GUI Programming

CMSC 202

Why Java GUI Development?

- After all CMSC 202 is is about Object Oriented Programming, not GUIs
- GUIs are a good example of OOP
- GUIs are another example of containers

Java and GUIs

- There are two primary built-in packages that provide GUI components in Java
  - java.awt.*
  - java.swing.*
- The Abstract Window Toolkit (AWT)
  - Java's original GUI toolkit
  - Leverages native toolkits to draw widgets
- Swing
  - Offers a more complete set of widgets
  - System or Java look and feel
  - Leverages AWT throughout APIs

Containers

- In Java, all GUI components go into a Container - which is simply a widget that can contain other widgets
- A top-level container can stand alone in a window environment
  - e.g. JFrame
- Some containers may only be added to other containers
  - e.g. JPanel

Components

- A component is simply an object that has a graphical representation that can be displayed on screen
- A component acts as a base class for all swing components, except top level containers
- Examples of components include:
  - JButton, JComboBox, JLabel, JList, JMenuBar, JPanel, JSlider, JSpinner, JTable, etc...

JFrame

- A JFrame is often the highest-level widget in your application in which all other widgets will get packed
- JFrames are usually constructed using the following constructor:

```
public JFrame(String title);
```

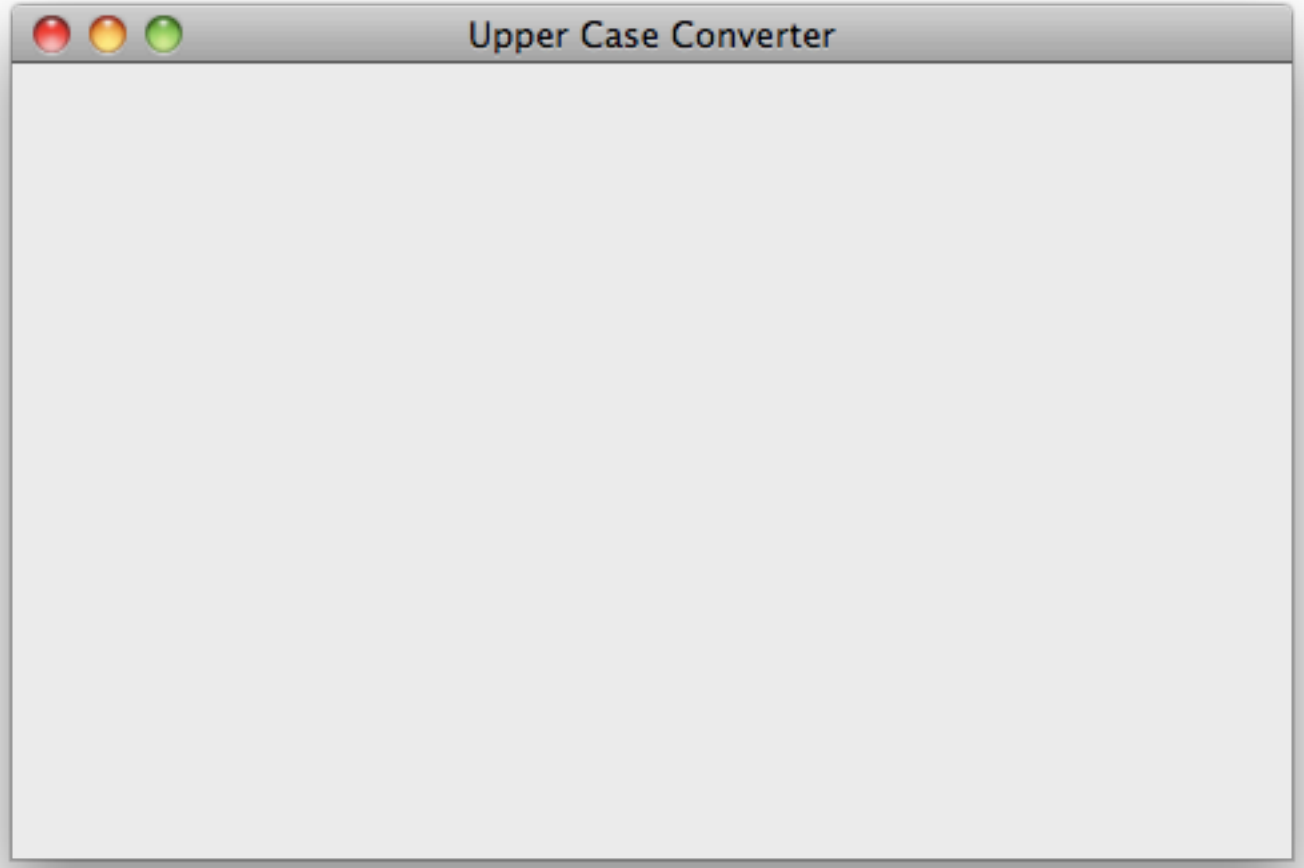
Common JFrame Methods

- add(Component c)
  - adds objects to the frame
- setVisible(boolean b)
  - makes the frame visible
- setLocation(int x, int y)
  - aligns top left corner of frame with coordinates on screen
- setSize(int width, int height)
  - sets size of frame in pixels
