Graphical User Interface (GUI), Part 1

- Applets
- The Model-View-Controller GUI Architecture
  - Separated Model Architecture
- Abstract Windowing Toolkit (AWT)
- Java Foundation Classes (JFC)

- Note this is a huge area many books are devoted solely to this topic.
- Here we will provide an overview and how to get started.

Applet

- An *applet* (application-let) is a Java program that runs in an internet browser.
- Characteristics of an Applet
  - Typically a smaller application.
  - Consists of a user interface component and various other components.
  - Program is downloaded.
    - Does not require any software to be installed on the client maschine.
  - Has the methods **`init`**, **`start`**, **`stop`**, and **`destroy`**.
    - Called by the system not called by the programmer.
  - Show in an HTML page
    - Has a special **`<APPLET>`** tag for this.
  - Runs "inside the sandbox" => much more safe, no viruses.
- Applets are displayed through a browser or through the applet viewer (a JDK tool).

Applet, cont

```
<applet  code="MyClass.class"
         codebase="http://www.myHome.com"
         archive="MyJarFile.jar"
         height="100"
         width="200">
</applet> <!-- never omitted -->
```

- Deprecated in HTML 4.0 (and XHTML), widely supported.
- Replaced by the **`<object>`** tag.

- For details on applets see package **`javax.swing.JApplet`** and **`java.applet.Applet`**.

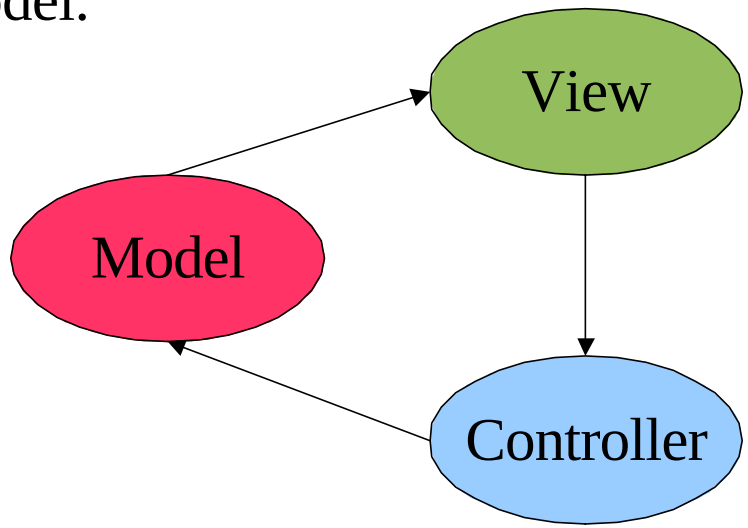
Applet, cont

From **`java.applet.Applet`**.

- **`init()`**.Called by the browser or applet viewer to inform this applet that it has been loaded into the system.
- **`start()`**.Called by the browser or applet viewer to inform this applet that it should start its execution, e.g., when visible in browser.
- **`stop()`**.Called by the browser or applet viewer to inform this applet that it should stop its execution, e.g., when applet becomes invisible in browser.
- **`destroy()`**.Called by the browser or applet viewer to inform this applet that it is being reclaimed and that it should destroy any resources that it has allocated.

Model-View-Controller Design

- Swing architecture is rooted in the *model-view-controller* (MVC) design (from the programming language SmallTalk).
- In the MVC architecture a visual application is broken up into three separate parts.
  - A *model* that represents the data for the application.
  - A *view* that is the visual representation of that data.
  - A *controller* that takes user input on the view and translates that to changes in the model.



