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

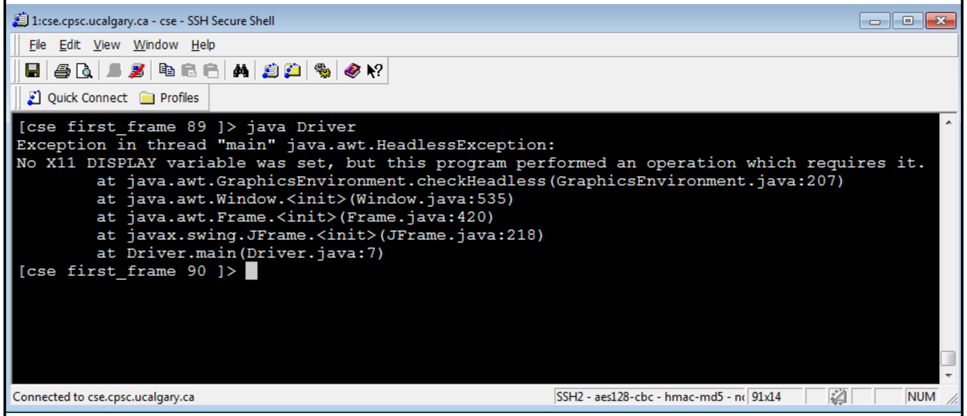
Tip For Success: Reminder

- Look through the examples and notes before class.
- This is especially important for this section because the execution of this programs will not be in sequential order.
- Instead execution will appear to 'jump around' so it will be harder to understand the concepts and follow the examples illustrating those concepts if you don't do a little preparatory work.
- Also the program code is more complex than most other examples.
- For these reasons tracing the code in this section is more challenging

James Tam

Don’t Run The GUI Code Via SSH!

- The former is graphical
- The latter is text-only


1:cse.cpsc.ucalgary.ca - cse - SSH Secure Shell
File Edit View Window Help
Quick Connect
Profiles

```
[cse first_frame 89 ]> java Driver
Exception in thread "main" java.awt.HeadlessException:
No X11 DISPLAY variable was set, but this program performed an operation which requires it.
        at java.awt.GraphicsEnvironment.checkHeadless(GraphicsEnvironment.java:207)
        at java.awt.Window.<init>(Window.java:535)
        at java.awt.Frame.<init>(Frame.java:420)
        at javax.swing.JFrame.<init>(JFrame.java:218)
        at Driver.main(Driver.java:7)
[cse first_frame 90 ]>
```

Connected to cse.cpsc.ucalgary.ca   SSH2 - aes128-cbc - hmac-md5 - n   91x14   NUM

James Tam

Options: Writing GUI Code At Home

1. Install JDK on your home computer: edit, compile and run your programs locally.
2. Use JDK on the CPSC network:
   a) Edit and compile your programs on the CPSC network using a remote login program (such as Putty) and a text-based editor (such as Emacs). The java compiler is called: javac
   b) Transfer your compiled byte code files (`.class`) from your CPSC UNIX account to your home computer by using the drive mapping technique (taught to you in tutorial).
   c) Alternatively to (b) you can use a file transfer program (e.g., Filezilla, secure FTP) although you will have learn its usage on your own.
   d) On your home computer open a command line (‘cmd’ in Windows) and run the java interpretter: java (Because program execution is occuring locally the graphics will be drawn by your computer and not via the remote login program).

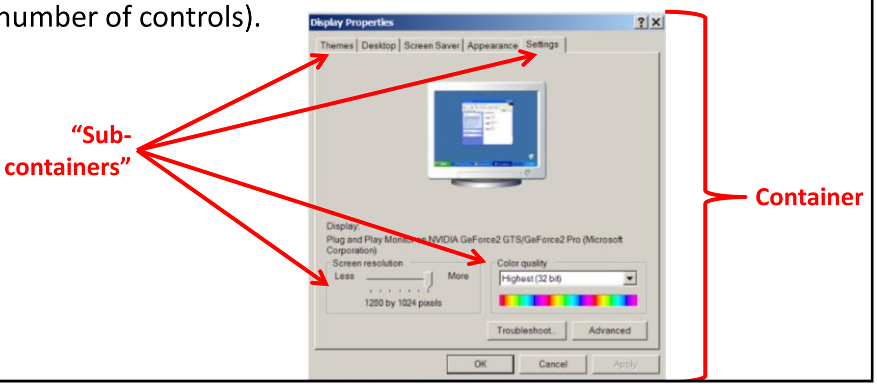
James Tam

Components

- They are many types of graphical controls and displays available:
  - `JButton, JFrame, JLabel, JList, JTextArea, Window`
- A graphical component is also known as a “widget”
- 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`).

Containers

- A special type of `Component` that is used to hold/contain other 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).



Display:
Plug and Play Monitor on NVIDIA GeForce2 GTS/GeForce2 Pro (Microsoft Corporation)
Screen resolution: 1280 by 1024 pixels
Color quality: Highest (32 bit)

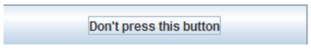
Containers (2)

- You must have at least one container object for your GUI:
  - Examples: JPanel, JWindow, JDialog, JFrame
  - (The most likely one for the assignment is `JFrame`)
- Components which have been added to a container will appear/disappear and be garbage collected along with the container.

James Tam

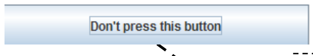
Some Relevant Java GUI libraries

1. Java classes for the `Components` and `Containers`
   - e.g., `JButton` class…
   - …located in `javax.swing` (`import javax.swing.*` or `import javax.swing.<class name>`)



Some Relevant Java GUI libraries (2)

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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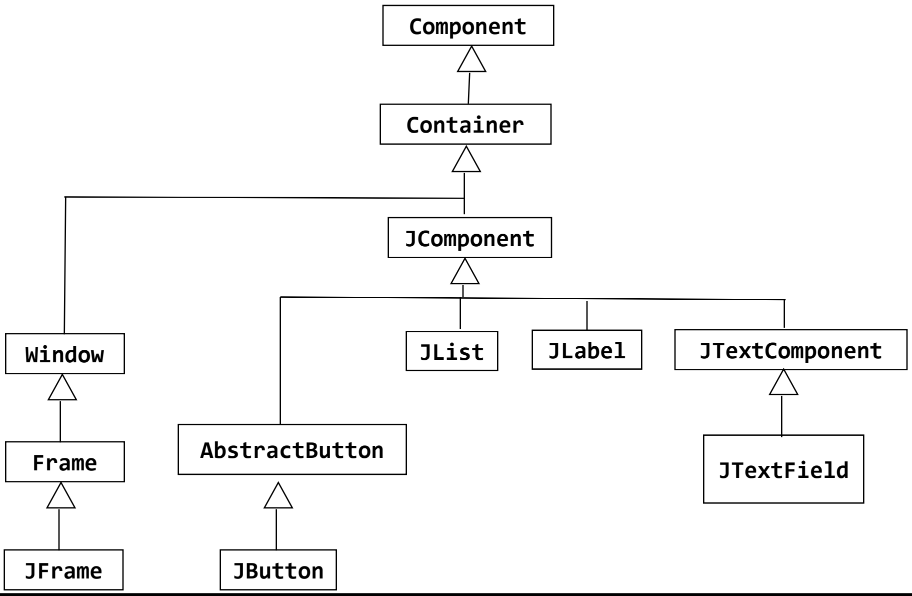
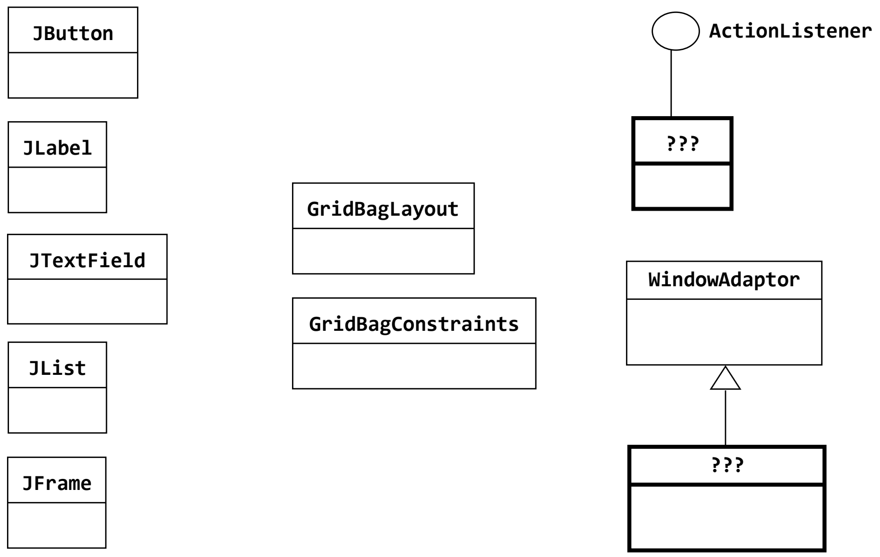
Hierarchy: Important Widget Classes



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

Traditional Software

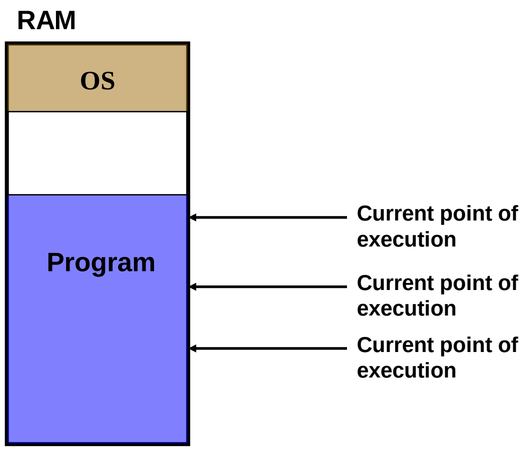
- The user can only interact with the program at places that are specified by the program (e.g., when an input statement is encountered).

