OBJECT-ORIENTED LANGUAGE AND THEORY

9. GUI PROGRAMMING WITH AWT & SWING

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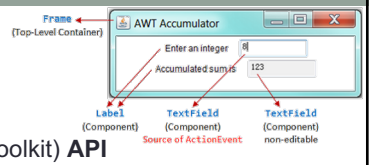
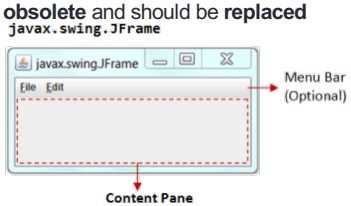
Outline

AWT and Swing



- **AWT** (Abstract Windowing Toolkit) **API**
  - From JDK 1.0
  - Most components have **become obsolete** and should be **replaced by Swing** components



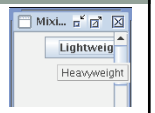
- **Swing** API
  - From JDK 1.1, as a part of **Java Foundation Classes** (JFC)
  - A much more comprehensive set of graphics libraries that enhances the AWT
  - JFC consists of **Swing**, *Java2D, Accessibility, Internationalization, and Pluggable Look-and-Feel Support APIs.*

JavaFX

- **JavaFX** is a software platform for creating and delivering desktop applications, as well as **rich internet applications** (RIAs) that can run across a wide variety of devices.
- **JavaFX** is intended to replace **Swing** as the standard ***GUI library*** *for* ***Java SE***, but both will be included for the foreseeable future.

*IFX is just a name, which is normally related with sound or visual effects in the **javafx** i was in the belief that the **fx** was function. ... FIPS **stands** for the Federal Information Processing Standardization*

Which should we choose?



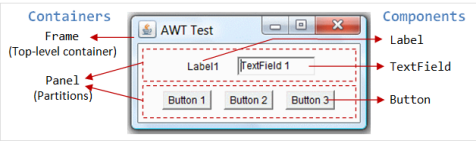
- **AWT**: for simple GUI, but not for comprehensive ones
  - Native OS GUI
  - Flatform-independent and device-independent interface
  - Heavyweight components

- **Swing**: Pure Java code with a more robust, versatile, and flexible library
  - Use AWT for windows and event handling
  - Pure-Java GUI, 100% portable and same across platform
  - Most components are light-weight, different look-and-feel
- **JavaFX:** for developing rich Internet applications
  - Can run across a wide variety of devices
  - More consistent in style and has additional options, e.g. 3D, chart, audio, video…

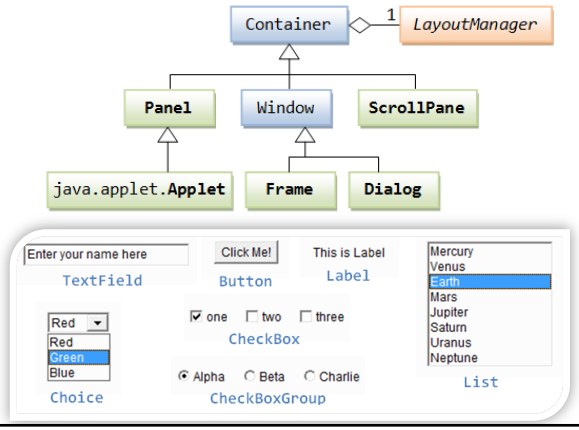
Outline

AWT UI Elements

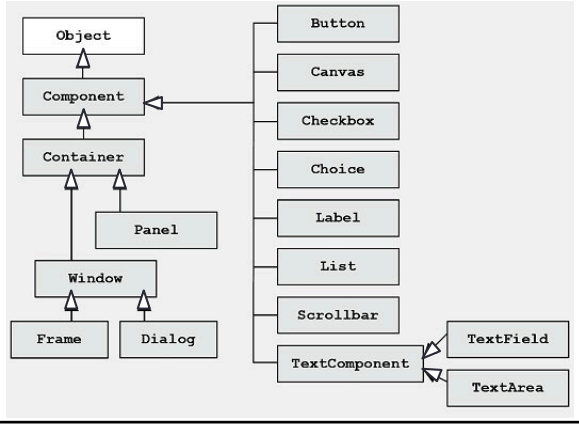
- ***Component***: Components are elementary GUI entities, e.g. Button, Label, and TextField
  - **GUI components are also called *controls* (Microsoft ActiveX Control), *widgets* (Eclipse's Standard Widget Toolkit, Google Web Toolkit)**, which allow users to interact with the application through these components (*such as button-click and text-entry)*
- ***Container***: Containers (e.g. Frame, Panel and Applet) are used to *hold components in a specific layout* (such as flow or grid). A container can also hold sub-containers.