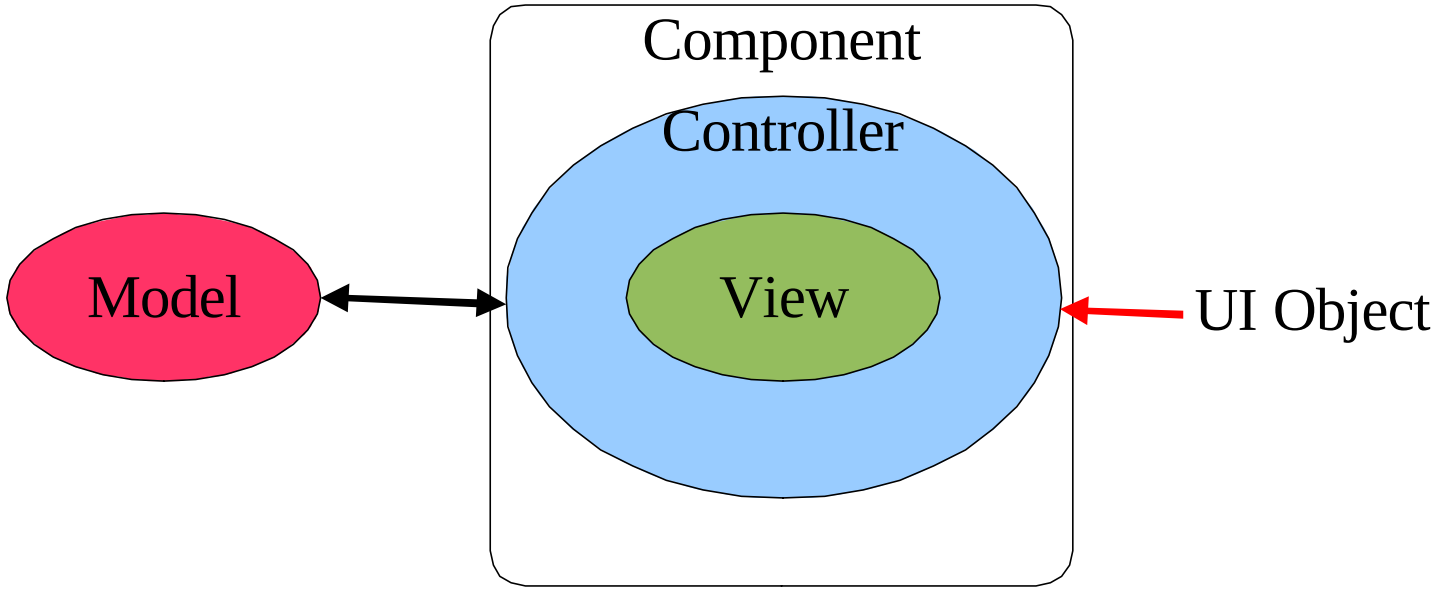
Model-View-Controller, cont.

- *Philosophy*: Don't call use, we call you! (event driven).
- Model
  - The core logic of the program that processes data independent of the GUI.
- View
  - Presentation of the model.
  - There can be several views on the same model.
  - Output to screen.
- Controller
  - Input from devices such as keyboard and mouse.
  - Effect the model directly and the view indirectly.

- However, to strict so Java uses a modified MVC model.

Separated Model Architecture

- Based on the MVC Architecture.
  - Merge the view and controller parts into a single User-Interface (UI) part.
  - Very difficult to write a generic controller that does not know the specifics about a view.
  - Center an application around its data not its user interface.



Separated Model Architecture, Example


```
// the model class
class Model {
  private int x;
  private int y;
  public Model () { x = 0; y = 0;}
  public int  getX() {return x;}
  public void setX(int x) {this.x = x;}
  public int  getY() {return y;}
  public void setY(int y) {this.y = y;}
  public int  calc() {return x*y;}
}
```

Separated Model Architecture, Example

```
// the view class
public class MVC1 extends JApplet {
  Model model     = new Model();
  JLabel xl       = new JLabel("x");
  JTextField x    = new JTextField(10);
  JLabel yl       = new JLabel("y");
  JTextField y    = new JTextField(10);
  JLabel prodl    = new JLabel("prod");
  JTextField prod = new JTextField(10);
  JButton calc    = new JButton("Calculate");

  /* see next slide for ActionListener */
  AL al = new AL();
  public void init() {
    Container cp = getContentPane();
    cp.setLayout (new GridLayout(4,2)); // change layout
    cp.add(xl);    cp.add(x);
    cp.add(yl);    cp.add(y);
    cp.add(prodl); cp.add(prod);
    cp.add(calc);
    calc.addActionListener(al);        // add action list
  }
```

