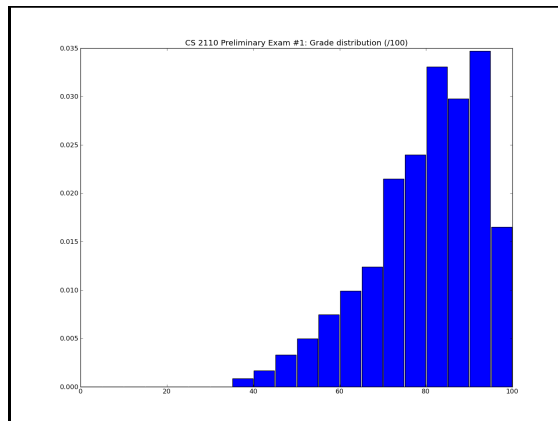


## Prelim 1 Exam

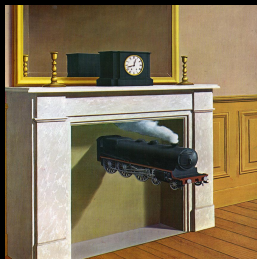
- Available for pick-up in hand-back office
  - Upson 305
  - Hours: MTWF noon-4pm, and R 12:30-4pm
- Solution posted soon
- Generally people did very well
  - Median was around 82%
- Regrades considered (for exceptional cases)
  - Submit written form (on webpage) within a week



## CS/ENGRD 2110 Object-Oriented Programming and Data Structures

Spring 2012

Doug James



### Lecture 14: Graphical User Interfaces (Dynamic)

## 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

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## Dynamics Overview

- Dynamics = causing and responding to actions
  - What actions?
    - Called events: mouse clicks, mouse motion, dragging, keystrokes
    - We would like to write code (a handler) that is invoked when an event occurs so that the program can respond appropriately
    - In Java, you can intercept events by providing an object that "hears" the event – a listener
  - What objects do we need to know about?
    - Events
    - Event listeners

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## Brief Example Revisited

```
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 BorderLayout(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) {
        new Intro();
    }
}
```



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## The Java Event Model

- Timeline
  - User or program does something to a component
    - clicks on a button, resizes a window, ...
  - Java issues an event object describing the event
  - A special type of object (a listener) "hears" the event
    - The listener has a method that "handles" the event
    - The handler does whatever the programmer programmed
- What you need to understand
  - Events: How components issue events
  - Listeners: How to make an object that listens for events
  - Handlers: How to write a method that responds to an event

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## Events

- An Event is a Java object
- Events are normally created by the Java runtime system
  - You can create your own, but this is unusual
- Normally events are associated with a component
- Most events are in `java.awt.event` and `javax.swing.event`
- All events are subclasses of `AWTEvent`
- Event types:
  - `ActionEvent`
  - `AdjustmentEvent`
  - `ComponentEvent`
  - `ContainerEvent`
  - `FocusEvent`
  - `HierarchyEvent`
  - `InputEvent`
  - `InputMethodEvent`
  - `InvocationEvent`
  - `ItemEvent`
  - `KeyEvent`
  - `MouseEvent`
  - `MouseWheelEvent`
  - `PaintEvent`
  - `TextEvent`
  - `WindowEvent`

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## Types of Events

- Each Swing Component can generate one or more types of events
  - The type of event depends on the component
    - Clicking a `JButton` creates an `ActionEvent`
    - Clicking a `JCheckbox` creates an `ItemEvent`
  - The different kinds of events include different information about what has occurred
    - All events have method `getSource()` which returns the object (e.g., the button or checkbox) on which the Event initially occurred
    - An `ItemEvent` has a method `getStateChange()` that returns an integer indicating whether the item (e.g., the checkbox) was selected or deselected

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## Event Listeners

- **`ActionListener`, `MouseListener`, `WindowListener`, ...**
- Listeners are Java interfaces
  - Any class that implements that interface can be used as a listener
- To be a listener, a class must implement the interface
  - E.g. an `ActionListener` must contain a method `public void actionPerformed(ActionEvent e)`

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## Implementing Listeners

- Which class should be a listener?
  - Java has no restrictions on this, so *any* class that implements the listener will work
- Typical choices:
  - Top-level container that contains whole GUI
 

```
public class GUI implements ActionListener
```
  - Inner classes to create specific listeners for reuse
 

```
private class LabelMaker implements ActionListener
```
  - Anonymous classes created on the spot
 

```
b.addActionListener(new ActionListener() {...});
```

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## Listeners and Listener Methods

- When you implement an interface, you must implement all the interface's methods
  - Interface `ActionListener` has one method:
    - `void actionPerformed(ActionEvent e)`
  - Interface `MouseListener` has five methods:
    - `void mouseClicked(MouseEvent e)`
    - `void mouseEntered(MouseEvent e)`
    - `void mouseExited(MouseEvent e)`
    - `void mousePressed(MouseEvent e)`
    - `void mouseReleased(MouseEvent e)`
  - Interface `MouseMotionListener` has two methods:
    - `void mouseDragged(MouseEvent e)`
    - `void mouseMoved(MouseEvent e)`

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## Registering Listeners

- How does a component know which listener to use?
- You must *register* the listeners
  - This connects listener objects with their source objects
  - Syntax: `component.add(Listener (Listener))`
  - You can register as many listeners as you like
- Example:

```
b.addActionListener(new ActionListener() {
    public void actionPerformed(ActionEvent e) {
        count++;
        label.setText(generateLabel());
    }
});
```

