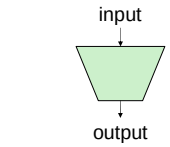
# Introduction to GUIs (Graphical User Interfaces)

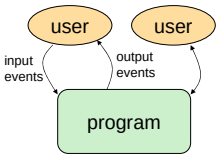
Lecture 18
CS211 – Spring 2007

## Interactive Programs

- "Classic" view of computer programs: transform inputs to outputs, stop




- Event-driven programs: interactive, long-running
  - Servers interact with clients
  - Applications interact with user(s)






## GUI Motivation

- Interacting with a program
  - Program-Driven
    - Statements execute in sequential, predetermined order
    - Typically use keyboard or file I/O, but program determines when that happens
    - Usually single-threaded
  - Event-Driven
    - Program waits for user input to activate certain statements
    - Typically uses a GUI (Graphical User Interface)
    - Often multi-threaded
- Design...Which to pick?
  - Program called by another program?
  - Program used at command line?
  - Program interacts often with user?
  - Program used in window environment?
- How does Java do GUIs?



## Java Support for Building GUIs

- Java Foundation Classes
  - Classes for building GUIs
  - Major components
    - awt and swing
    - Pluggable look-and-feel support
    - Accessibility API
    - Java 2D API
    - Drag-and-drop Support
    - Internationalization
- Our main focus: Swing
  - Building blocks of GUIs
    - Windows & components
    - User interactions
  - Built upon the AWT (Abstract Window Toolkit)
    - Java event model



## Java Foundation Classes

- Pluggable Look-and-Feel Support
  - Controls look-and-feel for particular windowing environment
  - E.g., Java, Windows, Motif, Mac
- Accessibility API
  - Supports assistive technologies such as screen readers and Braille
- Java 2D
  - Drawing
  - Includes rectangles, lines, circles, images, ...
- Drag-and-drop
  - Support for drag and drop between Java application and a native application
- Internationalization
  - Support for other languages



## GUI Statics and GUI Dynamics

- Statics: what's drawn on the screen
  - Components
    - buttons, labels, lists, sliders, menus, ...
  - Containers: components that contain other components
    - frames, panels, dialog boxes, ...
  - Layout managers: control placement and sizing of components
- Dynamics: user interactions
  - Events
    - button-press, mouse-click, key-press, ...
  - Listeners: an object that responds to an event
  - Helper classes
    - `Graphics`, `Color`, `Font`, `FontMetrics`, `Dimension`, ...

## Creating a Window

```
import javax.swing.*;

public class Basic1 {
   public static void main(String[] args) {
      //create the window
      JFrame f = new JFrame("Basic Test!");
      //quit Java after closing the window
      f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      f.setSize(200, 200); //set size in pixels
      f.setVisible(true); //show the window
   }
}
```




## Creating a Window Using a Constructor

```
import javax.swing.*;

public class Basic2 extends JFrame {

   public static void main(String[] args) {
      new Basic2();
   }

   public Basic2() {
      setTitle("Basic Test2!"); //set the title
      //quit Java after closing the window
      setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      setSize(200, 200); //set size in pixels
      setVisible(true); //show the window
   }
}
```



## A More Extensive Example

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class Intro extends JFrame {

   private int count = 0;
   private JButton myButton = new JButton("Push Me!");
   private JLabel label = new JLabel("Count: " + count);

   public Intro() {
      setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      setLayout(new FlowLayout(FlowLayout.LEFT)); //set layout manager
      add(myButton); //add components
      add(label);
      label.setPreferredSize(new Dimension(60, 10));

      myButton.addActionListener(new ActionListener() {
         public void actionPerformed(ActionEvent e) {
            count++;
            label.setText("Count: " + count);
         }
      });

      pack();
      setVisible(true);
   }

   public static void main(String[] args) {
      try {
         UIManager.setLookAndFeel(UIManager.getSystemLookAndFeelClassName());
      } catch (Exception exc) {}
      new Intro();
   }
}
```




## GUI Statics

- Determine which components you want
- Choose a top-level container in which to put the components (**`JFrame`** is often a good choice)
- Choose a layout manager to determine how components are arranged
- Place the components



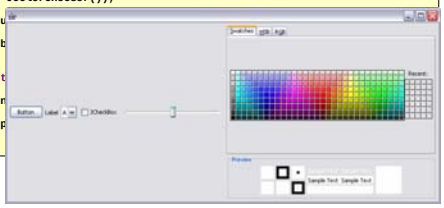
## Components = What You See

- Visual part of an interface
- Represents something with position and size
- Can be *painted* on screen and can receive events
- Buttons, labels, lists, sliders, menus, ...



## Component Examples