- setDefaultCloseOperation(int operation)
  - defines what should happen when the window is closed, usually call with the constant WindowConstants.EXIT_ON_CLOSE

JFrame Example

```
import javax.swing.JFrame;
import javax.swing.WindowConstants;

public class UpperCaseConverter extends JFrame {

    public UpperCaseConverter() {
        super("Upper Case Converter");
        setLocation(100, 100);
        setSize(480, 320);
        setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
    }

    public static void main(String[] args) {
        UpperCaseConverter ucc = new UpperCaseConverter();
        ucc.setVisible(true);
    }

}
```

JFrame Example



Layout Managers

- Every container has an underlying default LayoutManager
- The LayoutManager determines:
  - The size of the objects in the container and
  - How the objects will be laid out
- The default LayoutManager for a JFrame is a BorderLayout

BorderLayout

- The BorderLayout manager divides container into five regions
  - BorderLayout.NORTH
  - BorderLayout.SOUTH
  - BorderLayout.CENTER
  - BorderLayout.EAST
  - BorderLayout.WEST
- One component per region
- Component takes size of region
- Center region is greedy
- Components are added to center by default

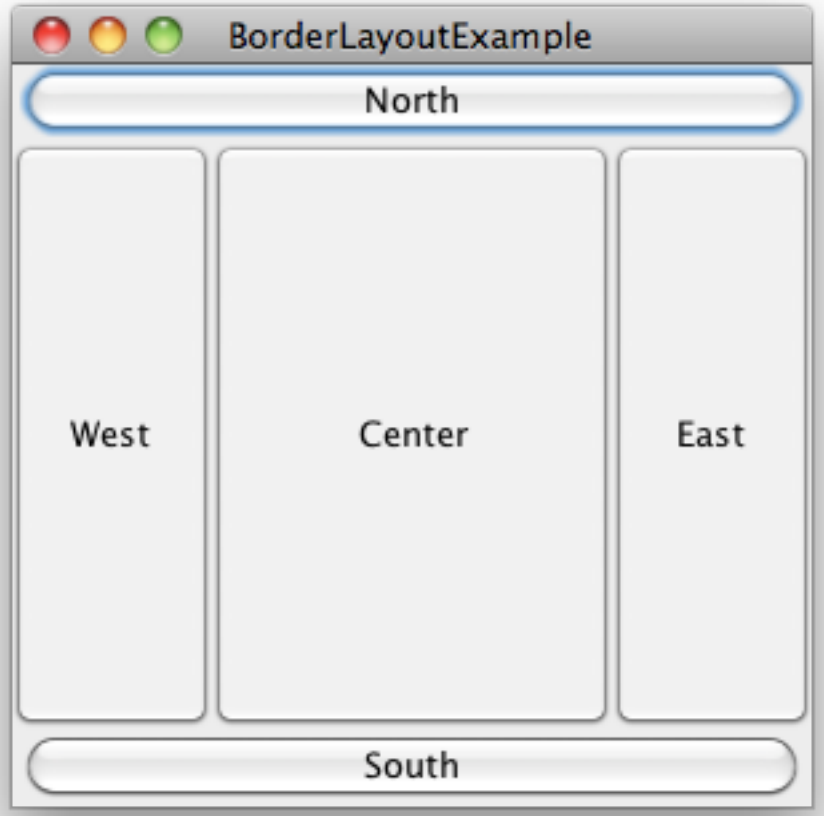
JButton

- A JButton provides a basic button that a user can interact with
- A JButton may consist of a combination of label and/or icon and is typically constructed using one of the following constructors:
  - JButton(Icon icon)
    - Creates a button with an icon
  - JButton(String text)
    - Creates a button with text
  - JButton(String text, Icon icon)
    - Creates a button with initial text and an icon