Separated Model Architecture, Example

```
// the controller class
class AL implements ActionListener {
    public void actionPerformed (ActionEvent e){
      int xValue = Integer.parseInt(x.getText());
      model.setX(xValue);
      int yValue = Integer.parseInt(y.getText());
      model.setY(yValue);
      String temp = Integer.toString(model.calc());
      prod.setText(temp);
    }
  }

public static void main(String[] args) {
    MVC1 applet = new MVC1();
    JFrame frame = new JFrame("MVC");
    frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);
    frame.getContentPane().add(applet);
    frame.setSize(150,150);
    applet.init();
    applet.start();
    frame.setVisible(true);
}
```

The HTML File

```
<html><head><title>Applet1</title></head><hr>
<OBJECT  classid="clsid:8AD9C840-044E-11D1-B3E9-00805F499D93"
  width="100" height="50" align="baseline"
  codebase="http://java.sun.com/products/plugin/1.2.2/jinstall-1_2_2-win.cab#Version=1,2,2,0">
<PARAM NAME="code" VALUE="MVC1.class">
<PARAM NAME="codebase" VALUE=".">
<PARAM NAME="type" VALUE="application/x-java-applet;version=1.2.2">
<COMMENT>
  <EMBED type=
    "application/x-java-applet;version=1.2.2"
    width="200" height="200" align="baseline"
    code="Applet1.class" codebase="."
    pluginspage="http://java.sun.com/products/plugin/1.2/plugin-install.html">
  <NOEMBED>
</COMMENT>
   No Java 2 support for APPLET!!
  </NOEMBED>
</EMBED>
</OBJECT>
<hr></body></html>
```

GUI Overview

- To create a Java GUI, you need to understand
  - Containers
  - Event
  - Event Handlers
  - Layout managers
  - Components
  - Special features

AWT and JFC/Swing

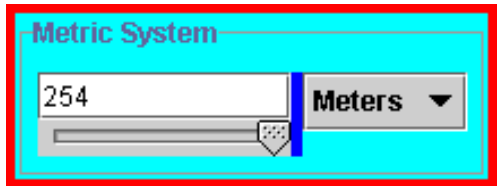
- Early Java development used graphic classes defined in the Abstract Windowing Toolkit (AWT).
  - See the packages **`java.awt`**
- In Java 2, JFC/Swing classes were introduced.
  - See the packages **`javax.swing`**
- Many AWT components have improved Swing counterparts.
  - An example, the AWT **`Button`** class corresponds to a more versatile Swing class called **`JButton`**.
- Swing does not generally replace the AWT; still use for AWT events and the underlying AWT event processing model.
- Here we focus mostly on Swing.

Containers

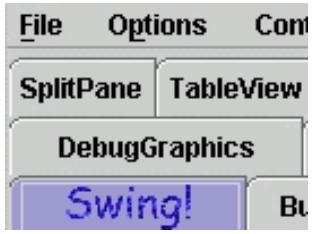
- A container is a special component that can hold other components.
- The AWT **`Applet`** class, as well as the Swing **`JApplet`** class, are containers.
- Other containers include
  - Frames
    - A frame is a container that is free standing and can be positioned anywhere on the screen.
    - Frames give the ability to do graphics and GUIs through applications and applets.
  - Dialog boxes
  - Panels
  - Panes
  - Toolbars

Containers (Top Level and General)