AWT Container Classes

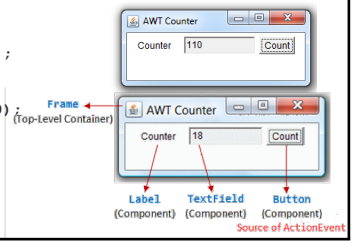


AWT Component Classes



Example: AWT Counter

```
import java.awt.Button;
import java.awt.Frame;
import java.awt.Label;
import java.awt.TextField;
import java.awt.event.ActionListener;

public class AWTCounter
        extends Frame {
   private Label lblCount;
   private TextField tfCount;
   private Button btnCount;
   private int count = 0; //Counter's

   // Setup GUI components
  public AWTCounter () {
      setLayout(new FlowLayout());

      lblCount = new Label("Counter");
      add(lblCount);

      tfCount = new TextField("0", 10);
      // set to read-only
      tfCount.setEditable(false);
      add(tfCount);

      btnCount =
          new Button("Count");
      add(btnCount);
      setTitle("AWT Counter");
      setSize(250, 100);

      setVisible(true);
  }
  public static void main(String args[]){
     AWTCounter simpleUI = new AWTCounter();
  }
}
```



Outline

1. GUI Programming in Java
2. AWT UI Elements
3. AWT Event Handling
4. Swing GUI Elements
5. Layout Manager

Example: AWT Counter with Event Handling

```
import java.awt.Button;
import java.awt.Frame;
import java.awt.Label;
import java.awt.TextField;
import java.awt.event.ActionListener;

public class AWTCounter
        extends Frame implements ActionListener {
   private Label lblCount;
   private TextField tfCount;
   private Button btnCount;
   private int count = 0; // Counter's value

   // Setup GUI components and event handling
  public AWTCounter () {
      setLayout(new FlowLayout());

      lblCount = new Label("Counter");
      add(lblCount);

      tfCount = new TextField("0", 10);
      tfCount.setEditable(false); // set to read-only
      add(tfCount);

      btnCount = new Button("Count");
      add(btnCount);

      //clicking Button source fires ActionEvent
      //btnCount registers this instance as ActionEvent listener
      btnCount.addActionListener(this);

      setTitle("AWT Counter");
      setSize(250, 100);

      setVisible(true);
}
```

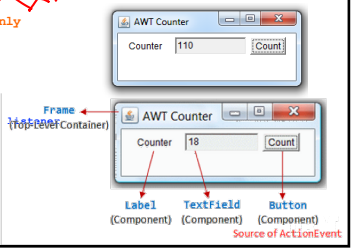
```
   public static void main(String[] args){
      AWTCounter app = new AWTCounter();
   }
    /** ActionEvent handler - Called back upon
button-click. */
   public void actionPerformed(ActionEvent e){
      ++count;
      // Display the counter value on the TextField
      tfCount.setText(count + "");
   }
}
```

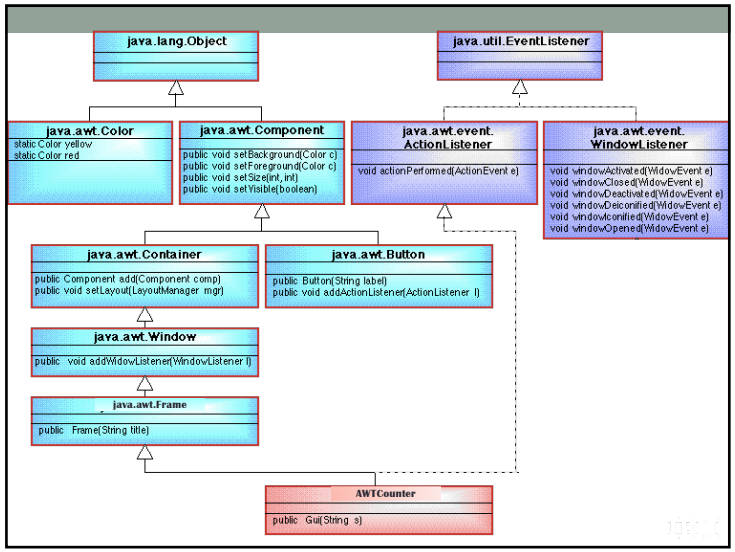
listener

Action

Xxx:

source





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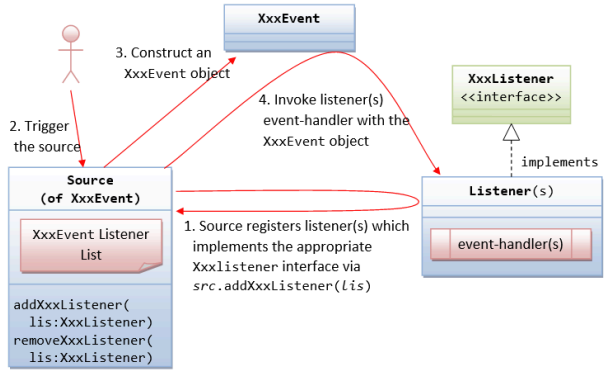
AWT Event Handling

Event Driven / Event Delegation



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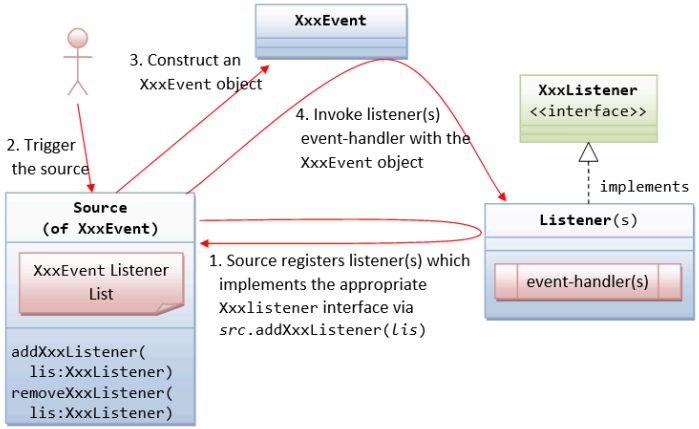
Quiz: Identify Source, Xxx for AWTCounter



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E.g. MouseListener (XxxListener) interface

```
//A MouseListener interface, which declares the signature of the handlers
//for the various operational modes.
public interface MouseListener {
  // Called back upon mouse-button pressed
  public void mousePressed(MouseEvent evt);
  // Called back upon mouse-button released
  public void mouseReleased(MouseEvent evt);
  // Called back upon mouse-button clicked (pressed and released)
  public void mouseClicked(MouseEvent evt);
  // Called back when mouse pointer entered the component
  public void mouseEntered(MouseEvent evt);
  // Called back when mouse pointer exited the component
  public void mouseExited(MouseEvent evt);
}
```

Add or remove XxxListener in the source:

```
public void addXxxListener(XxxListener lis);
public void removeXxxListener(XxxListener lis);
```

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```java
//An example provides implementation to the event handler methods
class MyMouseListener implements MouseListener {
   @Override
   public void mousePressed(MouseEvent e)  {
      System.out.println("Mouse-button pressed!");
   }
   @Override
   public void mouseReleased(MouseEvent e) {
      System.out.println("Mouse-button released!");
   }
   @Override
   public void mouseClicked(MouseEvent e)  {
      System.out.println("Mouse-button clicked (pressed and released)!");
   }
   @Override
   public void mouseEntered(MouseEvent e)  {
      System.out.println("Mouse-pointer entered the source component!");
   }
   @Override
   public void mouseExited(MouseEvent e)   {
      System.out.println("Mouse exited-pointer the source component!");
   }
}
```

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```java
import java.awt.*;
import java.awt.event.*;
public class MouseEventDemo extends Frame {
  private TextField tfMouseX; // to display mouse-click-x
  private TextField tfMouseY; // to display mouse-click-y
  //setup the UI components and event handlers
  public MouseEventDemo() {
        setLayout(new FlowLayout());
        add(new Label("X-Click: "));
        tfMouseX = new TextField(10); // 10 columns
        tfMouseX.setEditable(false;      add(tfMouseX);
        add(new Label("Y-Click: "));     tfMouseY = new TextField(10);
        tfMouseY.setEditable(false);     add(tfMouseY);
         /* "super" frame (source) fires the MouseEvent and adds an anonymous
instance of MyMouseListener as a MouseEvent listener */
        addMouseListener(new MyMouseListener());
        setTitle("MouseEvent Demo");     setSize(350, 100);   setVisible(true);
  }
  public static void main(String[] args) {
        new MouseEventDemo();  // Let the constructor do the job
  }
}
```

