Lesson – 6
Building GUIs in Java with Swing

Wholeness of the Lesson

- Swing is a windowing toolkit that allows developers to create GUIs that are rich in content and functionality. The ultimate provider of tools for the creation of beautiful and functional content is pure intelligence itself; all creativity arises from this field's self-interacting dynamics.

Introduction

- Swing – A set of GUI classes
  - Part of the Java's standard library
  - Much better than the previous library: AWT
    - Abstract Window Toolkit
    - AWT Still Used. Swing components still make use of aspects of the AWT – Swing is built "on top of" the old AWT. In particular, handling of events relies on the old event-handling model.

- ***JavaFX.*** In 2014, Oracle declared that Swing libraries would be developed no further, and that the windowing toolkit of choice had become JavaFX. JavaFX has more modern-looking components and has a more flexible API. Since Swing is still (as of 2015) far more widely used than JavaFX, Swing is presented here. With the release of Java 8, JavaFX became an integral part of the JRE (and JDK)

- Highlights
  - Swing has a rich and convenient set of user interface elements.
  - It supports MVC pattern.
  - Platform independent.
  - Components are often called ***lightweight*** components.
  - Swing components do not depend on peers to handle their functionality.

- ***Industry Standard.*** For standalone GUI development in Java, Swing is the toolkit most often used.
- ***Visual Designers***
  - Most widely used (as of 2016) is Netbeans, which provides excellent visual support for Swing.
  - Visual designers are better for prototypes than for creating production-quality UIs that need to be maintained
  - Usually, to use a visual designer effectively, you need to have a good understanding of how to write code to produce the effects you want.
  - SceneBuilder is a visual tool that comes with JavaFX – to use this tool, it is essential that a developer already knows how to program in JavaFX.

Outline of Topics

- MVC Design Pattern
- Swing Components and Containers
- Inheritance in Swing
- Laying Out Components with Layout Managers
- Handling Events
- Additional Technique: Displaying Pop-up Windows
- A sample UI: UserIO.java(Additional Examples – Optional)
- Working with Lists in a UI

Model-View-Controller Design Pattern

- To better understand Swing UI components, it is a good idea to review how Swing works at an architectural level.
- All Swing components (e.g. buttons, check boxes, text fields, etc) have three basic characteristics:
  - Its contents
    - such as the state of a button (pushed in or not), the text in a text field
  - Its visual appearance
    - color, size, etc.
  - Its behavior
    - reaction to events
- To implement these characteristics, Swing uses a well-known OO-design pattern - the Model-View-Controller pattern.

Model-View-Controller Design Pattern

- The MVC design pattern:
  - The model
    - stores the contents
  - The view
    - displays the contents
  - The controller
    - handles user input

Model-View-Controller Design Pattern

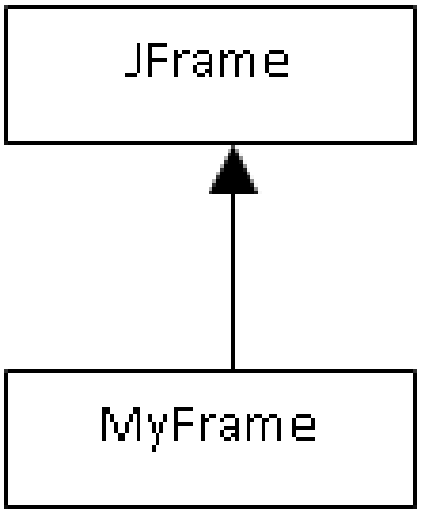
- The controller handles the user input events such as mouse clicks and keystrokes. It then decides whether to translate these events into changes in the model or the view.
  - e.g. if the user presses a button, the controller tells the view to perform action.
  - Swing insulates the programmer from the MVC architecture with classes such as JButton or JTextField that store the model and the view.