BorderLayoutExample

```
import java.awt.BorderLayout;

import javax.swing.JButton;
import javax.swing.JFrame;

public class BorderLayoutExample extends JFrame {

  public BorderLayoutExample(String name) {
    super(name);
    setSize(300, 300);
    add(new JButton("North"), BorderLayout.NORTH);
    add(new JButton("South"), BorderLayout.SOUTH);
    add(new JButton("East"), BorderLayout.EAST);
    add(new JButton("West"), BorderLayout.WEST);
    add(new JButton("Center"), BorderLayout.CENTER);
  }
  public static void main(String args[]) {
    BorderLayoutExample b = new BorderLayoutExample("BorderLayoutExample");
    b.setVisible(true);
  }
}
```

BorderLayoutExample



JPanel

- Say we want to put several buttons in the North region of the GUI, but BorderLayout only allows one component per region…
- Add a second level container like a JPanel
- JPanels have a FlowLayout manager by default

FlowLayout

- Lays components in a fluid direction as determined by its orientation
- By default, orientation is L → R, T → B
- Possible to set the horizontal and vertical width between components
- Components take preferred size
  - For buttons, preferred size is the size of the text within them

FlowLayout

```
// ...

public UpperCaseConverter() {

    // code from previous slides ...

    JPanel topPanel = new JPanel();
    JButton upperButton = new JButton("To Upper");
    JButton clearButton = new JButton("Clear");
    topPanel.add(upperButton);
    topPanel.add(clearButton);
    add(topPanel, BorderLayout.NORTH);
}

// ...
```

FlowLayout

JLabel

- The JLabel represents a static label
- Like buttons, they can consist of text and/or images and are usually constructed using one of the following constructors…
  - JLabel()
    - Creates a JLabel instance with no image and with an empty string for the title.
  - JLabel(Icon image)
    - Creates a JLabel instance with the specified image.
  - JLabel(String text)
    - Creates a JLabel instance with the specified text.
  - JLabel(String text, Icon icon, int horizontalAlignment)
    - Creates a JLabel instance with the specified text, image, and horizontal alignment

JTextField

- A JTextField provides an entry for a single line of text
- A JTextField may be constructed with a set width or with default text and is usually constructed using one of the following constructors:
  - JTextField()
    - Constructs a new TextField
  - JTextField(int columns)
    - Constructs a new empty TextField with the specified number of columns
  - JTextField(String text)
    - Constructs a new TextField initialized with the specified text
  - JTextField(String text, int columns)
    - Constructs a new TextField initialized with the specified text and columns