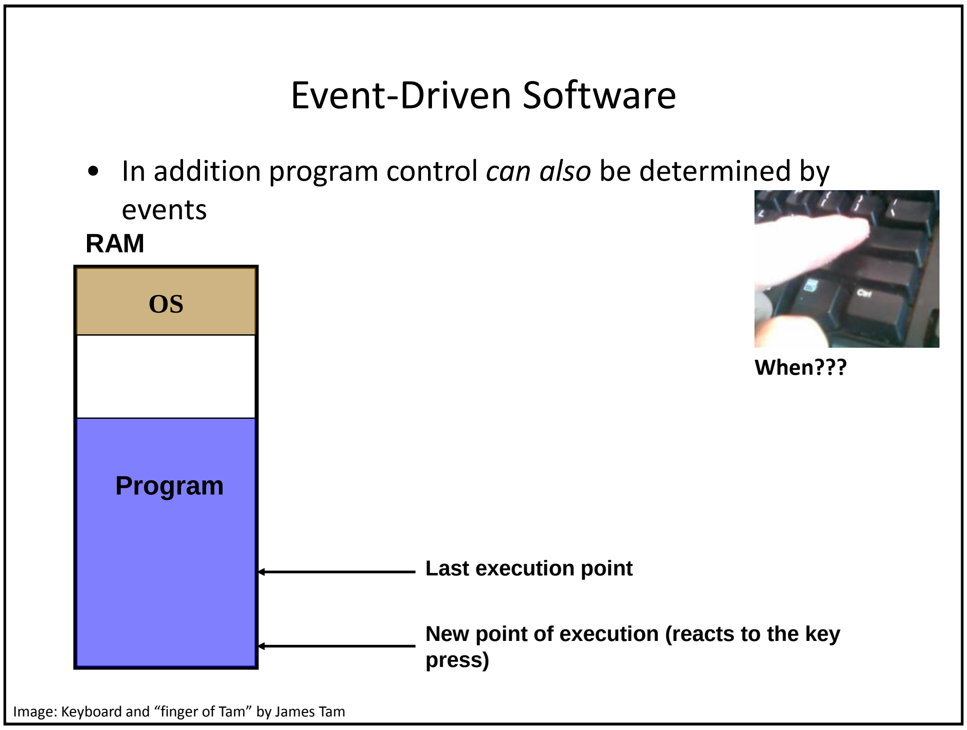
Example

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

Event-Driven Software

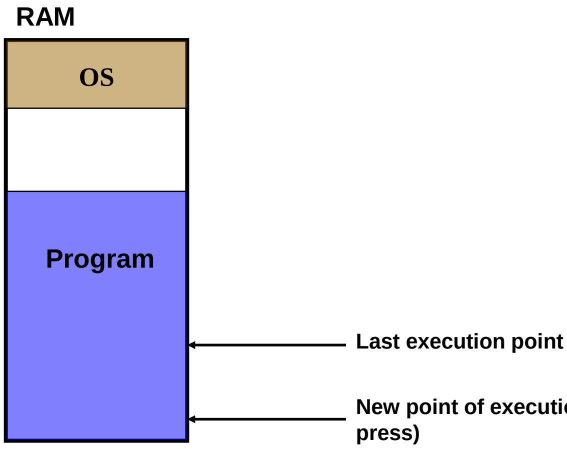
- Program control can also be sequential


RAM
OS
Program
Current point of execution
Current point of execution
Current point of execution



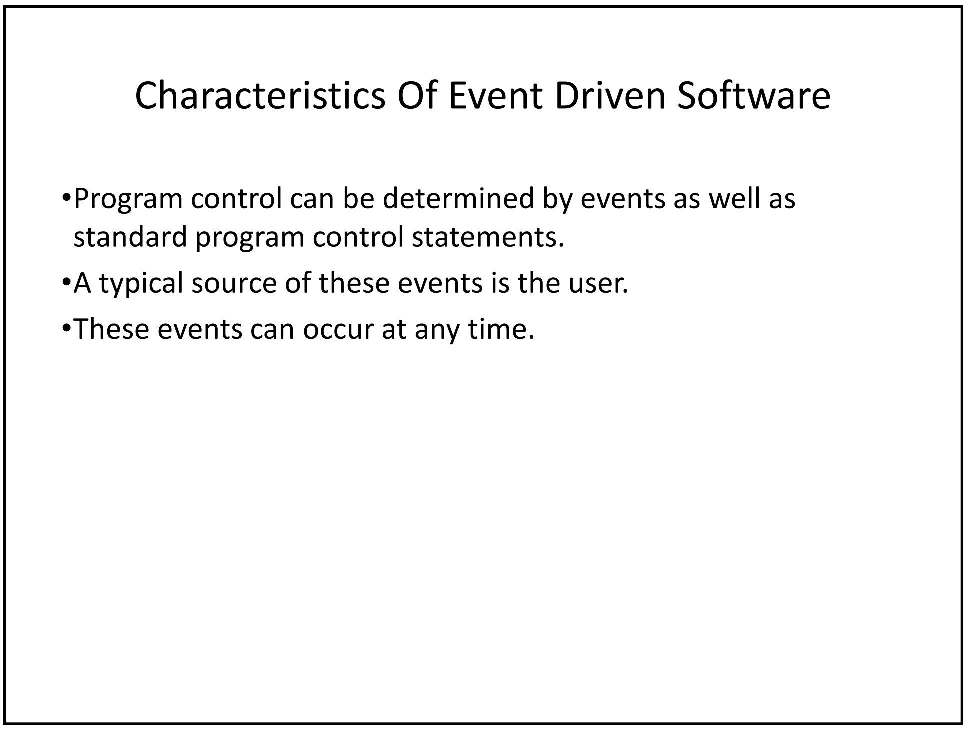
Event-Driven Software

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



When???

Image: Keyboard and "finger of Tam" by James Tam



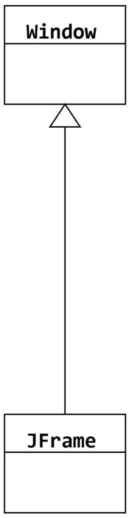
Characteristics Of Event Driven Software

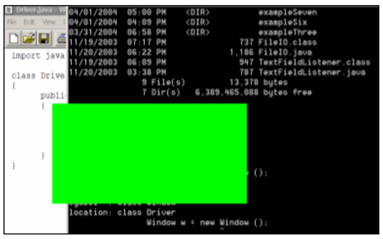
- Program control can be determined by events as well as standard program control statements.
- A typical source of these events is the user.
- These events can occur at any time.

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.

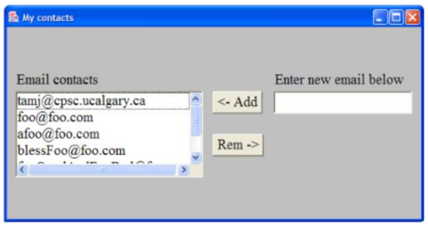
"Window" Classes





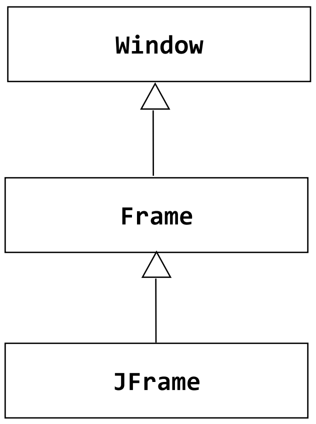
```
import java

class Drive
{
        publi
        {

        }
}
```

```
04/01/2004  05:00 PM    <DIR>          exampleSeven
04/01/2004  04:09 PM    <DIR>          exampleSix
03/31/2004  06:58 PM    <DIR>          exampleThree
11/19/2003  07:17 PM               737 FileIO.class
11/20/2003  06:22 PM             1,186 FileIO.java
11/19/2003  06:09 PM               947 TextFieldListener.class
11/20/2003  03:38 PM               787 TextFieldListener.java
               9 File(s)         13,378 bytes
               7 Dir(s)   6,389,465,088 bytes free

                                      ();

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



tamj@cpsc.ucalgary.ca
foo@foo.com
afoo@foo.com
blessFoo@foo.com

The “Window” Class Hierarchy



Class `JFrame`

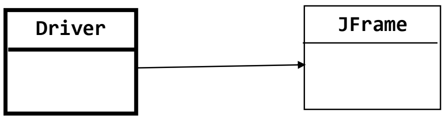
- For full details look at the online API:
  - http://download.oracle.com/javase/7/docs/api/javax/swing/JFrame.html

- 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**

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

- Location of the full example:
  `/home/233/examples/gui/1frame`



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

```
import javax.swing.JFrame;
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);
     }
}
```

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.

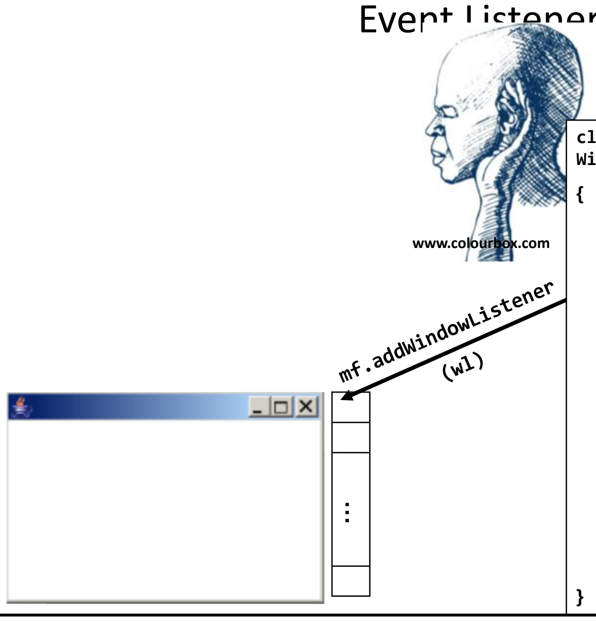
Window Events

- 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.

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

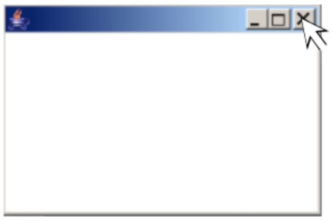
1) The frame must register all interested event listeners.
   – Track where notifications should be sent
2) The user triggers the event by closing the window
3) The window sends a message to all listeners of that event.
   – Send the notifications when the even occurs
4) The window event listener runs the code to handle the event (e.g., save information to a file).
   – When the object with an ‘interest’ in the event has been notified it executes a method appropriate to react to the event.

1. The Frame Must Register All Interested Event Listeners.

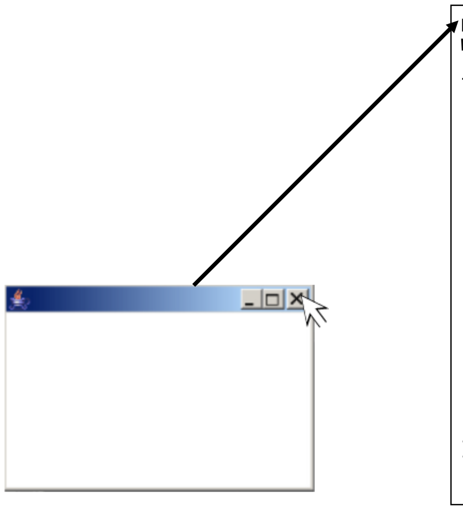