Main Idea in Swing

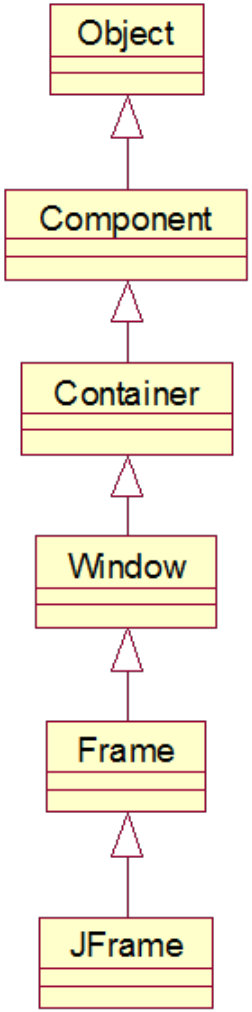
- ***Components and containers***. Swing provides components (like text boxes, buttons, checkboxes) and containers (frames, panels, applets,dialog) in which such components can be placed.
- ***Containers placed in other containers***. In Swing, a container is also considered to be another kind of component, so containers can be placed in other containers.
- ***Layout Managers for containers***. Every container supports the use of a layout strategy. To achieve the visual objectives in building Swing screens requires skillful use of layouts on multiple containers. We will do this in a simple way.
- ***Listeners = Event Handlers***. A Swing GUI becomes responsive to user actions (like button presses, item selections, etc) by means of an event handling model. In this model, there are "listeners" for user actions (like button presses and mouse clicks). When a relevant user action occurs, the listener is informed and the code that you have written to handle the event will then be executed.

Inheritance in Swing

The code makes it clear that, when you design a Swing application, you start by creating a *subclass* of Jframe. The class diagram in UML is the following:



Inheritance Hierarchy for JFrame

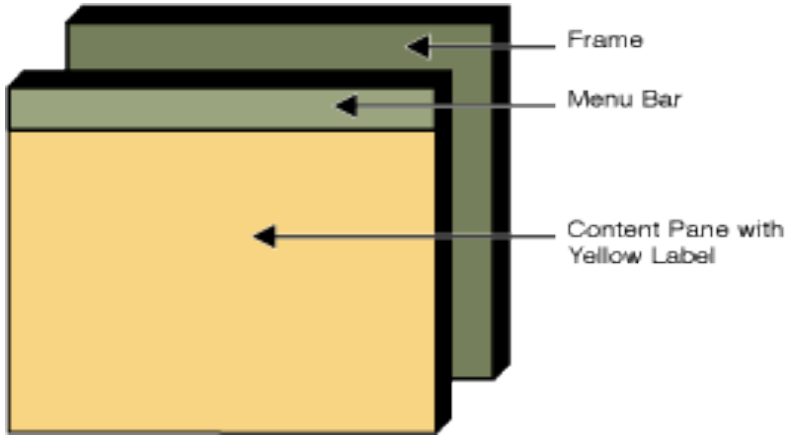


Top Level Containers: JFrame

- **`Import javax.swing.JFrame`**:
  - A main and Top-level window with a title and a border.
  - Can add components to the Contentpane(Container).
  - ability to minimize, maximize, and close the window
  - The contentPane is the area of the JFrame one can modify.

    Access it using the getContentPane()method of

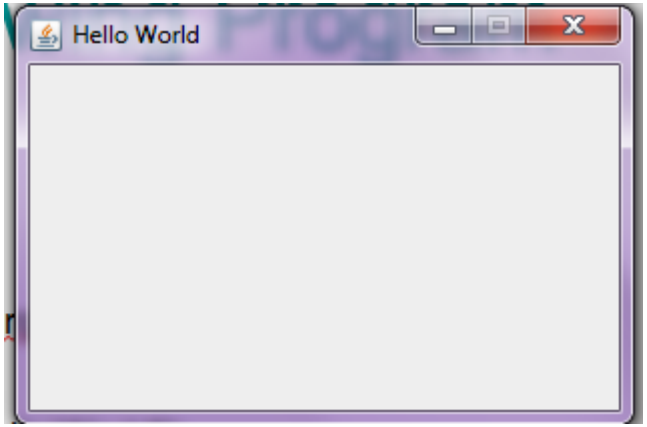
    a JFrame object.