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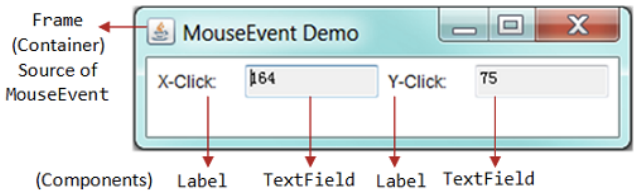
Quiz: MouseEventDemo

- Source: ?
- XxxEvent: ?
- What happens when running the program?



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```java
//An example provides implementation to the event handler
methods
class MyMouseListener implements MouseListener {
   @Override
   public void mousePressed(MouseEvent e)  {   }
   @Override
   public void mouseReleased(MouseEvent e) {   }
   @Override
   public void mouseClicked(MouseEvent e)  {
      tfMouseX.setText(evt.getX() + "");
      tfMouseY.setText(evt.getY() + "");
   }
   @Override
   public void mouseEntered(MouseEvent e)  {
      System.out.println("Enter the source component!");
   }
   @Override
   public void mouseExited(MouseEvent e)   {
      System.out.println("Exit the source component!");
   }
}
```

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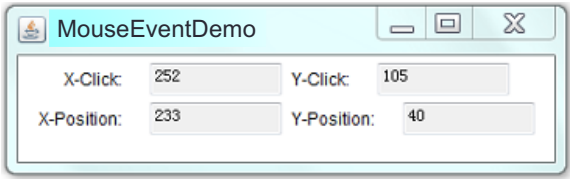
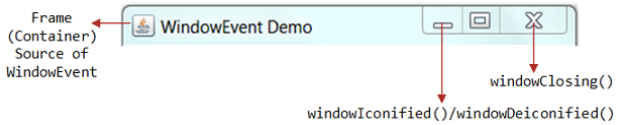
Exercise: Modify MouseEventDemo with more mouse events



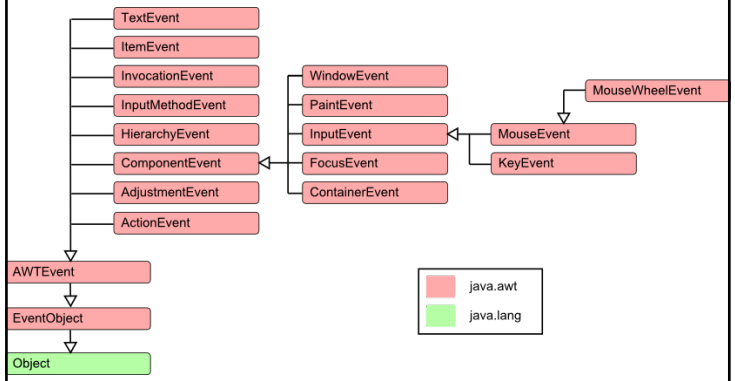