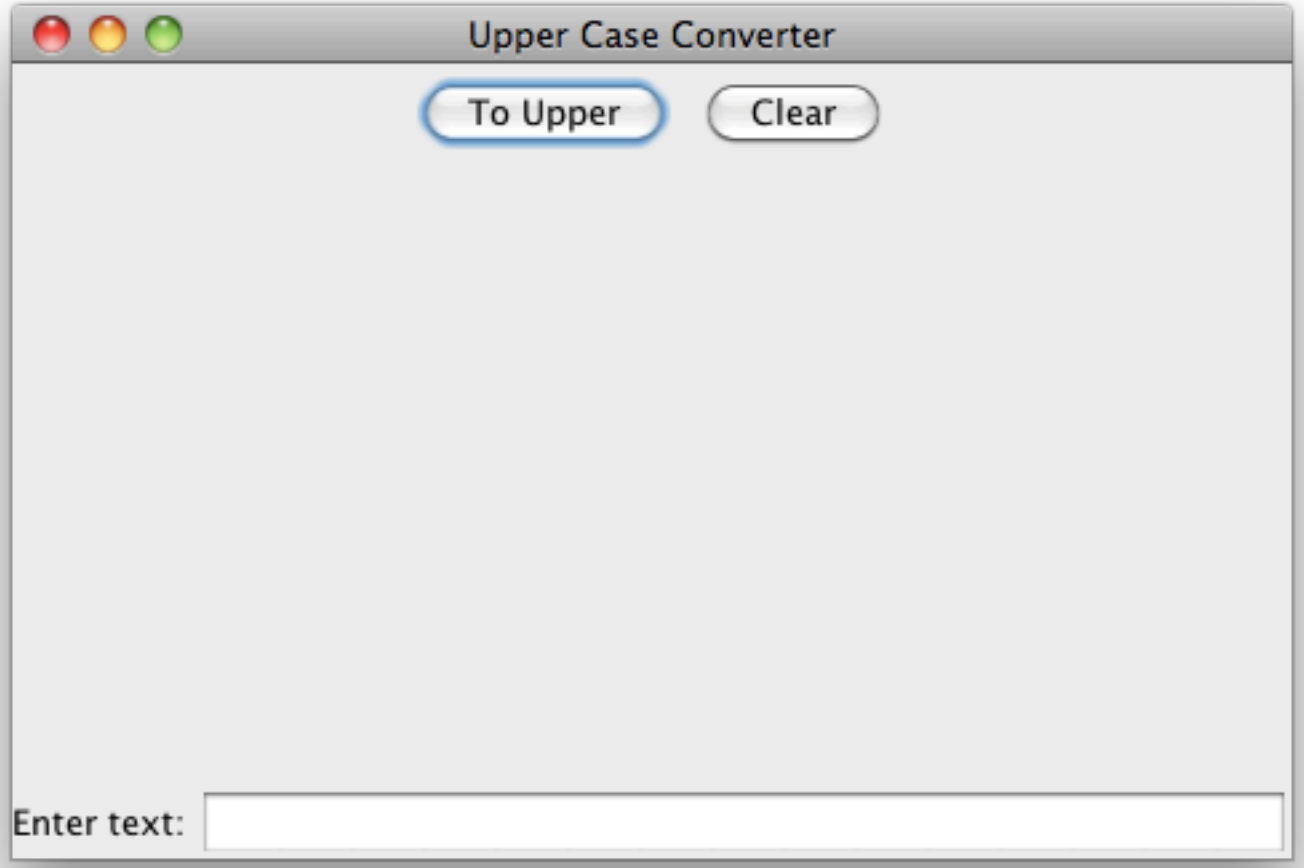
Overriding a Panel's Layout Manager

- You can also over-ride the layout manager for most containers
- For example, we can change a JPanel's layout from a flow layout to a border layout if that's more appropriate for what we're laying out

Overriding a Panel's Layout Manager

```
// ...

public UpperCaseConverter() {

    // code from previous slides ...

    JPanel bottomPanel = new JPanel();
    bottomPanel.setLayout(new BorderLayout());
    JLabel enterTextLabel = new JLabel("Enter text: ");
    JTextField textField = new JTextField(20);
    bottomPanel.add(enterTextLabel, BorderLayout.WEST);
    bottomPanel.add(textField, BorderLayout.CENTER);
    add(bottomPanel, BorderLayout.SOUTH);
}

// ...
```