My First Swing Program

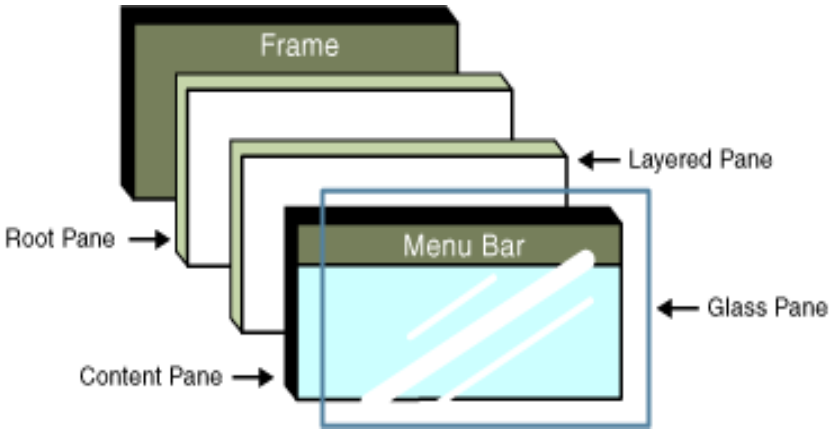
SwingFrame.java

```
import javax.swing.*;
public class SwingFrame
{
public static void main(String[] args)
{
JFrame frame = new JFrame();
frame.setTitle("Hello World");
frame.setSize(300,200);
frame.setResizable(false);
frame.setVisible(true);
frame.setLocation(100, 100);
frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
}
}
//SwingFrame.Java
```



Content pane

- Every top-level container indirectly contains an intermediate container known as a *content pane*.
- The content pane contains components in the window's GUI.
- To add a component to a container, you use one of the various forms of the **`add`** method.



Contentpane

```
import javax.swing.*;
import java.awt.*;
public class ChangeBackground extends JFrame{
        public static void main(String[] args) {
                ChangeBackground frame = new ChangeBackground(); }
        ChangeBackground(){
                setTitle("Backgroung Changing");
                setSize(300,300);
                setVisible(true);
            setDefaultCloseOperation( EXIT_ON_CLOSE );
            Container contentPane = getContentPane();
            contentPane.setBackground(Color.blue);
           //getContentPane().setBackground(Color.pink);
  }
}
```

Laying out components

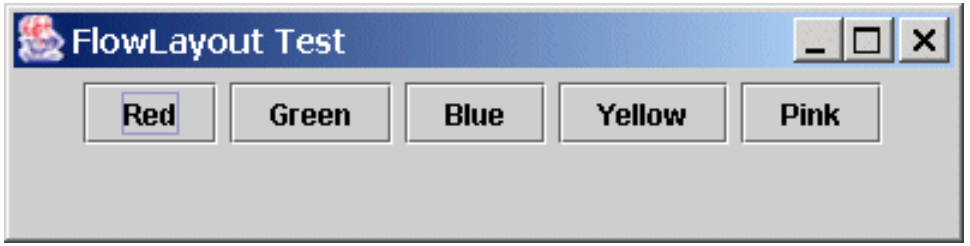
- Layout managers – basically tells form how to align components when they're added.
- Each Container has a layout manager associated with it.
- A JPanel is a Container – used to gather elements together.
  - to have different layout managers associated with different parts of a form, tile with JPanels and set the desired layout manager for each JPanel, then add components directly to panels.
- Most common and easiest to use are
  - FlowLayout
  - BorderLayout
  - GridLayout

FlowLayout manager

- Components are placed in a row from left to right in the order in which they are added.
- The default is to center the components but you can align them to the left or right by specifying LEFT or RIGHT in the constructor.
- A new row is started when no more components can fit in the current row.
- You can choose how you want to arrange components in this row.
- **`FlowLayout` is the default layout for `JPanel`s.**