```
class MyWindowListener extends
WindowAdapter
{

}
```

2. The User Triggers The Event By Closing The Window

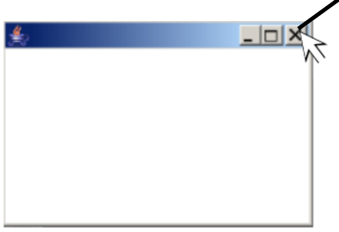


3. The Window Sends A Message To All Listeners Of That Event.



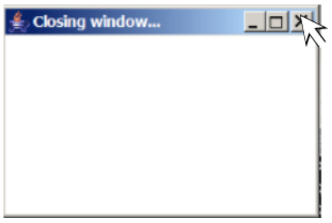
```
public class MyWindowListener extends
WindowAdapter
{
        public void windowClosing
           (WindowEvent e)
        {



         }
}
```

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...");
            aFrame.setVisible(false);
            aFrame.dispose();
        }
}
```

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

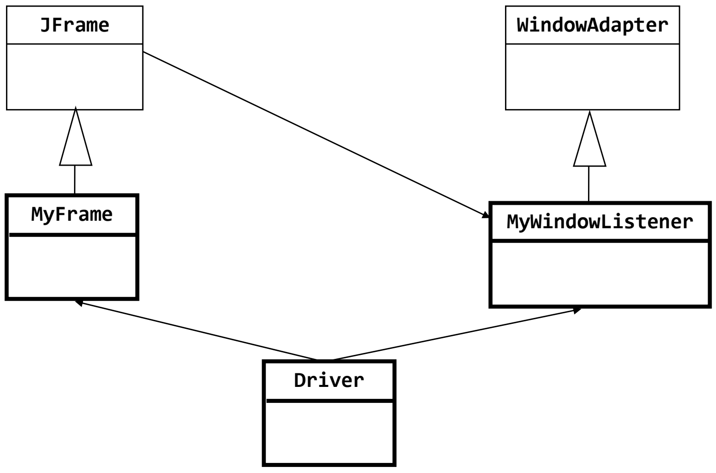


```
public class MyWindowListener extends
WindowAdapter
{
        public void windowClosing
          (WindowEvent e)
        {
            /* Code to react to event * /
            JFrame aFrame = (JFrame)
              e.getWindow();
            aFrame.setTitle("Closing
              window...");
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

An Example Of Handling A Frame Event

- Location of the example:
  `/home/233/examples/gui/2windowEvents`

An Example Of Handling A Frame Event (2)



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)
     {
         MyFrame aFrame = new MyFrame ();
         MyWindowListener aListener = new MyWindowListener() ;
         aFrame.addWindowListener(aListener);
         aFrame.setSize (WIDTH,HEIGHT);
         aFrame.setVisible(true);
     }
}
```

Class `MyFrame`

```
import javax.swing.JFrame;

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

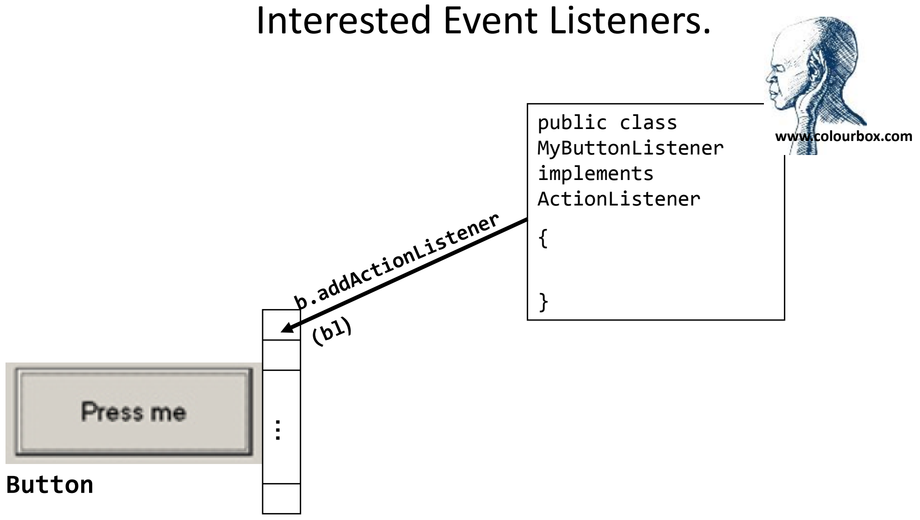
Class MyWindowListener

```
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...");
           // Pause program so user can see the window text
           try
               Thread.sleep(3000);
           catch (InterruptedException ex)
               System.out.println("Pausing of program was
                 interrupted");
           aFrame.setVisible(false);
           aFrame.dispose();
        }
}
```

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.

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

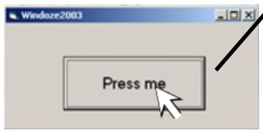


```
public class
MyButtonListener
implements
ActionListener
{

}
```

2. The User Triggers An Event By Pressing The Button

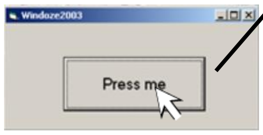
3. The Component Sends A Message To All Registered Listeners For That Event

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


    }
}
```

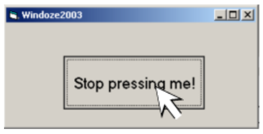


3. The Component Sends A Message To All Registered Listeners For That Event

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



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

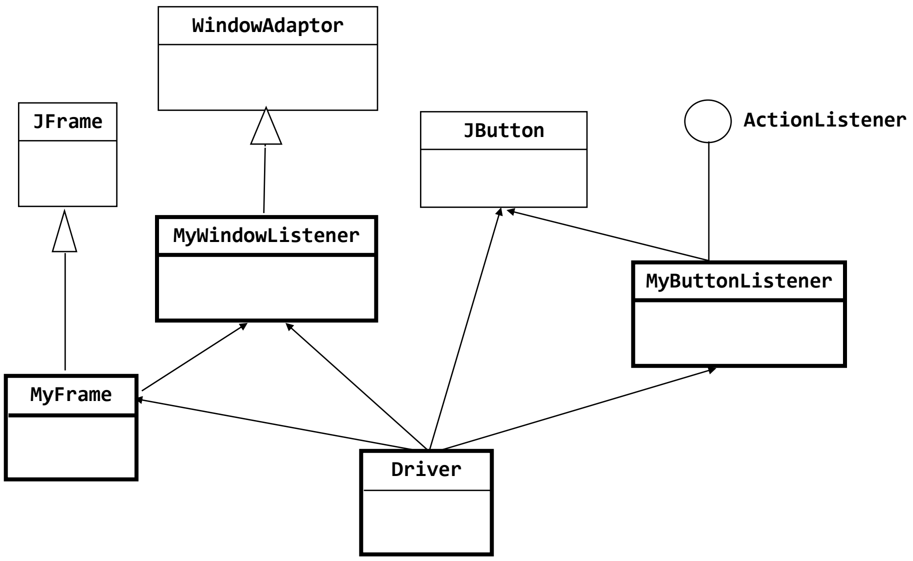


```
public class MyButtonListener
implements ActionListener
{
    public void actionPerformed
      (ActionEvent e)
    {
        JButton b = (JButton)
          e.getSource();
        b.setLabel("Stop pressing
         me!");
    }
}
```

An Example Of Handling A Button Event

- Location of the example:
  `/home/233/examples/gui/3ButtonEvents`

An Example Of Handling A Button Event (2)



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);
```

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);
      }
}
```

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!");
    }
}
```

How To Handle The Layout Of Components

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

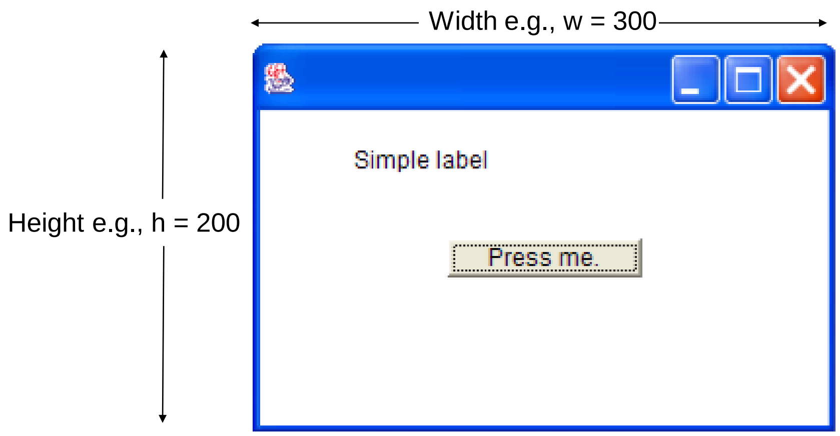
How To Handle The Layout Of Components

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

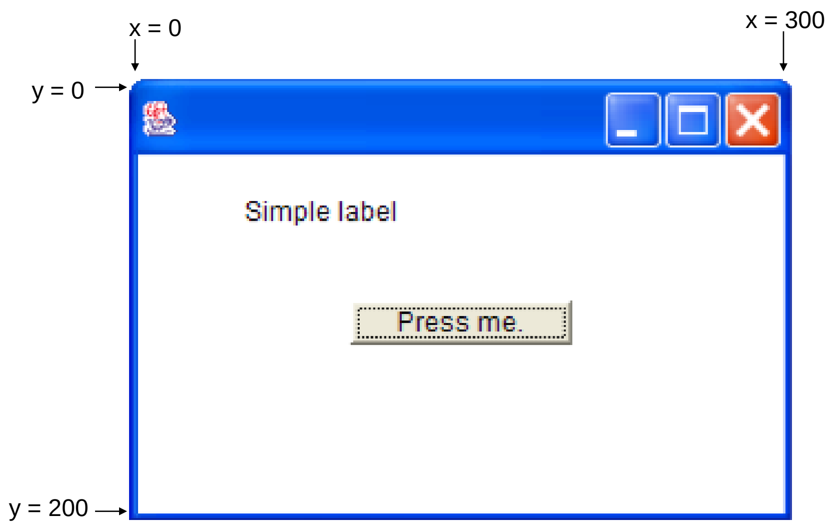
Layout Is Based On Spatial (X,Y) Coordinates

e.g. `MyFrame my =new MyFrame ();`

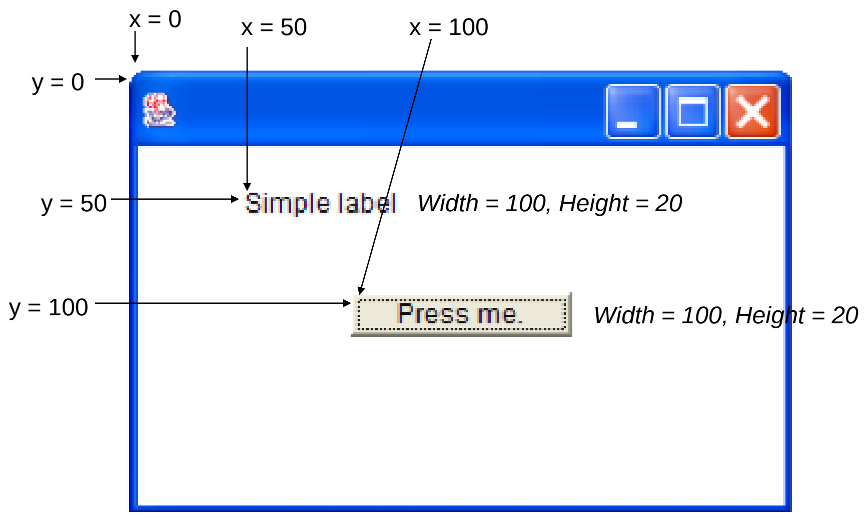
```
    my.setSize(300,200);
```



Layout Is Based On Spatial Coordinates



Coordinates Of Components: Relative To The Container



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.

A Example With Manual Layout

- Location of the example:

```
/home/233/examples/gui/4manualLayout
```

An Example With 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;
```

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

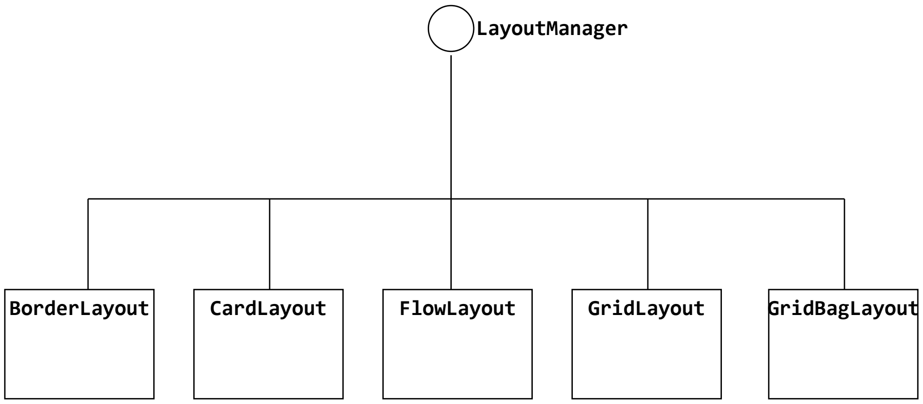
```
    public static void main (String [] args) {
        JFrame aFrame = new JFrame ();
        aFrame.setLayout(null);
        aFrame.setSize (WIDTH_FRAME,HEIGHT_FRAME);
        JButton aButton = new JButton("Press me.");
        aButton.setBounds(X_COORD_BUTTON,
                          Y_COORD_BUTTON,
                          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);
    }
}
```

How To Handle The Layout Of Components

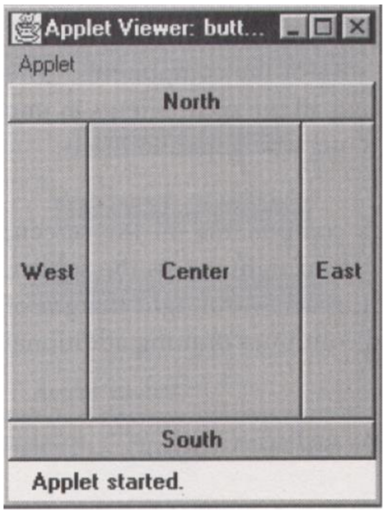
1. Manually set the coordinates yourself
2. **Use one of Java's built-in layout manager classes**

Java Layout Classes

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

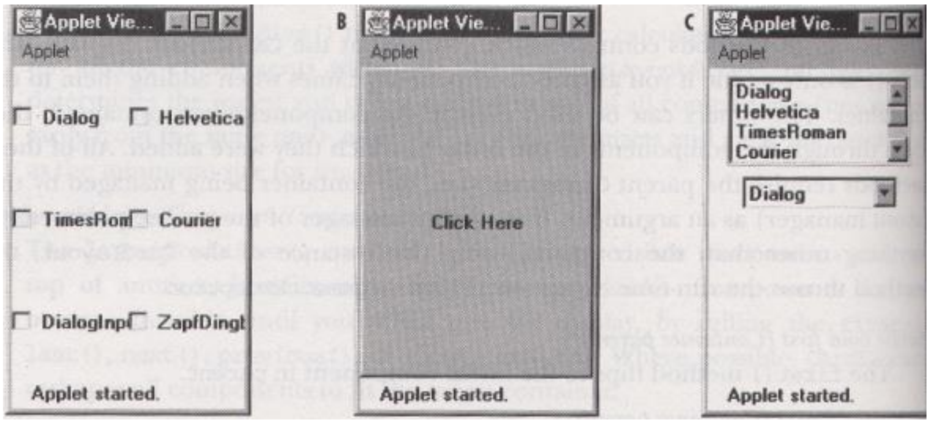


`BorderLayout` ("Compass Directions")



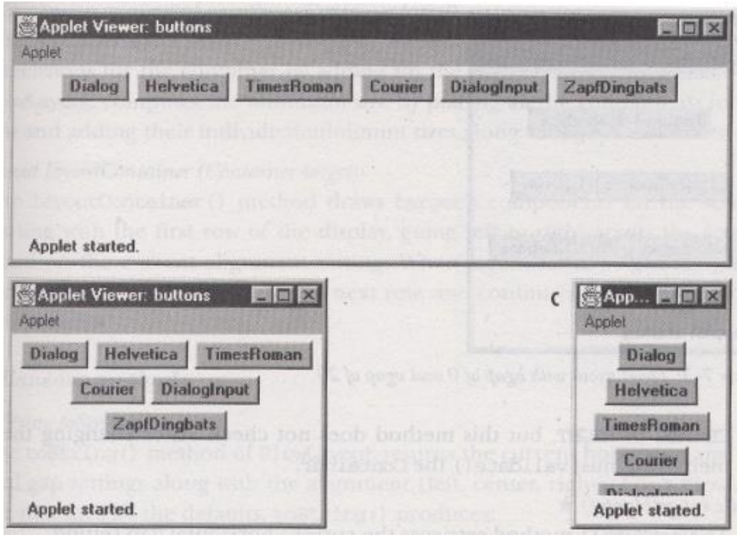
From Java: AWT Reference p. 256

CardLayout ("Tab-Like")



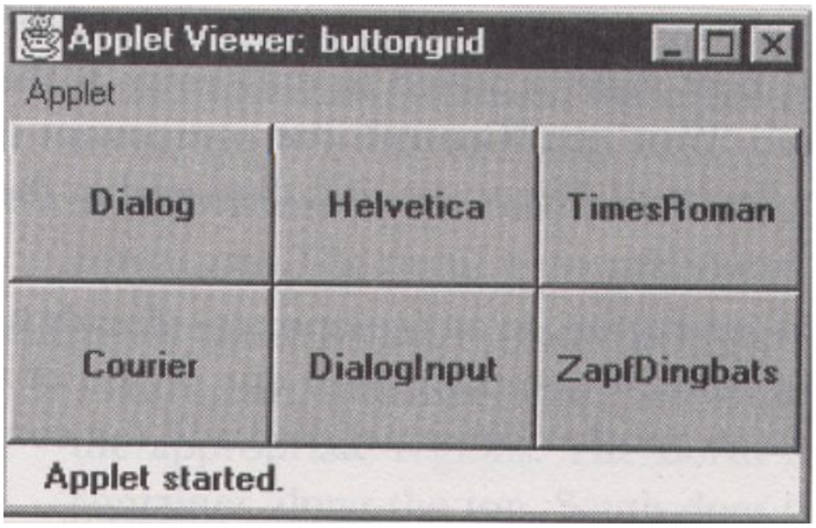
From Java: AWT Reference p. 264

FlowLayout (Adapts To Resizing "Web-Like")



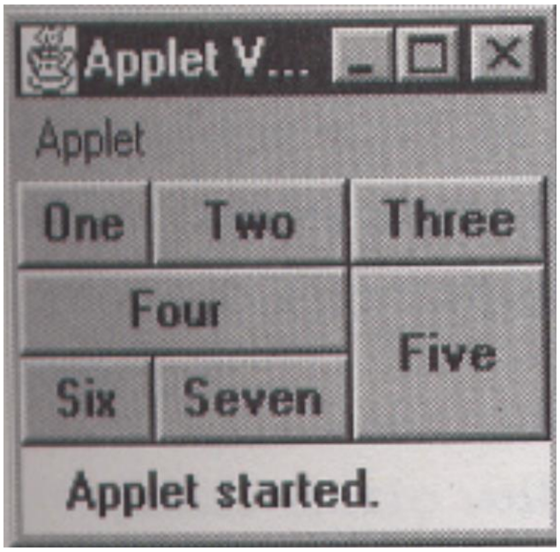
From Java: AWT Reference p. 253

GridLayout



From Java: AWT Reference p. 260

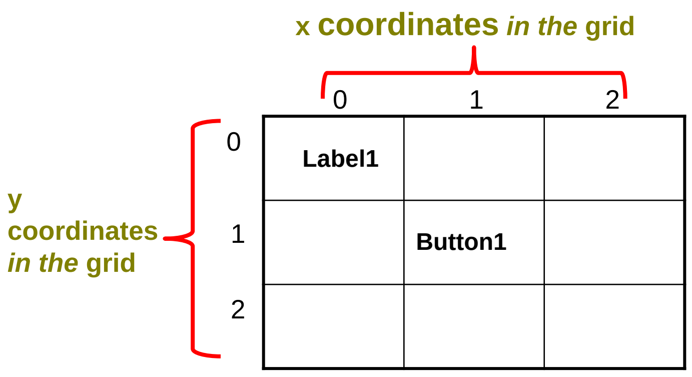
GridBagLayout



From Java: AWT Reference **p. 269**

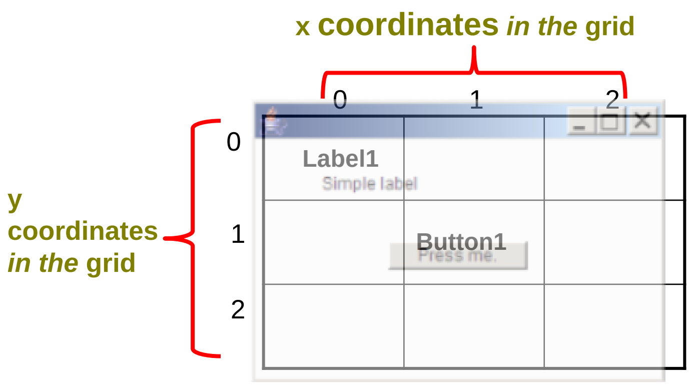
Implementing A GUI When Using The `GridBagLayout`

- Use graph paper or draw out a table.