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## Example 1: The Frame is the Listener

```
import javax.swing.*; import java.awt.*; import java.awt.event.*;
public class ListenerExample1 extends JFrame implements ActionListener {
    private int count;
    private JButton b = new JButton("Push Me!");
    private JLabel label = new JLabel("Count: " + count);
    public static void main(String[] args) {
        JFrame f = new ListenerExample1();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.setSize(200,100);
        f.setVisible(true);
    }
    public ListenerExample1() {
        setLayout(new FlowLayout(FlowLayout.LEFT));
        add(b); add(label);
        b.addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        count++;
        label.setText("Count: " + count);
    }
}
```

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## Example 2: The Listener is an Inner Class

```
import javax.swing.*; import java.awt.*; import java.awt.event.*;
public class ListenerExample2 extends JFrame {
    private int count;
    private JButton b = new JButton("Push Me!");
    private JLabel label = new JLabel("Count: " + count);
    class Helper implements ActionListener {
        public void actionPerformed(ActionEvent e) {
            count++;
            label.setText("Count: " + count);
        }
    }
    public static void main(String[] args) {
        JFrame f = new ListenerExample2();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.setSize(200,100); f.setVisible(true);
    }
    public ListenerExample2() {
        setLayout(new FlowLayout(FlowLayout.LEFT));
        add(b); add(label);
        b.addActionListener(new Helper());
    }
}
```

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## Example 3: The Listener is an Anonymous Class

```
import javax.swing.*; import java.awt.*; import java.awt.event.*;
public class ListenerExample3 extends JFrame {
    private int count;
    private JButton b = new JButton("Push Me!");
    private JLabel label = new JLabel("Count: " + count);
    public static void main (String[] args) {
        JFrame f = new ListenerExample3();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.setSize(200,100); f.setVisible(true);
    }
    public ListenerExample3() {
        setLayout(new FlowLayout(FlowLayout.LEFT));
        add(b); add(label);
        b.addActionListener(new ActionListener() {
            public void actionPerformed (ActionEvent e) {
                count++;
                label.setText("Count: " + count);
            }
        });
    }
}
```

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## Adapters

- Some listeners (e.g., **MouseListener**) have lots of methods; you don't always need all of them
  - For instance, you may be interested only in mouse clicks
- For this situation, Java provides "adapters"
  - An adapter is a predefined class that implements all the methods of the corresponding listener
    - Example: **MouseAdapter** is a class that implements all the methods of interfaces **MouseListener** and **MouseMotionListener**
  - The adapter methods do nothing
  - To easily create your own listener, you extend the adapter class, overriding just the methods that you actually need

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## Using Adapters

```
import javax.swing.*; import javax.swing.event.*;
import java.awt.*; import java.awt.event.*;
public class AdapterExample extends JFrame {
    private int count; private JButton b = new JButton("Mouse Me!");
    private JLabel label = new JLabel("Count: " + count);
    class Helper extends MouseAdapter {
        public void mouseEntered(MouseEvent e) {
            count++;
            label.setText("Count: " + count);
        }
    }
    public static void main(String[] args) {
        JFrame f = new AdapterExample();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.setSize(200,100); f.setVisible(true);
    }
    public AdapterExample() {
        setLayout(new FlowLayout(FlowLayout.LEFT));
        add(b); add(label);
        b.addMouseListener(new Helper());
    }
}
```

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## Notes on Events and Listeners

- A single component can have many listeners
- Multiple components can share the same listener
  - Can use `event.getSource()` to identify the component that generated the event
- For more information on designing listeners, see <http://download.oracle.com/javase/tutorial/uiswing/events/>.
- For more information on designing GUIs, see <http://download.oracle.com/javase/tutorial/uiswing/>.

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## GUI Drawing and Painting

- For a drawing area, extend `JPanel` and override the method
 

```
public void paintComponent(Graphics g)
```

  - `paintComponent` contains the code to completely draw *everything* in your drawing panel
  - Do not call `paintComponent` directly – instead, request that the system redraw the panel at the next convenient opportunity by calling `panel.repaint()`
  - `repaint()` requests a call `paintComponent()` “soon” (i.e. within milliseconds)

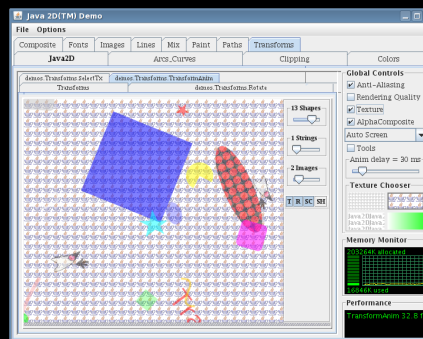
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## Java Graphics

- The `Graphics` class has methods for colors, fonts, and various shapes and lines
  - `setColor(Color c)`
  - `drawOval(int x, int y, int width, int height)`
  - `fillOval(int x, int y, int width, int height)`
  - `drawLine(int x1, int y1, int x2, int y2)`
  - `drawString(String str, int x, int y)`
- Take a look at
  - `java.awt.Graphics` (for basic graphics)
  - `java.awt.Graphics2D` (for more sophisticated control)
  - The 2D Graphics Trail: <http://java.sun.com/docs/books/tutorial/2d/>
  - examples on the web site

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## An example from the web



<http://linuxhippy.blogspot.com/2008/12/almost-pure-java2d.html>

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