FlowLayout - Example

```
public class FlowLayoutTest1 extends JFrame {
JButton b1=new JButton("Red"),
b2=new JButton("Green"),b3=new JButton("Blue"),
b4=new JButton("Yellow"),b5=new JButton("Pink");
  public FlowLayoutTest1() {
    setTitle("FlowLayout Test");
    setBounds(0,0,400,100);
    setLayout(new FlowLayout(FlowLayout.RIGHT));
    add(b1);    add(b2);    add(b3);    add(b4);    add(b5);
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    }
  public static void main(String args[]) {
  FlowLayoutTest1 f = new FlowLayoutTest1();
    f.setVisible(true);
  }
}FlowLayoutTest1.java
```

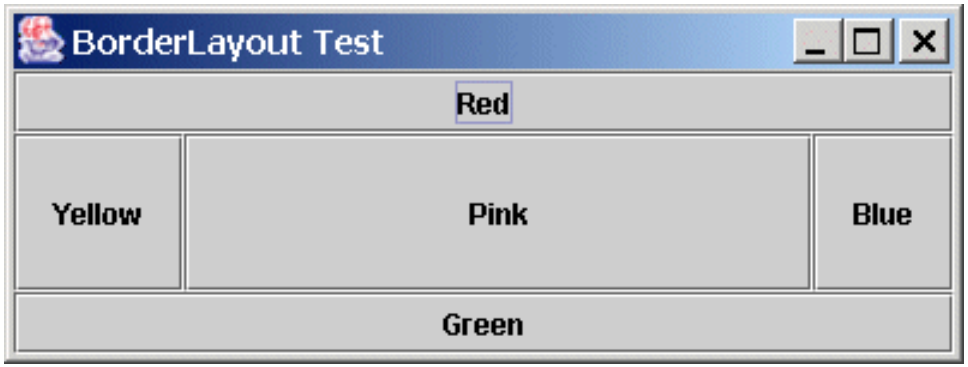


Border Layout

- **This is the default layout manager for the JFrame.**
- It has 5 sections - North, South, East, West, and Center.
- If you don't specify NORTH, SOUTH, EAST, WEST, or CENTER then CENTER is assumed by default.
- The programmer specifies the area in which a component should appear.
- The relative dimensions of the areas are governed by the size of the components added to them.

Border-Layout

Example




```
public class BorderLayoutTest extends JFrame {
  JButton b1=new JButton("Red"),
  b2=new JButton("Green"),b3=new JButton("Blue"),
  b4=new JButton("Yellow"),b5=new JButton("Pink");
  public BorderLayoutTest() {
       setTitle("BorderLayout Test");
       Container pane = getContentPane();
       pane.setLayout(new BorderLayout());
       setBounds(0,0,400,150);
       pane.add(b1,"North"); pane.add(b2,"South");
       pane.add(b3,"East");
       pane.add(b4,"West"); pane.add(b5,"Center");
  }
   public static void main(String args[]) {
       JFrame f = new BorderLayoutTest();
       f.setVisible(true);
  }
}
```

Setting layout managers

- Very easy to associate a layout manager with a component. Simply call the **setLayout** method on the Container:

```
JPanel p1 = new JPanel();
p1.setLayout(new FlowLayout(FlowLayout.LEFT));

JPanel p2 = new JPanel();
p2.setLayout(new BorderLayout());

JPanel p3 = new JPanel();
p3.setLayout(null);
```

As Components are added to the container, the layout manager determines their size and positioning.