Implementing A GUI When Using The `GridBagLayout`

- Use graph paper or draw out a table.



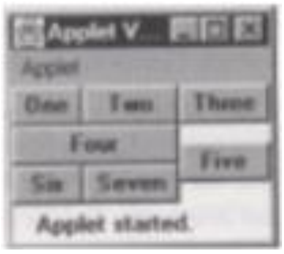
GridBagConstraints

- 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 for a particular `GridBagLayout`.
- For more complete information see:
  - *http://java.sun.com/javase/7/docs/api/java/awt/GridBagConstraints.html*

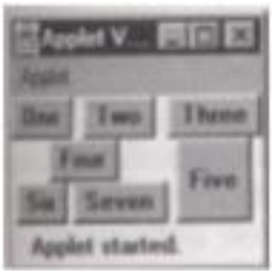
Some Important Parts Of The GridBagConstraints Class

```
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;
```

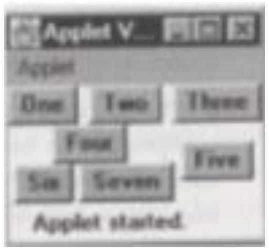
`GridBagContraints`: Fill Values



Horizontal



Vertical



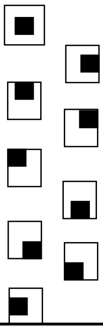
None

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;
```

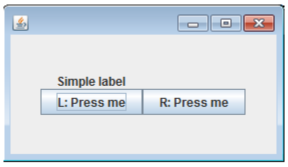
Some Important Parts Of The GridBagConstraints Class (3)

```
// 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;

// Only if the component is smaller than the available space.
// Determine the anchor direction
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;
```

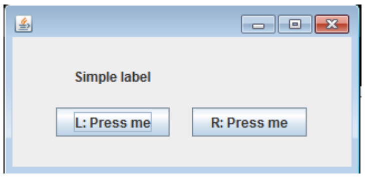


Some Important Parts Of The GridBagConstraints Class (4)

```
// With a particular 'cell' in the grid this attribute
// specifies the amount of padding around the component
// to separate it from other components.
// Usage:
// insets = new Insets(<top>,<left>,<bottom>,<right>);
// Example (Set top, left, bottom, and right)
// insets = new Insets(0, 0, 0, 0); // No padding (default)
public insets;
```



Insets = 0: no padding



Insets = 10: many spaces/padding

An Example Using The `GridBagLayout`

•Location of the example:
`/home/233/examples/gui/5gridbaglayout`

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);
     }
}
```

An Example Using The GridBagLayout: Class MyFrame

```
public class MyFrame extends Jframe {
    private JButton left;
    private JButton right;
    private JLabel aLabel;
    private GridBagLayout aLayout;
    GridBagConstraints aConstraint;

    public MyFrame () {
        MyWindowListener aWindowListener = new MyWindowListener ();
        addWindowListener(aWindowListener);
        aConstraint = new GridBagConstraints();
        Scanner in = new Scanner(System.in);
        System.out.print("Buffer size to pad the grid: ");
        int padding = in.nextInt();
```

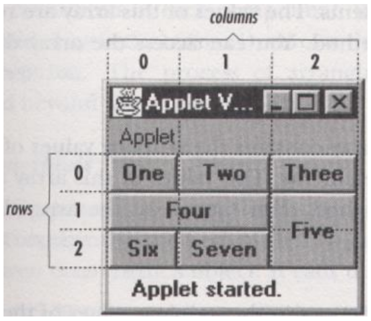
An Example Using The GridBagLayout: Class MyFrame (2)

```
        left = new JButton("L: Press me");
        right = new JButton("R: Press me");
        MyButtonListener aButtonListener = new MyButtonListener();
        left.addActionListener (aButtonListener);
        right.addActionListener (aButtonListener);
        aLabel = new JLabel("Simple label");
        aConstraint.insets = new
           Insets(padding,padding,padding,padding);
        aLayout = new GridBagLayout();
        setLayout(aLayout);     // Calling method of super class.
        addWidget(aLabel, 0, 0, 1, 1);
        addWidget(left, 0, 1, 1, 1);
        addWidget(right, 1, 1, 1, 1);
    }
```

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);
        add(widget);        // Calling method of super class.
    }
} // End of definition for class MyFrame
```

Advanced Uses Of GridBagLayout



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

From Java: AWT Reference p. 269

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/

Components Effecting The State Of Other Components

- Location of the example: `/home/233/examples/gui/6controlAffectControls`

Components Effecting The State Of Other Components: The `Driver` Class

```
public class Driver
{
    public static final int WIDTH = 800;
    public static final int HEIGHT = 600;
    public static void main (String [] args)
    {
          MyFrame aFrame = new MyFrame ();
          aFrame.setSize(WIDTH,HEIGHT);
          aFrame.setVisible(true);
    }
}
```

Components Effecting The State Of Other Components: Class MyFrame

```
public class MyFrame extends JFrame
{
   private JLabel aLabel1;
   private JLabel aLabel2;
   private JButton aButton;
   private MyButtonListener aButtonListener;
```

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

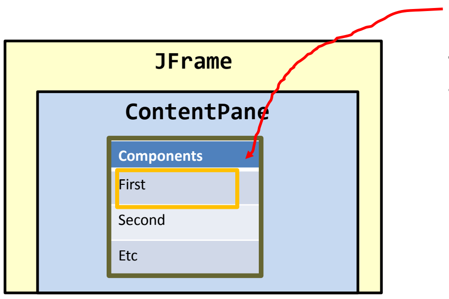
```
public MyFrame ()
{
      MyWindowListener aWindowListener =
        new MyWindowListener();
      addWindowListener(aWindowListener);
      aLabel1 = new JLabel("Label 1");
      aLabel2 = new JLabel("Label 2");
      aLabel1.setBounds(100,100,100,30);
      aLabel2.setBounds(300,100,100,30);
```

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

```
      aLabel1 = new JLabel("Label 1");
      aLabel2 = new JLabel("Label 2");
      aLabel1.setBounds(100,100,100,30);
      aLabel2.setBounds(300,100,100,30);
      aButtonListener = new MyButtonListener();
      aButton = new JButton("Press for multiple effects");
      aButton.addActionListener(aButtonListener);
      aButton.setBounds(150,300,200,50);
      add(aLabel1);
      add(aLabel2);
      add(aButton);
      setLayout(null);
    }
    public JLabel getLabel1 () { return aLabel1; }
    public JLabel getLabel2 () { return aLabel2; }
}
```

Note: JFrame Containment

- A JFrame actually contains just one GUI component, the content pane.
- GUI widgets that appear to be added to the JFrame are actually added to the content pane (a container in and of itself). Get the components inside the content pane to actually get the widgets that appeared to be added to the JFrame.



To access controls "added to the frame"

```
aContainer = aFrame.getContentPane()
component = aContainer.getComponent(0)
```

James Tam

Components Effecting The State Of Other Components: Class MyButtonListener

```
public void actionPerformed (ActionEvent e)
{
        JButton aButton = (JButton) e.getSource();
        MyFrame aFrame = (MyFrame)
          aButton.getRootPane().getParent();
        JLabel aLabel1 = aFrame.getLabel1();
        JLabel aLabel2 = aFrame.getLabel2();

        Container aContainer = aFrame.getContentPane();
        // First item added to list, first label
        Component aComponent = aContainer.getComponent(0);
        if (aComponent instanceof JLabel) {
            aLabel1 = (JLabel) aComponent;
            aLabel1.setText("Effect1");
        }
```

James Tam

Components Effecting The State Of Other Components: Class `MyButtonListener` (2)

```
        // Second item added to list, second label
        aComponent = aContainer.getComponent(1);
        if (aComponent instanceof JLabel) {
            aLabel2 = (JLabel) aComponent;
            aLabel2.setText("Effect1");
        }
}
```

James Tam

Last Example: Critique

- The implementation of the button listener class required knowledge of the implementation of the frame listener class.
  - The order in which controls are added to the frame must be known!
  - What if there are two different authors for these classes?
  - This approach couples the implementation of two classes (changes can introduce errors)

```
// From class MyFrame
 add(aLabel1);  // Added first
 add(aLabel2);  // Added second
 add(aButton);

// From class MyButtonListener
Component aComponent = aContainer.getComponent(0);
if (aComponent instanceof JLabel) {
    aLabel1 = (JLabel) aComponent;
    aLabel1.setText("Effect1");
}
```

Components Effecting The State Of Other Components: Alternate Approach

- Location of the example:
  `/home/233/examples/gui/7controlAffectControlsActionCommand`

The `Driver` Class

```
public class Driver
{
     public static final int WIDTH = 800;
     public static final int HEIGHT = 600;
     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 {
    public static final String B1IDENTIFIER = "1";
    public static final String B2IDENTIFIER = "2";
    private JButton button1;
    private JButton button2;
    private MyButtonListener aButtonListener;

    public MyFrame() {
        MyWindowListener aWindowListener = new
          MyWindowListener();
        addWindowListener(aWindowListener);
        aButtonListener = new MyButtonListener();
```

James Tam

Class MyFrame (2)

```
        button1 = new JButton("Button1");
        button1.setActionCommand(B1IDENTIFIER);
        button1.setBounds(100,100,100,30);
        button1.addActionListener(aButtonListener);

        button2 = new JButton("Button2");
        button2.setActionCommand(B2IDENTIFIER);
        button2.setBounds(300,100,100,30);
        button2.addActionListener(aButtonListener);

        add(button1);
        add(button2);
        setLayout(null);
    }

}
```

James Tam

Class MyButtonListener

- **Identifying the buttons**

```
public class MyButtonListener implements ActionListener
{
    public void actionPerformed(ActionEvent e)
    {
        JButton aButton = (JButton) e.getSource();
        MyFrame aFrame = (MyFrame)
          aButton.getRootPane().getParent();
        String temp = aButton.getActionCommand();
        if(temp.equalsIgnoreCase(MyFrame.B1IDENTIFIER))
            aFrame.setTitle("Button 1 pressed");
        else if(temp.equalsIgnoreCase(MyFrame.B2IDENTIFIER))
           aFrame.setTitle("Button 2 pressed");
    }
}
```

James Tam

This Version: 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 could get very long even though there are few sources of events (buttons)
  - What if the GUI has dozens of buttons or other controls

```
public void actionPerformed (ActionEvent e)
{
   String s = e.getActionCommand();

   if(temp.equalsIgnoreCase(MyFrame.B1IDENTIFIER))
       aFrame.setTitle("Button 1 pressed");
   else if(temp.equalsIgnoreCase(MyFrame.B2IDENTIFIER))
       aFrame.setTitle("Button 2 pressed");

}
```

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:

No reference name

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

```
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.