```
public interface MouseMotionListener {
  /* Called-back when a mouse-button is pressed on the
  source component and then dragged. */
  public void mouseDragged(MouseEvent e);
  /* Called-back when the mouse-pointer has been moved onto the
  source component but no buttons have been pushed. */
  public void mouseMoved(MouseEvent e);
}
```


Exercise: Modify AWTCounter with window events

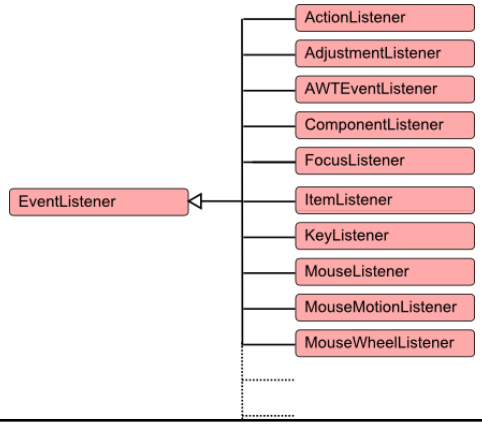
- Show the dialog box with a corresponding message for each event in WindowListener interface
  - close/open window
  - activate/deactivate window
  - iconify/deiconify window



Event Hierarchy



EventListener Hierarchy



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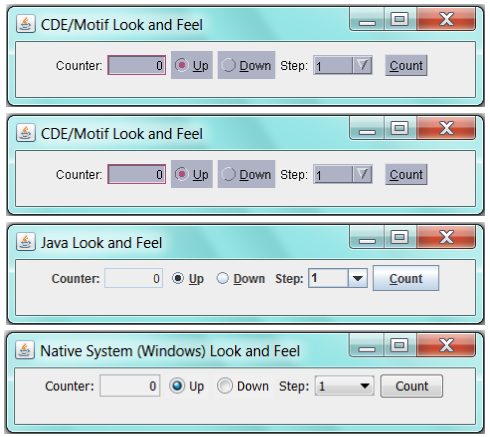
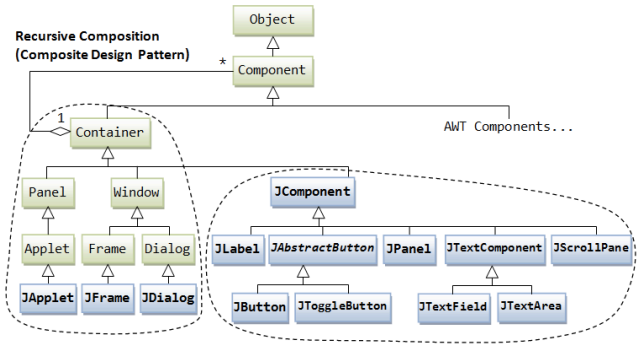
Java Swing

- Light Weight: Pure Java code
  - Freelance of native operational System's API
- Use the Swing components with prefix "J", e.g. JFrame, JButton, JTextField, JLabel, etc.
  - Advanced controls like Tree, color picker, table controls, TabbedPane, slider.
- Uses the AWT event-handling classes
- Highly Customizable
  - Often made-to-order in a very simple method as visual appearance is freelance of content.
- Pluggable look-and-feel
  - Modified at run-time, supported by accessible values.

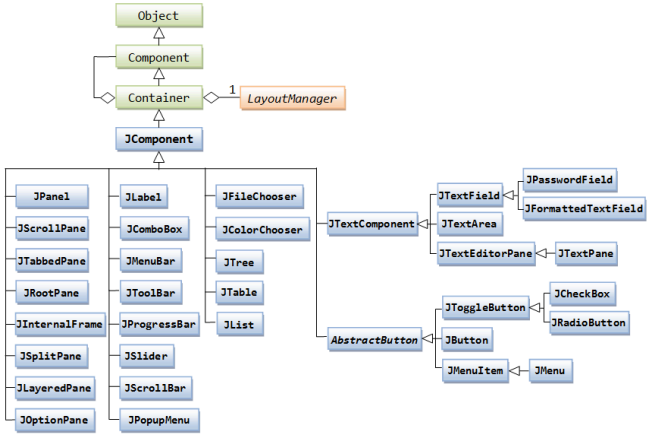
Swing – Different Look & Feel



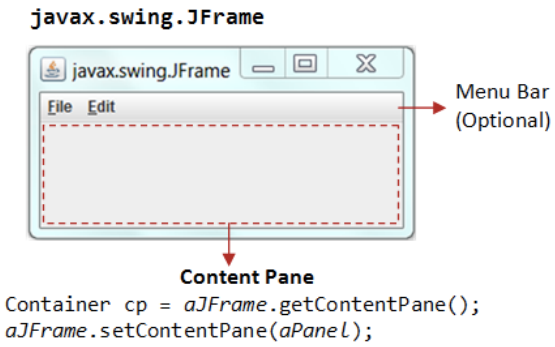
AWT and Swing Elements



Swing Containers and Components



Containers and ContentPane

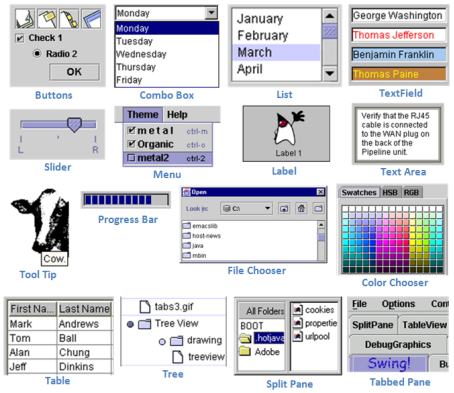



```
Container cp = aJframe.getContentPane();
aJframe.setContentPane(aPanel);
```


Swing components

Swing is huge (consists of 18 packages of 737 classes as in JDK 1.8) and has great depth

Compare to AWT:
12 packages of 370 classes




```
//A Swing GUI application inherits from top-level container
  public class SwingTemplate extends JFrame {
    // Constructor to setup the GUI components and event handlers
    public SwingTemplate() {
       // top-level content-pane from JFrame
       Container cp = getContentPane();
       cp.setLayout(new ....Layout());

       // Allocate the GUI components
       cp.add(....); //...