Applet



Panel

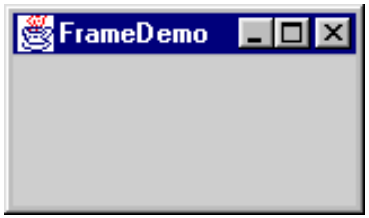


Tabbed Pane

Dialog

Scroll Pane

Toolbar



Frame

Split Pane

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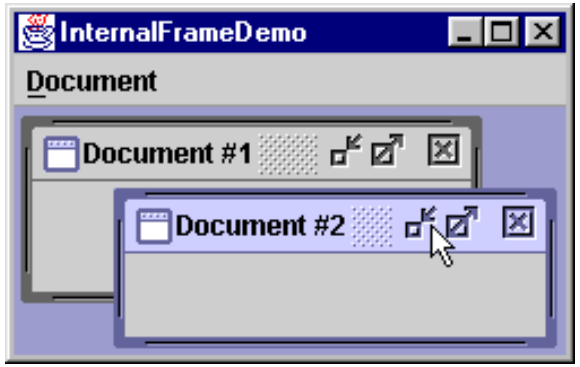
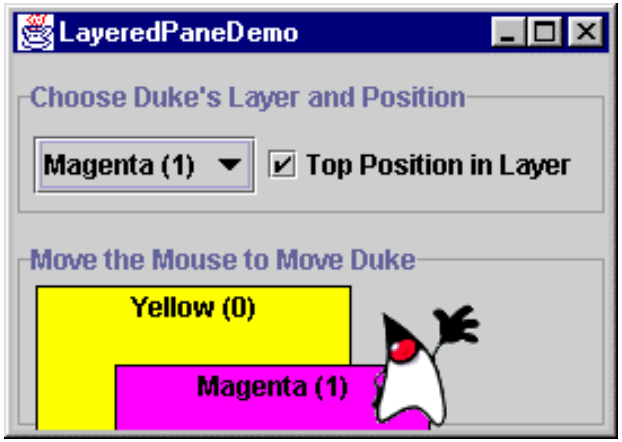
Special Containers

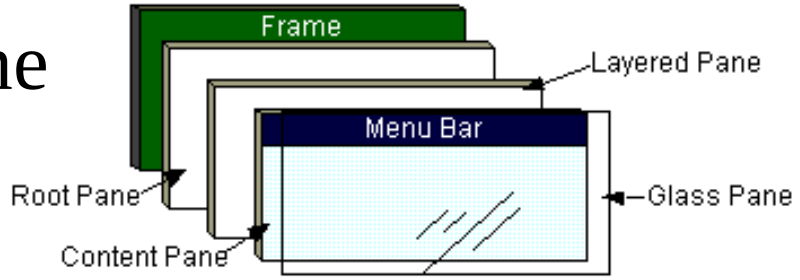
Internal frame





Layered pane

Root pane



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Events

- Every time the user types a character or pushes a mouse button, an event occurs.
- Any object can be notified of the event.
- All the objects have to do implement the appropriate interface and be registered as an event listener on the appropriate event source.

Events, cont.

- Several events implemented in **`java.awt.AWTEvent`** subclasses (**`java.awt.Event`** is deprecated).
  - Defines a lot of constants.

```
public abstract class AWTEvent extends EventObject {
  public void setSource(Object newSource);
  public int getID();
  public String toString();
  public String paramString();
  protected void consume();
  protected boolean isConsumed();
}
```

Events Handlers

- In the declaration for the event handler class, one line of code specifies that the class either implements a listener interface (or extends a class that implements a listener interface).

```
public class MyClass implements ActionListener
```

- In the event handler class the method(s) in the listener interface must be implemented

```
public void actionPerformed(ActionEvent e) {
    // code that "reacts" to the event
}
```

- Register an instance of the event handler class as a listener on one or more components.

```
myComponent.addActionListener(myClassInstance)
```

Events Handlers, cont.

```
class AL implements ActionListener {
    public void actionPerformed (ActionEvent e){
      int xValue = Integer.parseInt(x.getText());
      model.setX(xValue);
      int yValue = Integer.parseInt(y.getText());
      model.setY(yValue);
      String temp = Integer.toString(model.calc());
      prod.setText(temp);
    }
}
```

- Often an event handler that has only a few lines of code is implemented using an *anonymous inner class*.

Events Handlers, cont.

- **`SwingApplication`** has two event handlers.
  - Window closing (window events).
    `frame.setDefaultCloseOperation (JFrame.EXIT_ON_CLOSE);`
  - Button clicks (action events).
    see previous slide.
- Types of events (listeners defined in **`java.awt.event`**)
  - Click button ⇒ **`ActionListener`**
  - Close frame Þ **`WindowListener`**
  - Press mouse button Þ **`MouseListener`**
  - Move mouse Þ **`MouseMotionListener`**
  - Component visible Þ **`ComponentListener`**
  - Component gets focus Þ **`FocusListener`**

`WindowListener` and `MouseListener`

```
public interface WindowListener extends EventListerner {
  void windowActivated(WindowEvent e);
  void windowClosed(WindowEvent e);
  void windowClosing(WindowEvent e);
  void windowDeactivated(WindowEvent e);
  void windowDeiconified(WindowEvent e);
  void windowIconified(WindowEvent e);
  void windowOpened(WindowEvent e);
}
```

```
public interface MouseListener extends EventListener {
  public void mouseClicked(MouseEvent e);
  public void mousePressed(MouseEvent e);
  public void mouseReleased(MouseEvent e);
  public void mouseEntered(MouseEvent e);
  public void mouseExited(MouseEvent e);
}
```

Layout Managers

- A layout manager is an object that determines the manner in which components are displayed in a container.