An Example Using Anonymous Class And Object

- Location of the example:

`/home/233/examples/gui/8controlAffectControlsAnonymousObjectClass`

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.setTitle("Original");
         aFrame.setSize(WIDTH,HEIGHT);
         aFrame.setVisible(true);
     }
}
```

Class MyFrame

```
public class MyFrame extends JFrame
{
    private JLabel aLabel;
    private GridBagLayout aLayout;
    private GridBagConstraints aConstraint;
    private JButton left;
    private JButton right;
    public MyFrame ()
```

Class MyFrame (2)

```
public MyFrame () {
    MyWindowListener aWindowListener =
      new MyWindowListener ();
    addWindowListener(aWindowListener);
    aConstraint = new GridBagConstraints();

   left = new JButton("LEFT: Press right button.");
   left.setBackground(Color.lightGray);
```

Class MyFrame (3)

```
   left.addActionListener(new ActionListener()
   {  // class definition
       public void actionPerformed(ActionEvent e)  {
           // method definition: left button
           JButton left = (JButton) e.getSource();
           MyFrame aFrame = (MyFrame)
             left.getRootPane().getParent();
           String title = aFrame.getTitle();
           aFrame.setTitle("Left pressed");
           right = aFrame.getRight();
           right.setBackground(Color.green);
           left.setBackground(Color.lightGray);
           timeDelay();
          aFrame.setTitle(title);
       } // End method definition
    } // End class definition
  ); // End of parameter list for addActionListener()
```

James Tam

Class MyFrame (4)

```
right = new JButton("RIGHT: Press left button");
right.setBackground(Color.lightGray);
right.addActionListener(new ActionListener()
{  // Class definition
    public void actionPerformed(ActionEvent e)  {
        // Method definition
        JButton right = (JButton) e.getSource();
        MyFrame aFrame = (MyFrame)
          right.getRootPane().getParent();
        String title = aFrame.getTitle();
        JButton left = aFrame.getLeft();
        aFrame.setTitle("Right pressed");
        left.setBackground(Color.green);
        right.setBackground(Color.lightGray);
        timeDelay();
        aFrame.setTitle(title);
    }
});
```

James Tam

Class MyFrame (5)

```
    private void timeDelay ()
    {
        try {
               Thread.sleep(3000);
        }
        catch (InterruptedException e) {
               System.out.println("Problem with pausing of the
                 program");
        }
    }
    public JButton getLeft() { return(left); }
    public JButton getRight() { return(right); }
}
```

James Tam

'Friend Functions'

- Some programming languages allow classes to be 'friendly'.
- A method can be declared in class X so it's accessible by another class Y even though the method is outside of the scope of class Y.
- The 'friendly' method of class X allows access to all of the privates & protected parts of X to instances of Y.
- It's used when instances of classes X & Y operate closely.
- Java does not directly allow for friend functions but other languages such as C++ do.
- Does this violate encapsulation?

James Tam

Nested/Inner Classes

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

```
public class X {
     private class Y {

     }
}
```

Outer class

Inner class

- Why nest class definitions[1]:
  - 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.

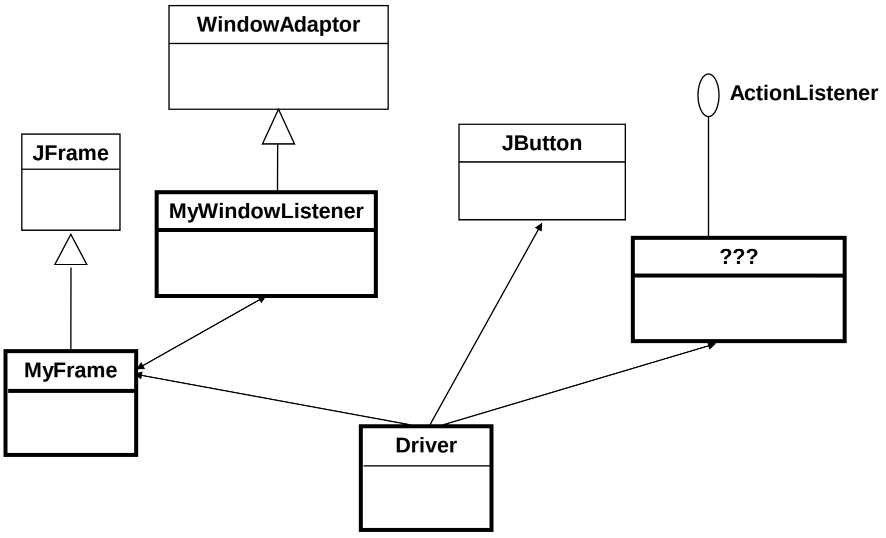
1 For more information: http://download.oracle.com/javase/tutorial/java/javaOO/nested.html

Example: Inner Classes

•Location Of example:

```
/home/233/examples/gui/9buttonAlternateInnerClasses
```

Example: Inner Classes (2)

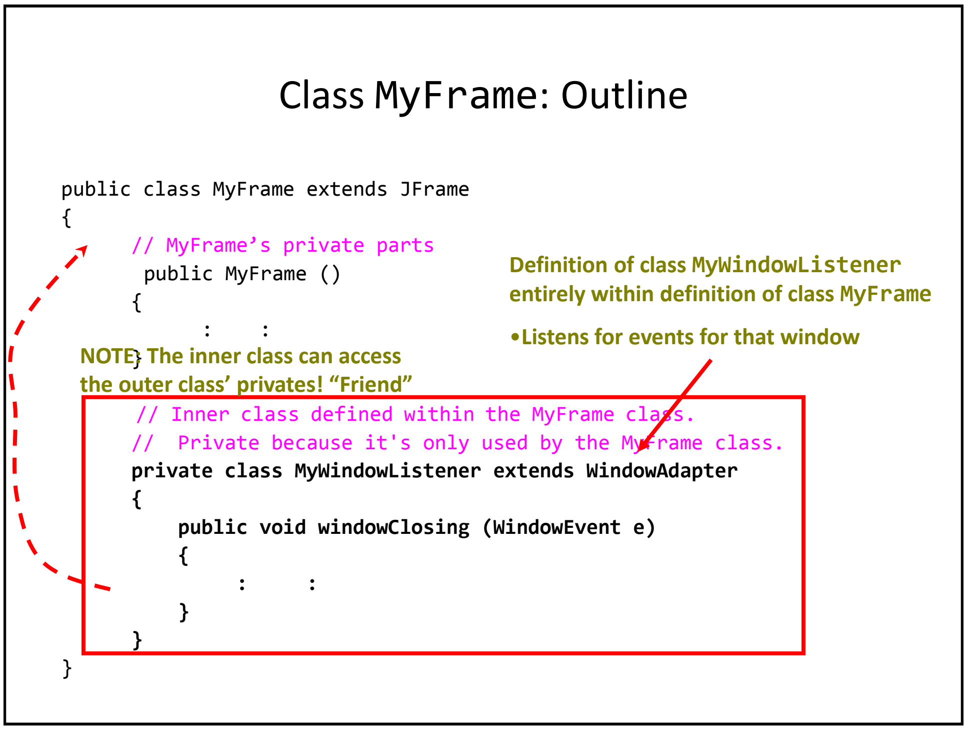


The Driver Class

```
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.");
```

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);
     }
}
```



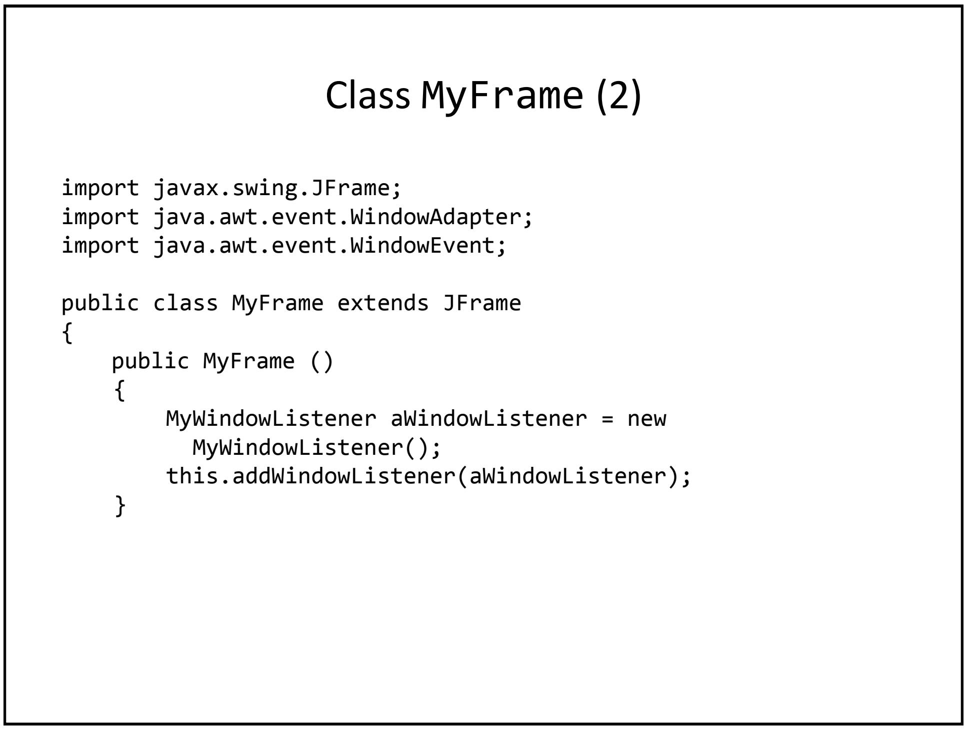
Class MyFrame: Outline

```
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)
           {
                :     :
           }
       }
}
```

Definition of class MyWindowListener entirely within definition of class MyFrame

- **Listens for events for that window**

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



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);
    }
```

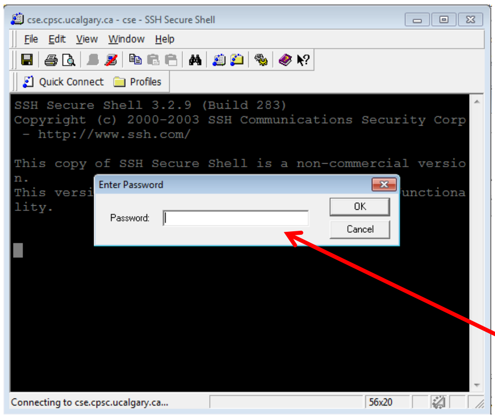
Class MyFrame (3)

```
    // 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

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

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

Dialog Boxes

- Typically take the form of a small window that 'pops up' during program execution.