Null Layout : ButtonSetDifferent.java
LoginView.java

Swing Components

Text Input

- Text fields
  - Use JTextField to accept one line of text
  - JPanel panel = new JPanel();
    JTextField textField = new JTextField("Default Input", 20);
    panel.add(textField);
  - You can use the setText method to change the text later.
    - textField.setText("Hello");
  - You can use the getText method to get the text from the field. Use the trim method to get rid of leading / trailing spaces.
    - String text = textField.getText()

Swing Text Components

- JLabel - not editable text
- JLabel firstNameLabel = new JLabel("First Name");
- JPasswordField - hides typed characters

```
JPasswordField passField = new JPasswordField(8);
String password = passField.getPassword();
password.setEchoChar('*');
```

- JTextArea - multi-line text entry and/or display

```
JTextArea commentArea = new JTextArea(2,30);
commentArea.setText(comment);
String x= commentArea.getText();
```

Swing Components

```
Jbutton okButton = new JButton("OK");
okButton.setBounds(70, 125, BUTTON_WIDTH, BUTTON_HEIGHT);
JScrollPane scrollText= new JScrollPane(textArea);
scrollText.setBounds(50, 5, 200, 135);
contentPane.add(scrollText);
JRadioButton unixButton = new JRadioButton("Unix",true);
JRadioButton winButton = new JRadioButton("Window",false);
JChecknew Box1 = JCheckBox("Java",true));
JChecknew Box2 = new JCheckBox("Perl",false));
```

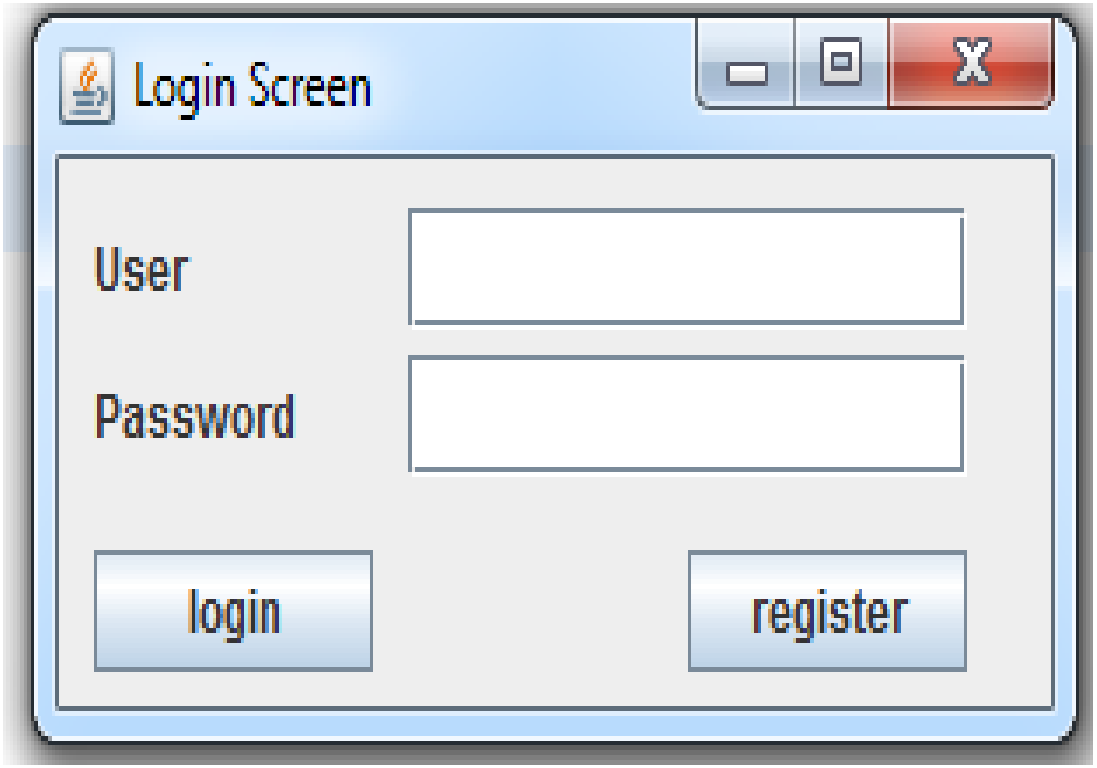
Demo : SwingComponent.java

Main Point

Swing classes are of two kinds: *components* and *containers*. A screen is created by creating components (like buttons, textfields, labels) and arranging them in one or more containers. ***Components and containers are analgous to the manifest and unmanifest fields of life; manifest existence, in the form of individual expressions, lives and moves within the unbounded container of pure existence.***

Practice

Design a given screen using absolute Positioning by setting Layout as null.