```
import javax.swing.*;
import java.awt.*;

public class ComponentExamples extends JFrame {

   public ComponentExamples() {
      setLayout(new FlowLayout(FlowLayout.LEFT));
      add(new JButton("Button"));
      add(new JLabel("Label"));
      add(new JComboBox(new String[] { "A", "B", "C" }));
      add(new JCheckBox("JCheckBox"));
      add(new JSlider(0, 100));
      add(new JColorChooser());

      setDefau
      pack();
      setVisib
   }

   public stat
      try {
         UIMan
      } catch
      new Comp
   }
}
```



## More Components

- **`JFileChooser`**: allows choosing a file
- **`JLabel`**: a simple text label
- **`JTextArea`**: editable text
- **`JTextField`**: editable text (one line)
- **`JScrollBar`**: a scrollbar
- **`JPopupMenu`**: a pop-up menu
- **`JProgressBar`**: a progress bar
- Lots more!

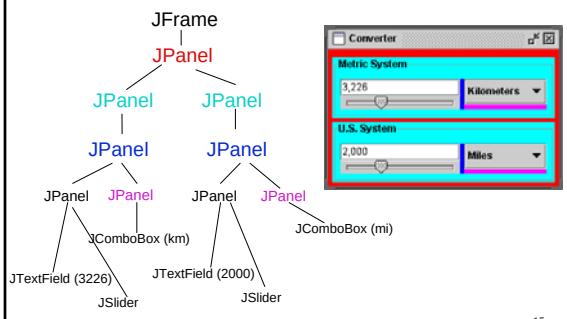


## Containers

- A container is a *component* that
  - Can hold other components
  - Has a *layout manager*
- Heavyweight vs. lightweight
  - A *heavyweight* component interacts directly with the host system
  - **`JWindow`**, **`JFrame`**, and **`JDialog`** are heavyweight
  - Except for these top-level containers, Swing components are almost all lightweight
    - **`JPanel`** is lightweight
- There are three basic *top-level* containers
  - **`JWindow`**: top-level window with no border
  - **`JFrame`**: top-level window with border and (optional) menu bar
  - **`JDialog`**: used for dialog windows
- Another important container
  - **`JPanel`**: used mostly to organize objects within other containers



## A Component Tree






## Layout Managers

- A layout manager controls placement and sizing of components in a container
  - If you do not specify a layout manager, the container will use a default:
    - **`JPanel`** default = **`FlowLayout`**
    - **`JFrame`** default = **`BorderLayout`**
- Five common layout managers: **`BorderLayout`**, **`BoxLayout`**, **`FlowLayout`**, **`GridBagLayout`**, **`GridLayout`**
- General syntax

```
container.setLayout(new LayoutMan());
```

- Examples:

```
JPanel p1 =
   new JPanel(new BorderLayout());

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



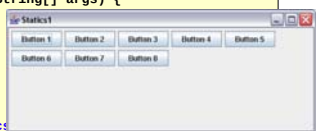
## Some Example Layout Managers

- **`FlowLayout`**
  - Components placed from left to right in order added
  - When a row is filled, a new row is started
  - Lines can be centered, left-justified or right-justified (see **`FlowLayout`** constructor)
  - See also **`BoxLayout`**
- **`GridLayout`**
  - Components are placed in grid pattern
  - number of rows & columns specified in constructor
  - Grid is filled left-to-right, then top-to-bottom
- **`BorderLayout`**
  - Divides window into five areas: North, South, East, West, Center
- Adding components
  - **`FlowLayout`** and **`GridLayout`** use `container.add(component)`
  - **`BorderLayout`** uses `container.add(component, index)` where **`index`** is one of
    - `BorderLayout.North`
    - `BorderLayout.South`
    - `BorderLayout.East`
    - `BorderLayout.West`
    - `BorderLayout.Center`