cse.cpsc.ucalgary.ca - cse - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles
Enter Password
Password:
OK
Cancel
Connecting to cse.cpsc.ucalgary.ca...
56x20

```
SSH Secure Shell 3.2.9 (Build 283)
Copyright (c) 2000-2003 SSH Communications Security Corp
 - http://www.ssh.com/

This copy of SSH Secure Shell is a non-commercial versio
n.
This versi                             unctiona
lity.
```

Part of the login 'dialog'

James Tam

`JDialog` Example

- Location of the full example:
  `/home/233/examples/gui/10dialogExample`

James Tam

The `Driver` Class

```
public class Driver
{
    public static void main(String [] args)
    {
        MyDialog aDialog = new MyDialog();
        aDialog.setBounds(100,100,300,200);
        aDialog.setVisible(true);
    }
}
```

James Tam

Class MyDialog

```
public class MyDialog extends JDialog implements ActionListener
{
    private static final int MATCH = 0;
    private static final String ACTUAL_PASSWORD = "123456";
    private JPasswordField aPasswordField;
    private JLabel aLabel;

    public MyDialog() {
        aLabel = new JLabel("Enter password");
        aLabel.setBounds(50,20,120,20);
        aPasswordField = new JPasswordField();
        aPasswordField.setBounds(50,40,120,20);
        aPasswordField.addActionListener(this);  //Event handler
        setLayout(null);
        addControls();  // #2
        setDefaultCloseOperation(JDialog.DISPOSE_ON_CLOSE);
    }
```

James Tam

Class MyDialog (2)

```
    public void addControls()
    {
        add(aLabel);
        add(aPasswordField);
    }
```

James Tam

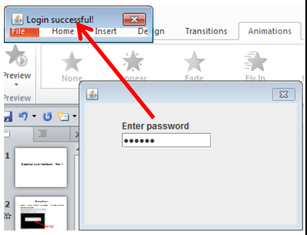
Class MyDialog (3)

```
public void actionPerformed(ActionEvent e) {
    Component aComponent = (Component) e.getSource();
    if (aComponent instanceof JPasswordField) {
        JPasswordField aPasswordField =
          (JPasswordField) aComponent;
        String passWordEntered = new
          String(aPasswordField.getPassword());
        if (passWordEntered.compareTo(ACTUAL_PASSWORD)
                                            == MATCH)
            loginSuccess();  // #4
        else
            loginFailed()
    }
}
```

James Tam

Class MyDialog (4)

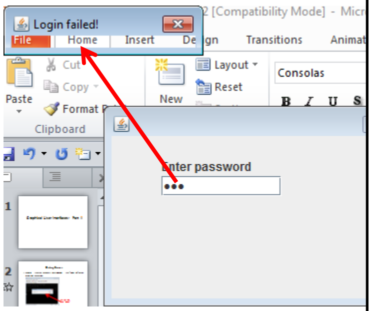
```
public void loginSuccess() {
    JDialog success = new JDialog();
    success.setTitle("Login successful!");
    success.setSize(200,50);
    success.setVisible(true);
    cleanUp(success);
}

public void cleanUp(JDialog popup) {
    try
        Thread.sleep(3000);
    catch (InterruptedException ex)
        System.out.println("Program interrupted");
    this.setVisible(false);
    this.dispose();
    popup.setVisible(false);
    popup.dispose();
    System.exit(0);  // Dialog cannot end whole program
}
```



James Tam

Class MyDialog (5)

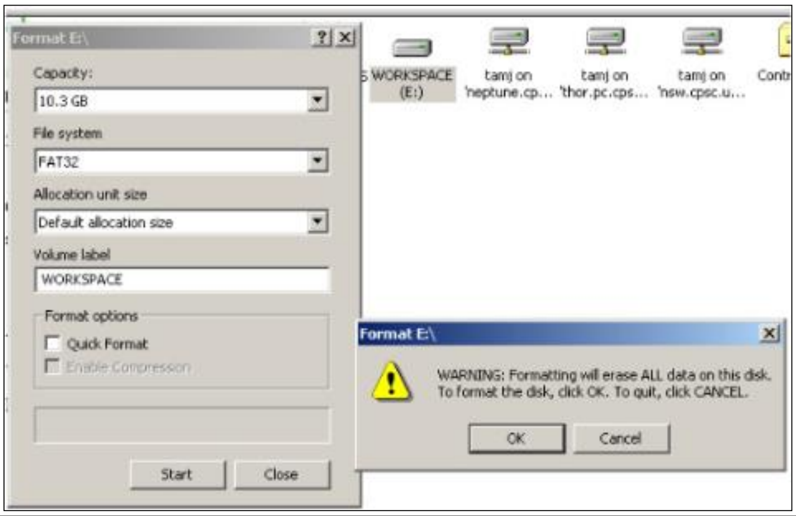
```
public void loginFailed()
{
    JDialog failed = new JDialog();
    failed.setTitle("Login failed!");
    failed.setSize(200,50);
    failed.setVisible(true);
    cleanUp(failed);
}
public void cleanUp(JDialog popup) {
    try
        Thread.sleep(3000);
    catch (InterruptedException ex)
        System.out.println("Program interrupted");
    this.setVisible(false);
    this.dispose();
    popup.setVisible(false);
    popup.dispose();
    System.exit(0);  // Dialog cannot end whole program
}
```



James Tam

Dialog Boxes And “User-Friendly Design”

- Note: used *sparingly* dialog boxes can communicate important information or to prevent unintentional and undesired actions.

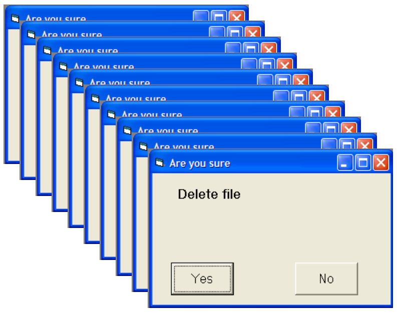


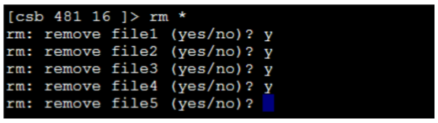
WARNING: Formatting will erase ALL data on this disk. To format the disk, click OK. To quit, click CANCEL.

James Tam

Dialog Boxes And "User-Friendly Design" (2)

- They interupt the regular use of the program so make sure they are only used sparingly
  - …they can easily be over/misused!)



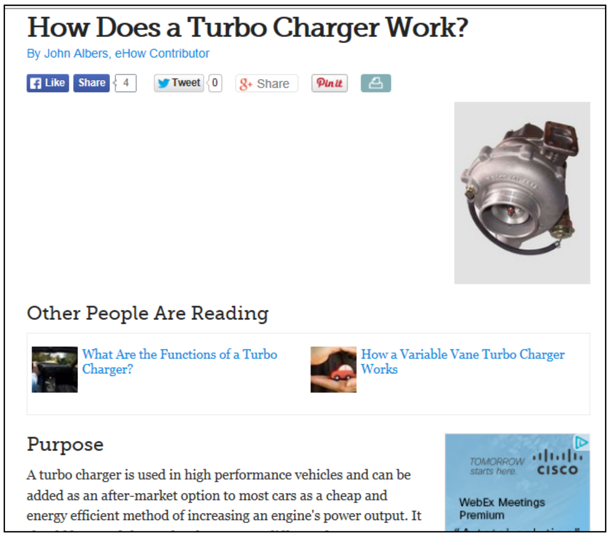


```
[csb 481 16 ]> rm *
rm: remove file1 (yes/no)? y
rm: remove file2 (yes/no)? y
rm: remove file3 (yes/no)? y
rm: remove file4 (yes/no)? y
rm: remove file5 (yes/no)?
```

James Tam

Dialogs Are Frequently Used Online

- Great! I've got the info that I need.



How Does a Turbo Charger Work?

By John Albers, eHow Contributor

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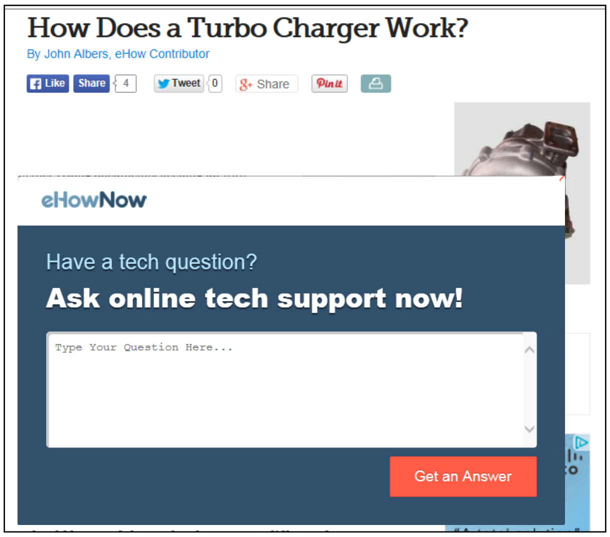
James Tam

Dialogs Are Frequently Used Online

- Hey I was reading that!



How Does a Turbo Charger Work?

By John Albers, eHow Contributor

eHowNow

Have a tech question?

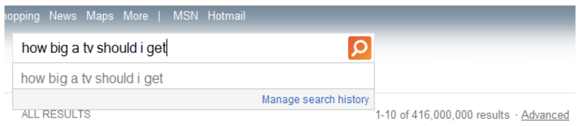
Ask online tech support now!

Type Your Question Here...

James Tam

Types Of Input Text Fields: Short

- `JTextField` (you already learned): Used to get short user input
  - e.g., entering login or personal information.



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opping News Maps More | MSN Hotmail
Manage search history
ALL RESULTS
1-10 of 416,000,000 results · Advanced

Bing search query

- Location of the full example:
  `/home/233/examples/gui/11textFieldExample`

James Tam

The Driver Class

```
public class Driver
{
    public static void main(String [] args)
    {
        MyFrame aFrame = new MyFrame();
    }
}
```

James Tam

Class MyFrame

```
public class MyFrame extends JFrame implements
ActionListener
{
    private JTextField text;
    private GridBagLayout aLayout;
    private GridBagConstraints aConstraint;
```

James Tam

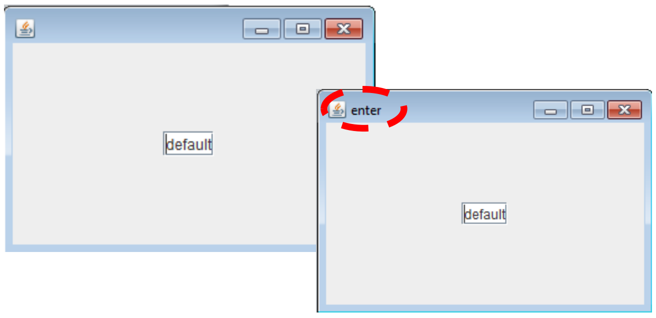
Class MyFrame: Using **JTextField**

```
public MyFrame()
{
  setSize(300,200);
  setDefaultCloseOperation
    (JFrame.DISPOSE_ON_CLOSE);
   aConstraint = new GridBagConstraints();
  aLayout = new GridBagLayout();
  setLayout(aLayout);
  text = new JTextField("default");
  text.addActionListener(this);
  addWidget(text,0,0,1,1);
  setVisible(true);
}
```

James Tam

Class MyFrame: **Reacting** To The Event

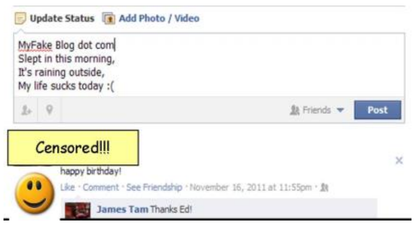
```
    public void actionPerformed(ActionEvent e)
    {
        setTitle("enter");
    }
}
```



James Tam

Types Of Input Text Fields: Long

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



MyFake Blog dot com
Slept in this morning,
It's raining outside,
My life sucks today :(

happy birthday!
Like · Comment · See Friendship · November 16, 2011 at 11:55pm
James Tam Thanks Ed!