       // Source object adds listener
       setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
      // Exit the program when the close-window button clicked
      setTitle("......");  //"super" JFrame sets title
      setSize(300, 150);   //"super" JFrame sets initial size
      setVisible(true);    // "super" JFrame shows
  }
  public static void main(String[] args) {
      new SwingTemplate();
  }
}
```

Example: SwingCounter

```
public class SwingCounter extends JFrame {
  private JTextField tfCount;
  private JButton btnCount;
  private int count = 0;
  public SwingCounter() {
    // Retrieve the content-pane of the top-level container JFrame
    // All operations done on the content-pane
    Container cp = getContentPane();   cp.setLayout(new
    FlowLayout());
    cp.add(new JLabel("Counter"));
    tfCount = new JTextField("0");
    tfCount.setEditable(false);          cp.add(tfCount);
    btnCount = new JButton("Count");     cp.add(btnCount);

    /* btnCount adds an anonymous instance of BtnCountListener (a
    named inner class) as a ActionListener */
    btnCount.addActionListener(new BtnCountListener());

    setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
    setTitle("Swing Counter");  setSize(300, 100);
    setVisible(true);
  }
```



```
    /** * BtnCountListener is a "named inner class" used as
    ActionListener. This inner class can access private
    variables of the outer class. */
    private class BtnCountListener implements ActionListener {
      @Override public void actionPerformed(ActionEvent evt) {
            ++count;
            tfCount.setText(count + "");
      }
    }
    public static void main(String[] args) {
      // Run GUI codes in Event-Dispatching thread
      // for thread-safety
      SwingUtilities.invokeLater(new Runnable() {
        @Override public void run() {
              new SwingCounter();
        }
      });
    }
}
```


Inner class

- A nested class (or commonly called inner class) is a class defined inside another class

```
public class MyOuterClass {
  // outer class defined here ......
  // an nested class defined inside the outer class
  private class MyNestedClass1 { ...... }
  // an "static" nested class defined inside the outer class
  public static class MyNestedClass2 { ...... }
  ......
}
```


Properties of inner classes

- a normal class: can contain constructors, member variables and member methods, can also be declared static, final or abstract, can be created instances
- Is a *member* of the outer class, just like any member variables and methods defined inside a class
- Can access the private members (variables/methods) of the enclosing outer class, as it is at the *same level* as these private members
- Can have private, public, protected, or the *default* access, just like any member variables and methods defined inside a class
  - A private inner class is only accessible by the enclosing outer class, and is not accessible by any other classes
- NOT a *subclass* of the outer class