Key to *Interactive* User Interfaces: Events

- An event is an object that represents an action:
  - user clicks the mouse
  - user presses a key on the keyboard
  - user closes a window
- In Swing, objects add or implement *listeners* for events.
  - Listeners are *interfaces*.
  - Interfaces are not classes: They define functionality that other classes implement.
  - It's a contract that certain functionality will be provided.

How to Implement an Event Handler

Every event handler requires three pieces of code:

1. declaration of the event handler class that implements a listener interface

public class MyClass implements ActionListener

2. registration of an instance of the event handler class as a listener

someComponent.addActionListener(instanceOfMyClass);

3. providing code that implements the methods in the listener interface in the event handler class

public void actionPerformed(ActionEvent e) { //code that reacts to the action...

}

```
// Implementing Event Listener actionPerformed method in the current class
public class GuiDemo1 implements ActionListener{
 JButton button;
  public static void main(String[] args) {
      GuiDemo1 gui=new GuiDemo1();
      gui.go();
   }
   public void go() {
      JFrame frame=new JFrame();
      button=new JButton("Click");
      frame.getContentPane().add(button);
      button.addActionListener(this);
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      frame.setSize(300, 200);
      frame.setTitle("Click Demo");
      frame.setVisible(true);
   }
 public void actionPerformed(ActionEvent e) {
     button.setText("I've been clicked");
}
}
```

Implementing Events in Inner class

```
public class Events extends JFrame{

private JLabel label;
private JButton button;
private JLabel label1;
private JButton button1;

public Events(){
setLayout(new FlowLayout());
button = new JButton("Click to Get Text");
add(button);
label = new JLabel("");
add(label);
button1 = new JButton("Click to Clear Text");
add(button1);
// User defined class to handle events
event e = new event();
button.addActionListener(e);
event1 e1 = new event1();
button1.addActionListener(e1);
}

//Inner Class
 class event implements ActionListener{
@Override
public void actionPerformed(ActionEvent e) {
label.setText("Now you can see the text of Label");
}}
class event1 implements ActionListener{
@Override
public void actionPerformed(ActionEvent e1) {
label.setText(" ");
setBackground(Color.PINK);}}
public static void main(String[] args) {
Events Gui = new Events();
Gui.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
Gui.setTitle("First Event Frame");
Gui.setSize(300,100);
Gui.setVisible(true);
}
}
```

Implementing in Anonymous Inner class

```
JButton loginButton = new JButton("login");
loginButton.setBounds(10, 80, 80, 25);
frame.add(loginButton);
JButton registerButton = new JButton("register");
registerButton.setBounds(180, 80, 80, 25);
frame.add(registerButton);
//Anonymous class
registerButton.addActionListener(new
ActionListener() {
@Override
public void actionPerformed(ActionEvent e) {
JButton source = (JButton) e.getSource();
JOptionPane.showMessageDialog(source,
source.getText()
+ " button has been pressed");
}
});
```

```
loginButton.addActionListener(new
ActionListener(){
public void actionPerformed(ActionEvent e) {
JButton source = (JButton) e.getSource();
JOptionPane.showMessageDialog(source,
source.getText()
+ " button has been pressed");
}
});
```

Demo Programs

- GuiDemo1.java
- Events.java
- LoginView3.java
- Ch6TextFrame2
- ImageSelection //Optional
- ArithmeticOperation
- JMenuExample // Optional

Displaying Pop-up Messages

The Swing class `JOptionPane` makes it easy to pop up a standard dialog box that prompts users for a value or informs them of something (such as error messages). See the Java API docs for all the different options in using this class. We focus on one common usage here:

Example: In our example, we will add one more piece of functionality. When the user types in the word "error" in the text box, the GUI will respond by displaying a popup with an error message:

After the user presses MyButton, we see

When the user clicks OK, we see that the "Type a string" prompt appears.

