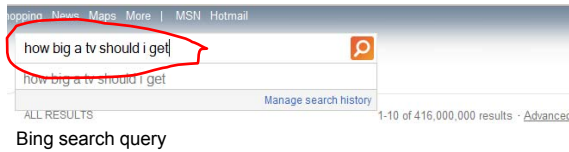
An Example Employing A List: Private Inner Class (MyListListener)

```
private class MyListListener implements ListSelectionListener
{
    public void valueChanged(ListSelectionEvent e) {
        JList aList = (JList)e.getSource();
        int index = aList.getSelectedIndex();
        DefaultListModel aModel = (DefaultListModel) aList.getModel();
        Object anObject = aModel.getElementAt(index);
        if (anObject instanceof String) {
            String aString = (String) anObject;
            MyFrame aFrame = (MyFrame) aList.getRootPane().getParent();
            JTextField aTextField = aFrame.getTextField();
            aTextField.setText(aString);
        }
    }
}
```

James Tam

JTextField

- Frequently used to get short user input
 - e.g., entering login or personal information.



- Getting more extensive input
 - e.g., feedback form, user review/comments on a website
 - Requires the use of another control: JTextArea



James Tam

Capturing JTextField Events

- Location of the example:
 - /home/233/examples/gui/tenth_JTextField
 - OR
 - www.cpsc.ucalgary.ca/~tamj/233/examples/gui/tenth_JTextField

James Tam

Capturing TextFieldEvents: Class MyFrame

```
public class MyFrame extends JFrame
{
    private JLabel instructions;
    private JTextField inputField;
    public MyFrame ()
    {
        setLayout(null);
        instructions = new JLabel("Enter some text below and hit return");
        instructions.setBounds(20,100,200,20);
        inputField = new JTextField();
        inputField.setBounds(20,150,200,20);
    }
}
```

James Tam

Capturing TextFieldEvents: Class MyFrame (2)

```
inputField.addActionListener (
    new ActionListener()
    {
        public void actionPerformed (ActionEvent e)
        {
            JTextField aTextField = (JTextField) e.getSource ();
            MyFrame aFrame = (MyFrame)
                aTextField.getRootPane().getParent ();
            aFrame.setTitle (aTextField.getText());
        }
    } );
add(instructions);
add(inputField);
setVisible(true);
}
```

James Tam

Important Concepts And Terms

- GUI
- Event-based software
- Registering listeners
- Call back (event-to-code)

James Tam

References

- Books:
 - “*Java Swing*” by Robert Eckstein, Marc Loy and Dave Wood (O’Reilly)
 - “*Absolute Java*” (4th Edition) by Walter Savitch (Pearson)
 - “*Java: How to Program*” (6th Edition) by H.M. Deitel and P.J. Deitel (Pearson)
- Websites:
 - Java API specifications: <http://download.oracle.com/javase/7/docs/api/>
 - Java tutorials: <http://download.oracle.com/javase/tutorial/uiswing/>
 - Java tutorial (layout):
<http://docs.oracle.com/javase/tutorial/uiswing/layout/using.html>

James Tam

You Should Now Know

- The difference between traditional and event driven software
- How event-driven software works (registering and notifying event listeners)
- How some basic Swing controls work
 - Capturing common events for the controls such as a button press
- How to layout components using layout managers and laying them out manually using a coordinate system