- There are several predefined layout managers defined in the Java standard class library.
  - Flow Layout (in **`java.awt`**)
  - Border Layout (in **`java.awt`**)
  - Card Layout (in **`java.awt`**)
  - Grid Layout (in **`java.awt`**)
  - GridBag Layout (in **`java.awt`**)
  - Box Layout (in **`javax.swing`**)
  - Overlay Layout (in **`javax.swing`**)

Layout Managers, cont.

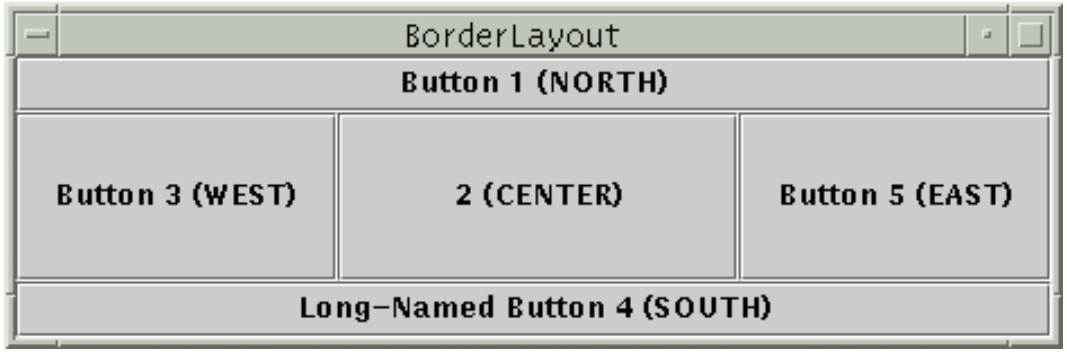
- Every container has a default layout manager, but we can also explicitly set the layout manager for a container.
- Each layout manager has its own particular rules governing how the components will be arranged.
- Some layout managers pay attention to a component's preferred size or alignment, and others do not.
- The layout managers attempt to adjust the layout as components are added and as containers are resized.

Flow Layout

- A flow layout puts as many components on a row as possible, then moves to the next row
- Rows are created as needed to accommodate all of the components.
- Components are displayed in the order they are added to the container.
- The horizontal and vertical gaps between the components can be explicitly set.
- Default for **`JPanel`**.

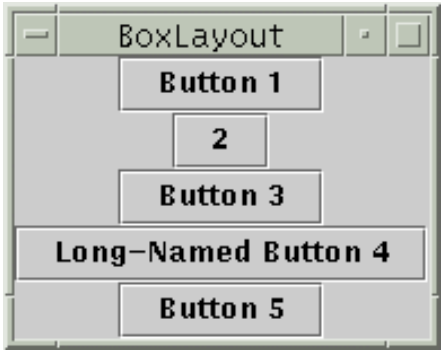
Border Layout

- A border layout defines five areas into which components can be added.
- The default for most GUIs



Box Layout

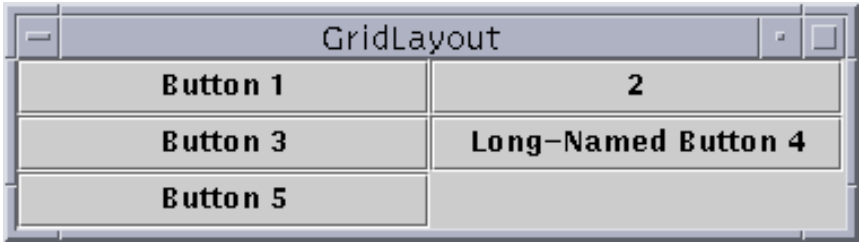
- A box layout organizes components either horizontally (in one row) or vertically (in one column).
- Special rigid areas can be added to force a certain amount of spacing between components.
- By combining multiple containers using box layout, many different configurations can be created.
- Multiple containers with box layouts are often preferred to one container that uses the more complicated gridbag layout manager.