To achieve this behavior, we modify the listener code to check for the input "error" like this:

```
class MyButtonListener implements ActionListener {
    public void actionPerformed(ActionEvent evt){
            String textVal = text.getText();
            final String prompt = "Type a string";
            final String youWrote = "You wrote: ";
            if(textVal.equals("") ||
                        textVal.equals(prompt) ||
                        textVal.startsWith(youWrote)){

                text.setText(prompt);
            }
            else if(textVal.equalsIgnoreCase("error")){
                showMessage("An error has occurred!");
                text.setText(prompt);
            }
            else {

                text.setText(youWrote+"\""+textVal+"\".");
            }
    }
}
```

- The work of displaying the message is encapsulated in the `showMessage()` method:

```
private void showMessage(String message){
 JOptionPane.showMessageDialog(this,
       message,
       "Error",
       JOptionPane.ERROR_MESSAGE);
}
```

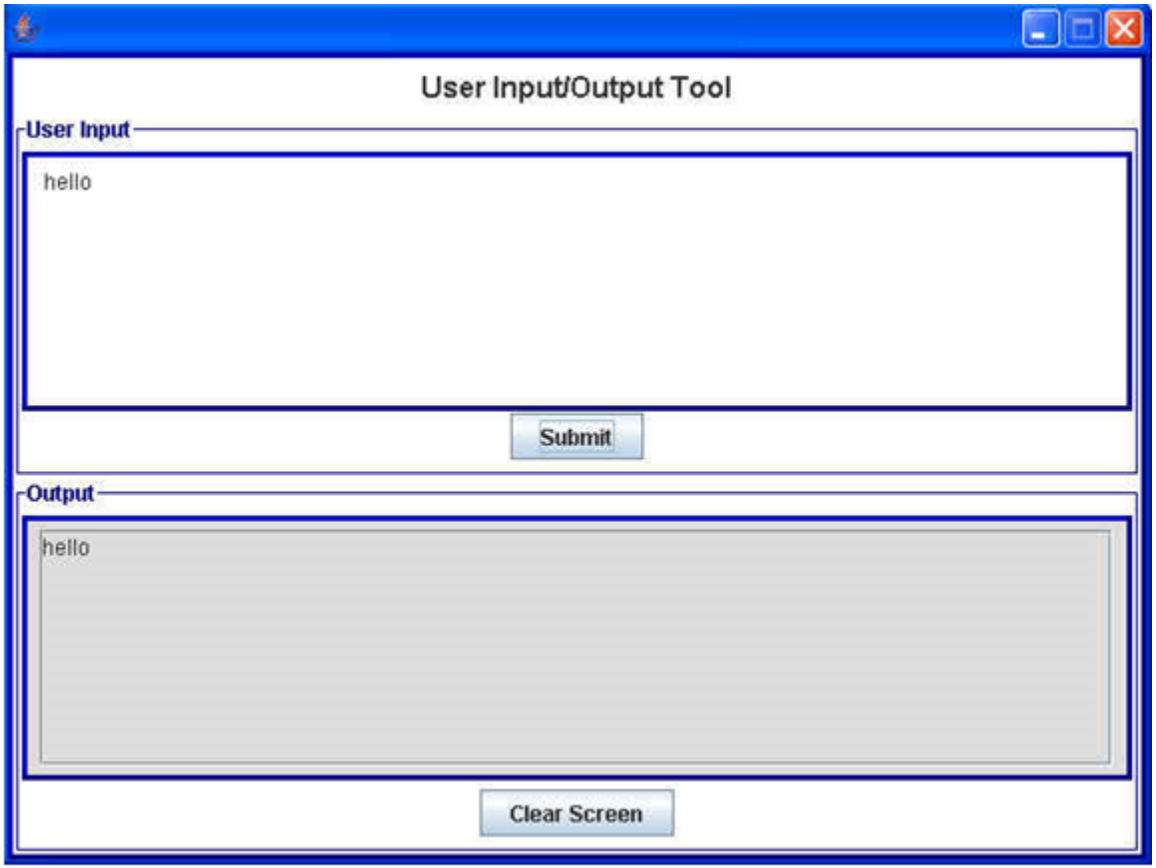
Main Point

A GUI becomes responsive to user interaction (for example, button clicks and mouse clicks) through Swing's event-handling model in which event sources are associated with listener classes, whose actionPerformed method is called (and is passed an event object) whenever a relevant action occurs. To make use of this event-handling model, the developer defines a listener class, implements actionPerformed, and, when defining an event source (like a button), registers the listener class with this event source component. ***The "observer" pattern that is used in Swing mirrors the fact that in creation, the influence of every action is felt everywhere; existence is a field of infinite correlation; every behavior is "listented to" throughout creation.***

Additional Examples(Optional)

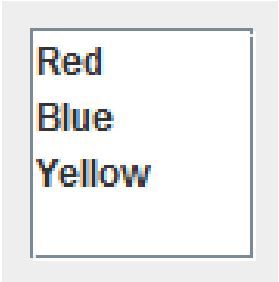
The UserIO GUI

- The class `UserIO` is a simple GUI that we will use in class for some of the labs. It makes use of the principles described here, uses some additional techniques, and is well suited for displaying input/output behavior. See package lesson6.useriogui



Working with JLists in Swing

- A more sophisticated component in Swing is a JList, which displays selectable lists.



- JLists are normally embedded in a JScrollPane to support changes in the size of the list.

```
mainScroll = new JScrollPane(mainList);
```

- It is possible to load data for a JList directly, but the best practice is to load it using a *data model*.

