

CS/ENGRD 2110 Object-Oriented Programming and Data Structures

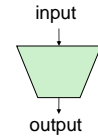
Spring 2012
Thorsten Joachims



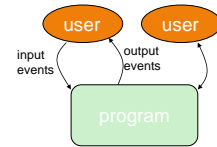
Lecture 14: Graphical User Interfaces (Static)

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)



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GUI Motivation

- Interacting with a Program
 - Program-Driven = Proactive
 - Statements execute in sequential, predetermined order
 - Typically use keyboard or file I/O, but program determines when that happens
 - Usually single-threaded
 - Event-Driven = Reactive
 - 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?

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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

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Java Foundation Classes

- Pluggable Look-and-Feel Support
 - Controls look-and-feel for particular windowing environment
 - E.g., Java, Windows, 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

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GUI Statics and GUI Dynamics

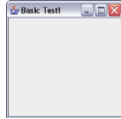
- Statics: what's drawn on the screen
 - Components
 - E.g. buttons, labels, lists, sliders, menus, ...
 - Containers
 - components that contain other components
 - E.g. frames, panels, dialog boxes, ...
 - Layout managers
 - control placement and sizing of components
- Dynamics: user interactions
 -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

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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
    }
}
```



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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(EXIT_ON_CLOSE);
        setSize(200, 200); //set size in pixels
        setVisible(true); //show the window
    }
}
```

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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(EXIT_ON_CLOSE);
        setLayout(new FlowLayout(FlowLayout.LEFT)); //set layout manager
        add(mybutton); //add components
        add(label);
    }

    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();
}
```



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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

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Components = What You See

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

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Component Examples

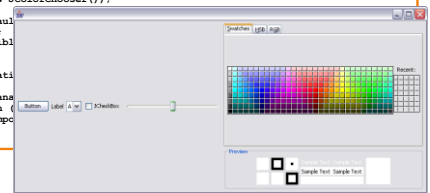
```
import javax.swing.*;
import java.awt.*;

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());
    }

    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    pack();
    setVisible(true);
}

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



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!

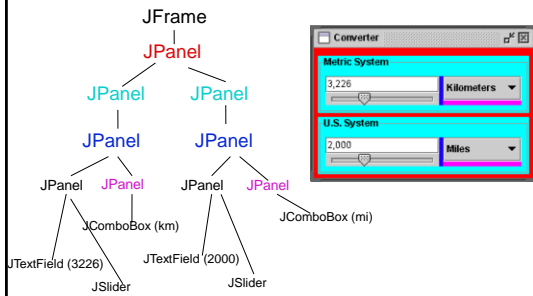
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Containers

- A container is a component that
 - Can hold other components
 - Has a layout manager
- 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
- 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

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A Component Tree



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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());

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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

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FlowLayout Example

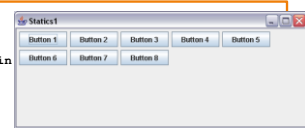
```

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

public class Statics1 {
    public static void main (
        new SIGUI();
    )
}

class SIGUI {
    private JFrame f;

    public SIGUI() {
        f = new JFrame("Statics1");
        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);
    }
}
    
```



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BorderLayout Example

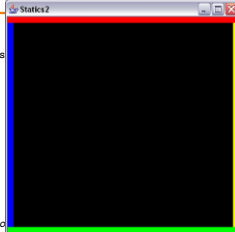
```
import javax.swing.*;
import java.awt.*;

public class Statics2 {
    public static void main(String[] args) { new S2GUI(); }

    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_CLOSE);
            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);
        }
    }
}
```



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GridLayout Example

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

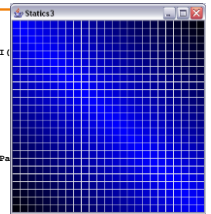
public class Statics3 {
    public static void main(String[] args) { new S3GUI(); }

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

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

    class MyPanel extends JPanel {
        MyPanel() {
            setPreferredSize(new Dimension(SIZE, SIZE));
        }

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



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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

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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, Mac)
 - Basic API: javax.swing.*
- **Did Swing replace AWT?**
 - Not quite: both use the AWT event model

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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

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