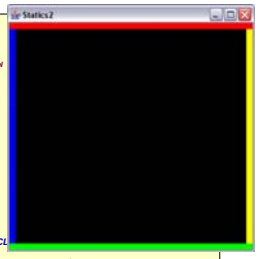


## **`FlowLayout`** Example

```
import javax.swing.*;
import java.awt.*;

public class Statics1 {
   public static void main(String[] args) {
      new S1GUI();
   }
}

class S1GUI {
   private JFrame f;

   public S1GUI() {
      f = new JFrame("Statics
      f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      f.setSize(500, 200);
      f.setLayout(new FlowLayout(FlowLayout.LEFT));
      for (int b = 1; b < 9; b++)
         f.add(new JButton("Button " + b));
      f.setVisible(true);
   }
}
```



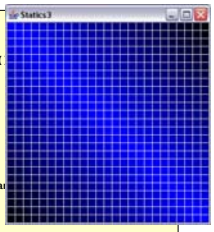
## `BorderLayout` Example



```
import javax.swing.*;
import java.awt.*;

public class Statics2 {
   public static void main(String[] args) { new
}

class ColoredJPanel extends JPanel {
   Color color;
   ColoredJPanel(Color color) {
      this.color = color;
   }
   public void paintComponent(Graphics g) {
      g.setColor(color);
      g.fillRect(0, 0, 400, 400);
   }
}

class S2GUI extends JFrame {
   public S2GUI() {
      setTitle("Statics2");
      setDefaultCloseOperation(JFrame.EXIT_ON_CL
      setSize(400, 400);
      add(new ColoredJPanel(Color.RED), BorderLayout.NORTH);
      add(new ColoredJPanel(Color.GREEN), BorderLayout.SOUTH);
      add(new ColoredJPanel(Color.BLUE), BorderLayout.WEST);
      add(new ColoredJPanel(Color.YELLOW), BorderLayout.EAST);
      add(new ColoredJPanel(Color.BLACK), BorderLayout.CENTER);
      setVisible(true);
   }
}
```



## `GridLayout` Example



```
import javax.swing.*;
import java.awt.*;

public class Statics3 {
   public static void main(String[] args) { new S3GUI(
}

class S3GUI extends JFrame {
   static final int DIM = 25;
   static final int SIZE = 12;
   static final int GAP = 1;

   public S3GUI() {
      setTitle("Statics3");
      setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      setLayout(new GridLayout(DIM, DIM, GAP, GAP));
      for (int i = 0; i < DIM * DIM; i++) add(new MyPa
      pack();
      setVisible(true);
   }

   class MyPanel extends JPanel {
      MyPanel() { setPreferredSize(new Dimension(SIZE, SIZE)); }
      public void paintComponent(Graphics g) {
         float gradient =
            1f - ((float)Math.abs(getX() - getY()))/(float)((SIZE + GAP) * DIM);
         g.setColor(new Color(0f, 0f, gradient));
         g.fillRect(0, 0, getWidth(), getHeight());
      }
   }
}
```



## More Layout Managers

- **`CardLayout`**
  - Tabbed index card look from Windows
- **`GridBagLayout`**
  - Most versatile, but complicated
- Custom
  - Can define your own layout manager
  - But best to try Java's layout managers first...
- Null
  - No layout manager
  - Programmer must specify absolute locations
  - Provides great control, but can be dangerous because of platform dependency



## AWT and Swing

- AWT
  - Initial GUI toolkit for Java
  - Provided a "Java" look and feel
  - Basic API: **`java.awt.*`**
- Swing
  - More recent (since Java 1.2) GUI toolkit
  - Added functionality (new components)
  - Supports look and feel for various platforms (Windows, Motif, Mac)
  - Basic API: **`javax.swing.*`**
- Did Swing replaced AWT?
  - Not quite: both use the AWT event model



## Code Examples

- Intro.java
  - Button & counter
- Basic1.java
  - Create a window
- Basic2.java
  - Create a window using a constructor
- Calculator.java
  - Shows use of **`JOptionPane`** to produce standard dialogs
- ComponentExamples.java
  - Sample components
- Statics1.java
  - **`FlowLayout`** example
- Statics2.java
  - **`BorderLayout`** example
- Statics3.java
  - **`GridLayout`** example
- LayoutDemo.java
  - Multiple layouts