```
JList<String> list = new JList<String>(listModel);
```

A data model keeps data separate from its presentation – this supports the MVC design pattern, which allows presentation and data and change independently. For example, you can present the same data in multiple ways.

Events and Listeners

Event	**Listener**	**Example**
ActionEvent	ActionListener	Button Pressed
AdjustmentEvent	AdjustmentListener	Move a scrollbar
FocusEvent	FocusListener	Tab into a textarea
ItemEvent	ItemListener	Checkbox checked
KeyEvent	KeyListener	Keystroke occurred in a component
MouseEvent	MouseListener	Mouse button click
MouseEvent	MouseMotionListener	Mouse moves or drags
TextEvent	TextListener	A text's component text changed
WindowEvent	WindowListener	Window was closed

Summary

Development in Swing requires knowledge of three areas:

1. ***Containers and Components***. The elements that a user makes use of to interact with a UI – like buttons, textfields, etc – are *components,* which are arranged in Swing *containers*.

2. ***Layout Managers***. Design of a UI first requires the developer to visualize, and sketch out, the desired appearance of windows. This design is translated into Swing components and containers by skillful use of LayoutManagers, which provide rules that determine dimensions and positions of components on the window

3. ***Event-Handling.*** The functionality of a UI – by which a user can initiate an action to obtain a response – is achieved in Swing with *listeners*. Typically on a UI, *ActionListeners,* which are implemented with event-handling code, are attached to components. The event-handling mechanism of Java translates user actions into events that causes the ActionListener code to execute.

Connecting the Parts of Knowledge With the Wholeness of Knowledge

The self-referral dynamics

arising from the reflexive association of container classes

1. In Swing, components are placed and arranged in container classes for attractive display.
2. In Swing, containers are also considered to be components; this makes it possible to place and arrange container classes inside other container classes. These self-referral dynamics support a much broader range of possibilities in the design of GUIs.

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3. **Transcendental Consciousness:** TC is the self-referral field of all possibilities.
4. **Wholeness moving within itself**: In Unity Consciousness, all activity is appreciated as the self-referral dynamics of one's own Self.