Other Layout Managers

Card layout. The area contains different components at different times.

Gridbag layout. The most sophisticated and flexible.



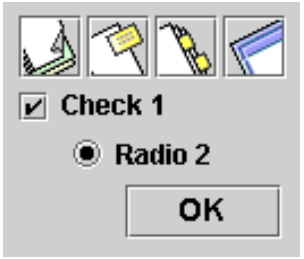
Grid layout. All equal size in a grid.

"Atomic" Components

- The root in the component hierarchy is **`JComponent`**.
- The **`JComponent`** provides the following functionality to its descendants, e.g., **`JLabel`**, **`JRadioButton`**, and **`JTextArea`**.
  - Tool tips
  - Borders
  - Keyboard-generated actions
  - Application-wide pluggable look and feel
  - Various properties
  - Support for layout
  - Support for accessibility
  - Double buffering

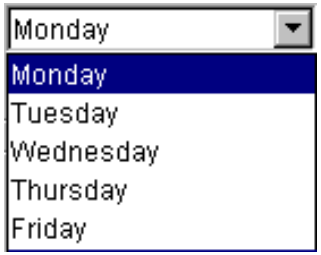
Basic Components

Button

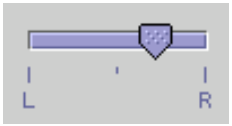


Menu

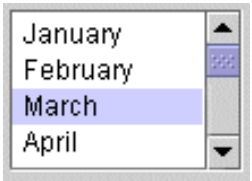
Combo Box



Slider



List



Text Field

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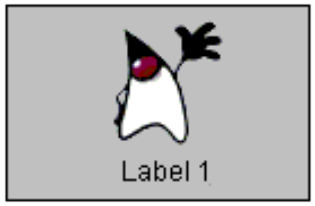
Non-Editable Displays

Label



Progress bar

Tool tip

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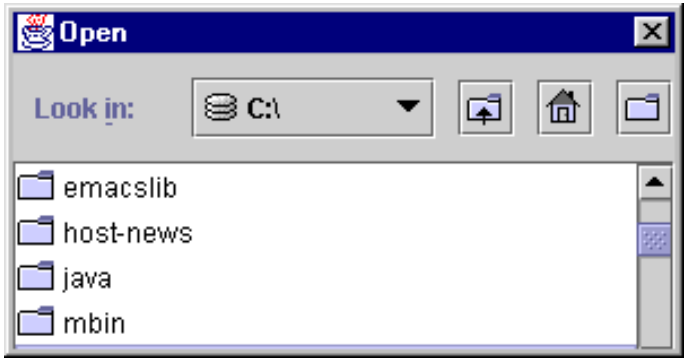
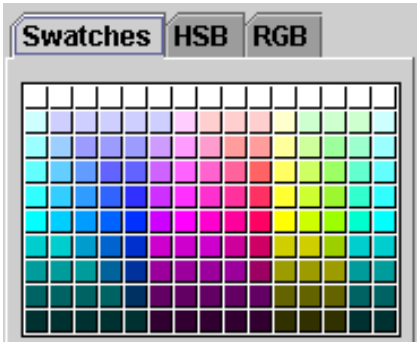
Editable Displays

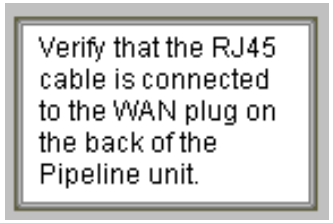


File Chooser

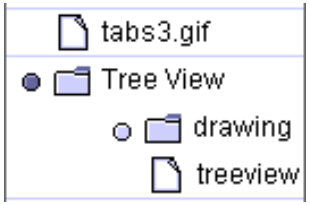


Color Chooser

Table



Text



Tree

[Source: java.sun.com]

Summary

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  - Separated Model Architecture
- Abstract Windowing Toolkit (AWT)
- Java Foundation Classes (JFC)