Overriding a Panel's Layout Manager



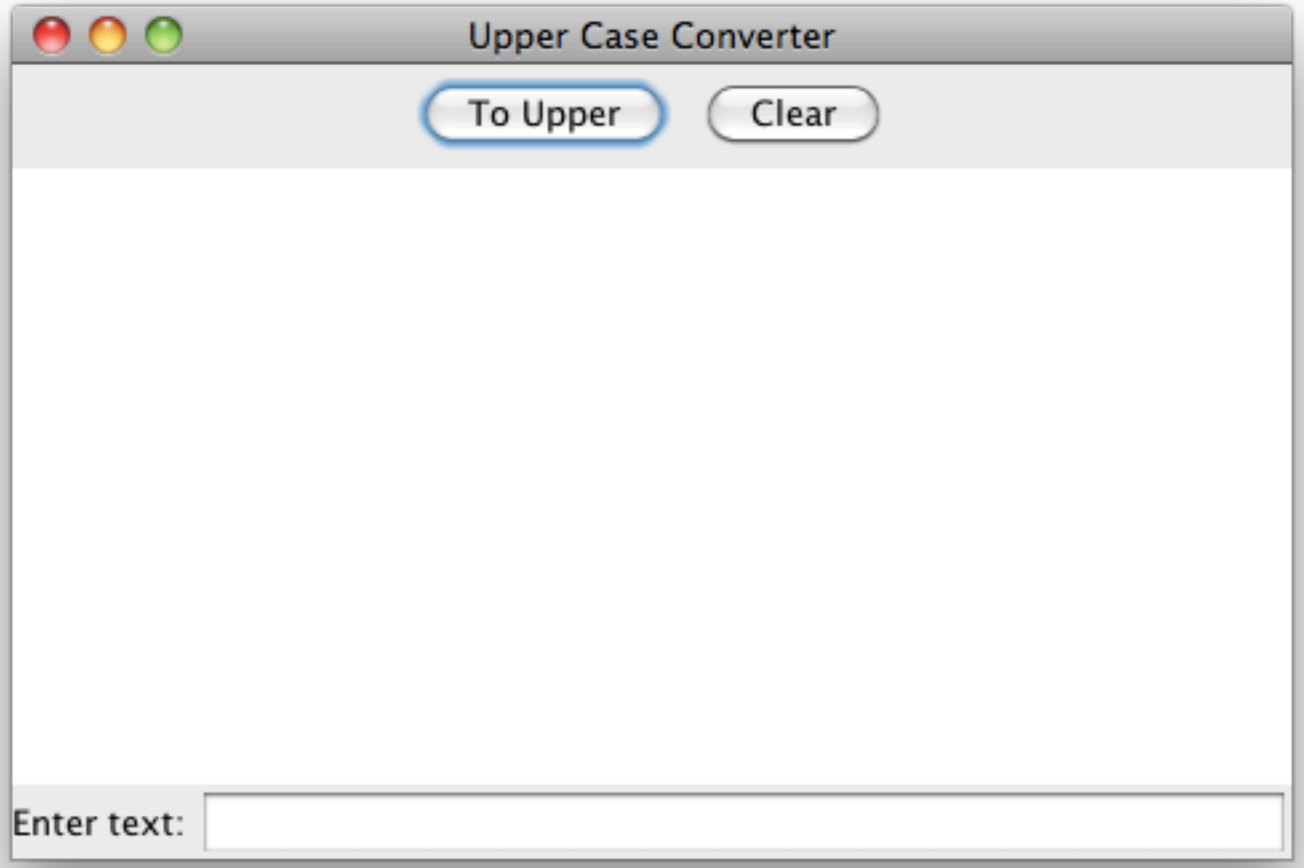
JTextArea

- A JTextArea is similar to a JTextField, except that it is capable of displaying multiple lines of text
- A JTextArea can be constructed with a given size and/or default text and is typically constructed using one of the following constructors:
  - JTextArea()
    - Constructs a new TextArea.
  - JTextArea(int rows, int columns)
    - Constructs a new empty TextArea with the specified number of rows and columns.
  - JTextArea(String text)
    - Constructs a new TextArea with the specified text displayed.
  - JTextArea(String text, int rows, int columns)
    - Constructs a new TextArea with the specified text and number of rows and columns.

JTextArea

```
// ...

public UpperCaseConverter() {

    // code from previous slides ...

    JTextArea textArea = new JTextArea();
    textArea.setEditable(false);
    add(textArea, BorderLayout.CENTER);
}

// ...
```

JTextArea



Responding to Actions

- Currently our button doesn't do anything when pressed, to respond to this action we need to add an ActionListener
- An ActionListener can be added to a button using the following method:
  - public void addActionListener(ActionListener l);
- The ActionListener interface is quite simple, in that it only requires one to implement a single method:
  - void actionPerformed(ActionEvent e)

Letting our class implement ActionListener

- One approach to implementing an ActionListener is to have “this” class implement it

```
button.addActionListener(this);
```

Implementing ActionListener as an Anonymous Class

- Another approach is to actually define an inline anonymous class to handle the actions
- The class is considered inline as it is declared in the context of another class
- It is also considered anonymous, as the new class is not given a name

Simple Action Listeners

```
// ...

public UpperCaseConverter() {

    // code from previous slides ...
    upperButton.addActionListener(new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            System.out.println("button pressed");
        }
    });
    clearButton.addActionListener(new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            System.out.println("button pressed");
        }
    });
}

// ...
```