Facebook status update field

- Location of the full example:
  `/home/233/examples/gui/12textAreaExample`

James Tam

The `Driver` Class: Using `JTextArea`

```
public class Driver {
    public static void main(String [] args) {
        JFrame frame = new JFrame();
        frame.setSize(400,250);
        JTextArea text = new JTextArea();
        JScrollPane scrollPane = new JScrollPane(text);
        text.setFont(new Font("Times",Font.BOLD, 32));
        for (int i = 0;i < 10; i++)
            text.append("foo" + i + "\n");
        frame.add(scrollPane);
        MyDocumentListener l = new MyDocumentListener();
        (text.getDocument()).addDocumentListener(l);
        frame.setVisible(true);
        frame.setLayout(null);
        frame.setDefaultCloseOperation(JFrame.DISPOSE_ON_CLOSE);
    }
}
```

James Tam

The Text Listener: MyDocumentListener

```
public class MyDocumentListener implements DocumentListener {
    public void changedUpdate(DocumentEvent e) { // Modify
        System.out.println("updated");
        method(e);
    }

    public void insertUpdate(DocumentEvent e) { // Add
        System.out.println("insert");
        System.out.println(e.getLength());
        method(e);
    }
    public void removeUpdate(DocumentEvent e) { // Remove
        System.out.println("removed");
        method(e);
    }
}
```

James Tam

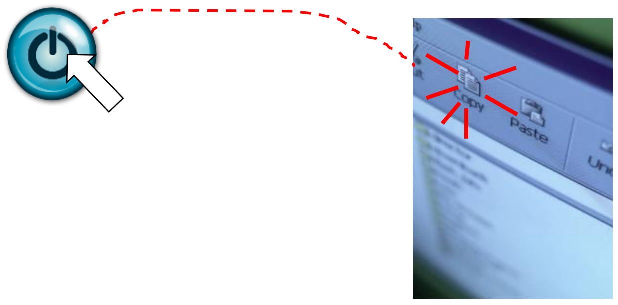
The Text Listener: MyDocumentListener (2)

```
    public void method(DocumentEvent e) {
        Document d = e.getDocument();
        try {
            String s = d.getText(0,d.getLength());
            System.out.println(s);
        }
        catch (BadLocationException ex)
        {
            System.out.println(ex);
        }
    }
```

James Tam

Controls Affecting Other Controls

- As previously shown this is not an uncommon occurrence

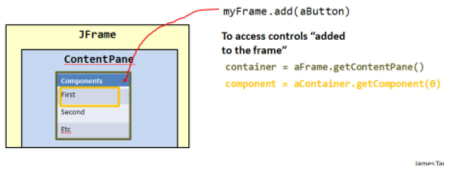


- The code to react to the event allows for easy access to the control that raised the event.

James Tam

Ways Of Accessing Other Controls

1. Via Java Swing containment
   - Example to illustrate with `JButton` control:
   - `/home/233/examples/gui/6controlAffectControls`



```
myFrame.add(aButton)
```

To access controls "added to the frame"

```
container = aFrame.getContentPane()
component = aContainer.getComponent(0)
```

   - JT's $0.02
     - Stylistically acceptable (of course!)
     - Can be challenging to track down specific container/method

James Tam

Ways Of Accessing Other Controls (2)

2. Implementing the listener class as a nested inner class.
   - (Recall that if one class is defined inside the definition of another class that the inner class is within the scope of the outer class and as a consequence it can access private attributes or methods).
   - JT's $0.02: take care that you don't employ this technique too often and/or to bypass encapsulation/information hiding.

```
public class MyFrame extends JFrame {
    private JLabel a Label;
      ...
   private class MyWindowListener extends extends
     WindowAdapter {
         public void windowClosing  (WindowEvent e) {
             aLabel.setText("Shutting down");
        }
   } // End definition for inner window listener class
}  // End definition for outer frame class
```

James Tam

Ways Of Accessing Other Controls (3)

3. Adding the control as an attribute of the control that could raise the event.
   - Once you have access to the container then you can use accessor methods to get a reference to all the GUI components contained within that container.
   - The previously mentioned example (#6) illustrated this:

```
public class MyFrame extends Jframe {
     private JLabel aLabel1;
     private JLabel aLabel2;
       ...
     public JLabel getLabel1 () { return aLabel1; }
     public JLabel getLabel2 () { return aLabel2; }
}
```

   - JT's $0.02:
     - Replaces Java's containment with a simpler one that you created

James Tam

Ways Of Accessing Other Controls (4)

– Note: adding one control as an attribute of another control need not be limited only to actual ‘containers’ such as `JFrame` or `JDialog`

– Example (button event changes a label)

```
public class MyButton extends JButton {
     private JLabel aLabel;
     ...
     public Jlabel getLabel() {  return(aLabel); }
}

public class MyButtonListener implements ActionListener {
    public void actionPerformed(ActionEvent e) {
        MyButton aButton = (MyButton) e.getSource();
        JLabel aLabel = aButton.getLabel();
    }
}
```

James Tam

Example Illustrating The Third Approach[1] And Adding Graphics To Controls

• Location of the complete example:

`/home/233/examples/gui/13containment`

1 Adding a control as an attribute of another control need not be limited only to traditional container classes such as a `JFrame`

James Tam

The Driver Class

```
public class Driver
{
    public static void main(String [] args)
    {
       MyFrame aFrame = new MyFrame();
       aFrame.setVisible(true);
    }
}
```

James Tam

Class MyFrame

```
public class MyFrame extends JFrame
{
    public static final String DEFAULT_LABEL_STRING = "Number
      presses: ";
    public static final int WIDTH = 700;
    public static final int HEIGHT = 300;
    private MyButton frameButton;
    private MyButton labelButton;
    private JLabel aLabel;
    private int numPresses;

    public MyFrame()
    {
       numPresses = 0;
       initializeControls();
       initializeFrame();
    }
```

James Tam

Class MyFrame (2)

```
public void addControls() {
   add(frameButton);
   add(labelButton);
   add(aLabel);
}

public JLabel getLabel() {
   return(aLabel);
}

public int getNumPresses() {
   return(numPresses);
}

public void incrementPresses() {
   numPresses++;
}
```

James Tam

Class MyFrame (3)

```
public void initializeFrame()
{
   setSize(WIDTH,HEIGHT);
   setLayout(null);
   addControls();
   setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
}
```

James Tam

Class MyFrame (4)

No path provided: location is the same directory as the program

```
    public void initializeControls() {
        ImageIcon anIcon = new ImageIcon("IconP
        frameButton = new MyButton("Affects
                                   window",anIcon,this);
        frameButton.setBounds(50,100,150,20);
        frameButton.addActionListener
          (new FrameButtonListener()); // Frame events only
        labelButton = new MyButton("Affects label",anIcon,this);
        labelButton.setBounds(250,100,150,20);
        labelButton.addActionListener
          (new LabelButtonListener());  // Label events only
        aLabel = new JLabel(DEFAULT_LABEL_STRING +
                         Integer.toString(numPresses));
        aLabel.setBounds(450,100,150,20);
    }
}
```

James Tam

Class MyButton

```
public class MyButton extends JButton
{
    private Component aComponent;

    public MyButton(String s,
                    ImageIcon pic,
                    Component aComponent)
    {
        super(s,pic);
        this.aComponent = aComponent;
    }

    public Component getComponent()
    {
        return(aComponent);
    }
}
```

Each instance will have a reference to a Java GUI widget (label, frame etc.)

Image reference passed onto the appropriate super class constructor

James Tam

Class To Change Label: LabelButtonListener

```
public class LabelButtonListener implements ActionListener
{
    public void actionPerformed(ActionEvent anEvent)
    {
        MyButton aButton = (MyButton) anEvent.getSource();
        MyFrame aFrame = (MyFrame) aButton.getComponent();
        aFrame.incrementPresses();  // Frame stores count
        JLabel aLabel = aFrame.getLabel(); "Number presses: "
        String s = MyFrame.DEFAULT_LABEL_STRING;
        int currentPresses = aFrame.getNumPresses();
        s = s + Integer.toString(currentPresses);
                                          "Number presses: "<#>
        aLabel.setText(s); // Label displays current count
    }
}
```

James Tam

Class To Update Frame: FrameButtonListener

```
public class FrameButtonListener implements ActionListener
{
    // Assumes screen resolution is at least 1024 x 768
    private final static int MAX_X = 1023;
    private final static int MAX_Y = 767;

    // Time in milliseconds
    private final int DELAY_TIME = 2500;
```

James Tam

Class To Update Frame: FrameButtonListener (2)

```
public void actionPerformed(ActionEvent anEvent)
{
   MyButton aButton = (MyButton) anEvent.getSource();
   JFrame aFrame = (JFrame) aButton.getComponent();
   aFrame.setTitle("Don't you click me! I'm in a bad
                    mood!!!");
   Random aGenerator = new Random();
   // Control randomly "runs away" based on screen size
   int x = aGenerator.nextInt(MAX_X);
   int y = aGenerator.nextInt(MAX_Y);
   aFrame.setLocation(x,y); // Move control to new location
   aButton.setBackground(Color.RED);  // Control is angry
   pause();
   aFrame.setTitle("");  // Angry text is gone
}
```

James Tam

Class To Update Frame: FrameButtonListener (3)

```
    private void pause()  // Give user time to note GUI changes
    {
       try
       {
           Thread.sleep(DELAY_TIME);
       }
       catch (InterruptedException ex)
       {
           ex.printStackTrace();
       }
    }
}
```

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

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

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