```
public class SwingCounter extends JFrame {
  private JTextField tfCount;
  private JButton btnCount;
  private int count = 0;
  public SwingCounter() {
      ...
      btnCount.addActionListener(new BtnCountListener());
      ...
  }
  //... (main)
  /* Allocate an anonymous instance of an anonymous inner
  class that implements ActionListener as ActionEvent
  listener */
  btnCount.addActionListener(new ActionListener() {
     @Override public void actionPerformed(ActionEvent evt) {
            ++count;
            tfCount.setText(count + "");
     }
  });
}
```

Named Inner Class

Anonymous Inner Class

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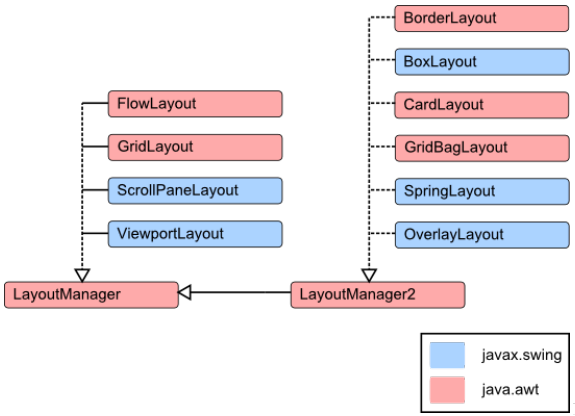
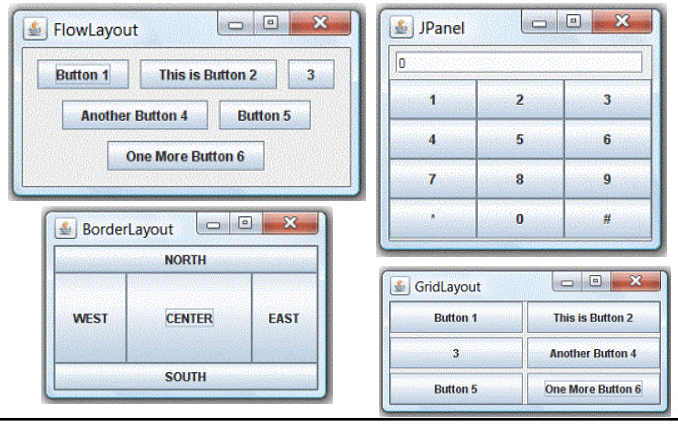
AWT and Swing Layout

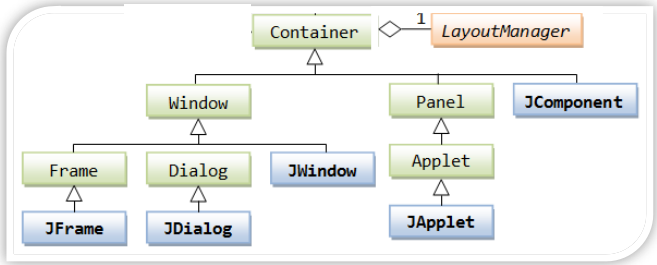


Layout management



Set layout for a container

```
// java.awt.Container
public void setLayout(LayoutManager mgr)
```



Setup a layout for a container

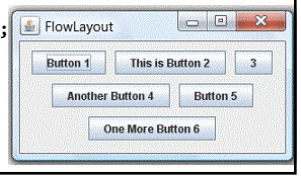
- Construct an instance of the chosen layout object, via new and constructor, e.g., new FlowLayout())
- Invoke the setLayout() method of the Container, with the layout object created as the argument;
- Place the GUI components into the Container using the add() method in the correct order; or into the correct zones.

```
Panel pnl = new Panel();
// Add a new Layout object to the Panel container
pnl.setLayout(new FlowLayout());
// The Panel container adds components in a proper order
pnl.add(new JLabel("One"));
pnl.add(new JLabel("Two"));
pnl.add(new JLabel("Three"));
```

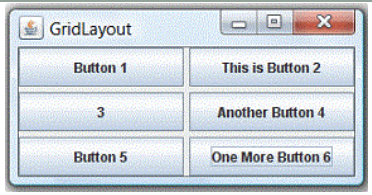

E.g. FlowLayout

```
public class AWTFlowLayoutDemo extends Frame {
  private Button btn1, btn2, btn3, btn4, btn5, btn6;
  public AWTFlowLayoutDemo () {
      // from left-to-right, and flow from top-to-bottom
      setLayout(new FlowLayout());
      btn1 = new Button("Button 1");              add(btn1);
      btn2 = new Button("This is Button 2");      add(btn2);
      btn3 = new Button("3");                     add(btn3);
      btn4 = new Button("Another Button 4");      add(btn4);
      btn5 = new Button("Button 5");              add(btn5);
      btn6 = new Button("One More Button 6");     add(btn6);

      setTitle("FlowLayout Demo");
      setSize(280, 150); setVisible(true);
  }
  public static void main(String[] args) {
      new AWTFlowLayoutDemo();
  }
}
```



E.g. GridLayout




```
...
/* set layout to 3x2
GridLayout, horizontal and vertical gaps of 3 pixels,
components are added from left-to-right, top-to-bottom */
setLayout(new GridLayout(3, 2, 3, 3));
btn1 = new Button("Button 1");              add(btn1);
btn2 = new Button("This is Button 2");      add(btn2);
btn3 = new Button("3");                     add(btn3);
btn4 = new Button("Another Button 4");      add(btn4);
btn5 = new Button("Button 5");              add(btn5);
btn6 = new Button("One More Button 6");     add(btn6);
...
```