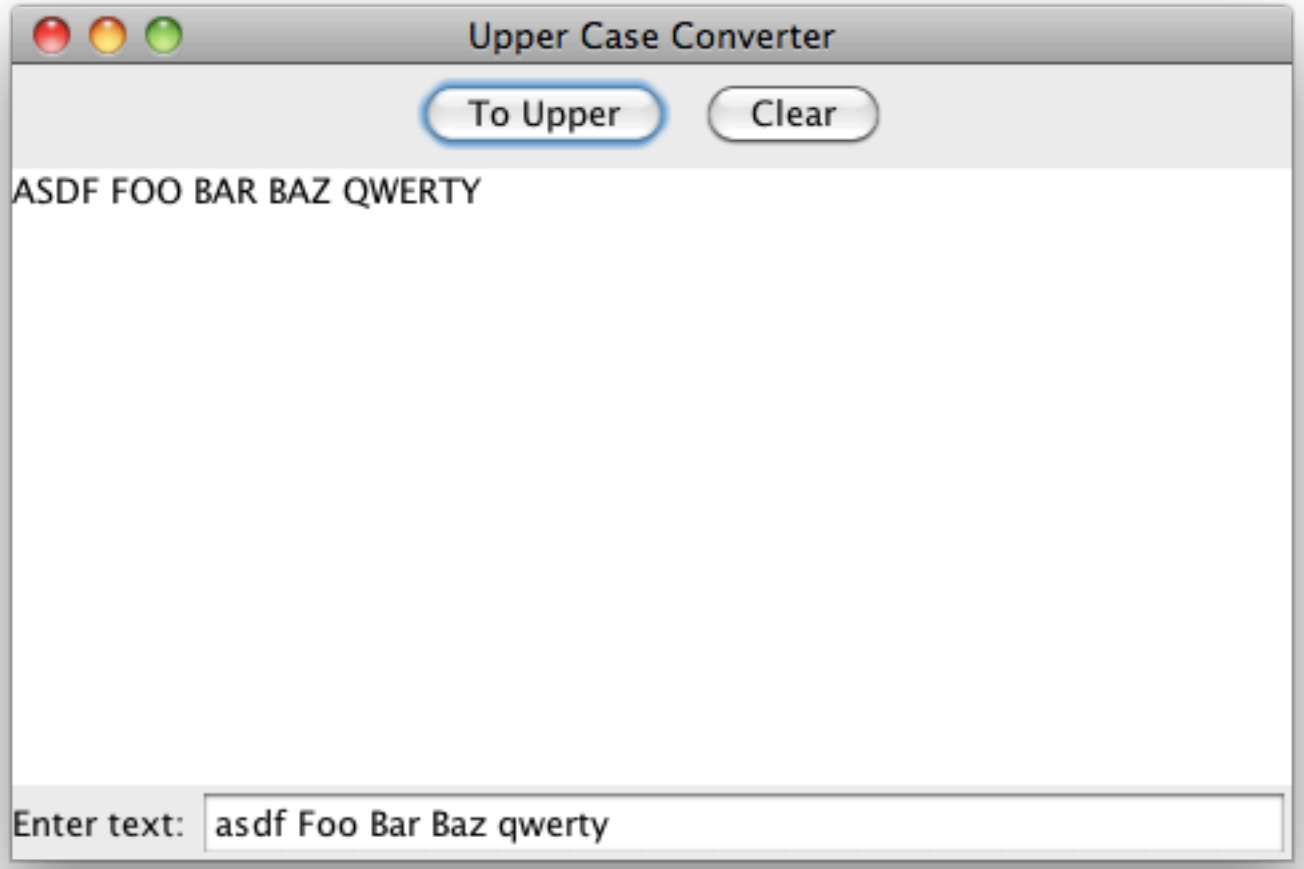
Manipulating Widgets

- Rather than simply printing “button pressed” let’s modify our ActionListener to read the value of the JTextField and write to the JTextArea
- As such we're going to need to references to those widgets — we have 2 options
  - Store the widgets as members of the class
  - Mark the widget references as final

More Interesting Action Listeners

```
// ...

public UpperCaseConverter() {

    // code from previous slides...
    // with upperButton and clearButton declared final

    upperButton.addActionListener(new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            textArea.setText(textField.getText().toUpperCase());
        }
    });

    clearButton.addActionListener(new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            textArea.setText("");
            textField.setText("");
            textField.requestFocus();
        }
    });
}
// ...
```

More Interesting Action Listeners



Look and Feel

- By default, Java uses its own Look and Feel
- If you'd like to use the native look and feel for your OS, simply perform the following before displaying any windows:

```
try {
    UIManager.setLookAndFeel(
        UIManager.getSystemLookAndFeelClassName()
    );
} catch (Exception e) {
    // handle or ignore
}
```

Scratching the Surface

- What we've looked at here is really just the tip of the iceberg, there a lot to swing
- Some selected references...
  - A Visual Guide to Layout Managers
  - Swing Features
  - A Visual Guide to Swing Components
  - Trail: Creating a GUI With JFC/Swing