Building a GUI in Java with Swing

Software Engineering
CITS1220
Lecture Outline

1. Swing components
2. Building a GUI
3. Animating the GUI
Swing

- A collection of classes of GUI components
- Contains classes to implement windows, buttons, menus etc.
- Uses “event listener” model to attach handlers to the UI components
- Huge and complex collection of packages
- Augments/replaces older AWT
Basic Workflow

- Create a window to hold your entire GUI
- Arrange UI components inside the window
  - Add individual components, or
  - Group components into containers and add *them* to the window
- Attach handler(s) to each UI component to handle the events they generate
The main window

- The class `javax.swing.JFrame` is used as the outermost window in a Swing GUI

  - `java.lang.Object`
    - `java.awt.Component`
      - `java.awt.Container`
      - `java.awt.Window`
      - `java.awt.Frame`
      - `javax.swing.JFrame`
Extend JFrame

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

public class MyGUI extends JFrame {
    // Declare UI components

    public MyGUI(String title) {
        super(title);
        // Add UI components
        pack();
        setVisible(true);
    }
}
```
Constructor

- First, call the superclass constructor
- Then add any UI components (none yet)
- Then “pack” the window - this lays out the UI components
- Make the window visible
  - Currently the window appears, but does nothing at all!
Getting rid of the window

- What should happen if the user closes the window?
- For the main application, closing should terminate the program
  ```java
  setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
  ```
- Other options are
  - DO NOTHING ON CLOSE, HIDE ON CLOSE, DISPOSE ON CLOSE
UI Components

- Many UI components, including
  - JLabel - information labels
  - JButton - clickable buttons
  - JTextField - text entry fields

- Organize these with
  - A layout manager, and
  - JPanel to group components
An RPN Calculator

A JLabel for the output

Lots of JButton

A JPanel to organise the buttons

The outside JFrame

9234.0134
The contents of any container are laid out according to a specified “layout manager”

- `java.awt.FlowLayout` - free flowing
- `java.awt.BorderLayout` - five different areas (center, north, south, east, west)
- `java.awt.GridLayout` - rectangular grid
- `java.awt.GridBagLayout` - complex grid
Which layouts?

- The overall JFrame will have a BorderLayout with a JLabel in the “North” position and the button panel in the “Center” position
- In the constructor for MyGUI we add
  ```java
  setLayout(new BorderLayout());
  ```
Add the display label

- In the instance variables
  ```java
  private JLabel display;
  ```

- In the constructor
  ```java
  display = new JLabel("0", SwingConstants.RIGHT);
  add(display, BorderLayout.NORTH);
  ```
Declare the buttons

- Extra instance variables

```java
private JButton[] numbers = new JButton[10];

private JButton add;
private JButton sub;
private JButton mul;
private JButton div;

private JButton decimal;
private JButton enter;
```
Create the buttons

for (int i=0; i<10; i++)
    numbers[i] = new JButton(String.valueOf(i));

decimal = new JButton(".");

add = new JButton("+");
sub = new JButton("-");
div = new JButton("/");
mul = new JButton("*");

enter = new JButton("Enter");
Create the button panel

```java
JPanel buttonPanel = new JPanel();
buttonPanel.setLayout(new GridLayout(4,4));
```
Add buttons to the panel..

```java
buttonPanel.add(numbers[7]);
buttonPanel.add(numbers[8]);
buttonPanel.add(numbers[9]);
buttonPanel.add(mul);
...
```

- Each new component occupies the next empty grid position working row by row..

```java
...
buttonPanel.add(numbers[0]);
buttonPanel.add(decimal);
buttonPanel.add(enter);
buttonPanel.add(div);
```
Add panel to main JFrame

add(buttonPanel,BorderLayout.CENTER);
Ugly GUI

- This is pretty ugly at the moment - it can be beautified with borders, background colours, images etc.
- However this is beyond our immediate scope!
Adding logic

- Now we need to add the logic - to actually respond to button clicks etc.
- The GUI will be responsible for the entry and display of the numbers, while an existing class will manage the arithmetic
Make the GUI an ActionListener

- Declare that the class implements the java.awt.event.ActionListener interface

```java
import java.awt.event.*;
public class MyGUI extends JFrame
    implements ActionListener {

    // previous code goes here

}
```
Register with all the buttons

While the GUI constructs the buttons, it should register itself with them

```java
for (int i=0; i<10; i++) {
    numbers[i] = new JButton(String.valueOf(i));
    numbers[i].addActionListener(this);
}
decimal = new JButton(".");
decimal.addActionListener(this);
```
A required method

- To claim to be an `ActionListener`, the GUI object must implement
  
  ```java
  void actionPerformed(ActionEvent e)
  ```

- Whenever an action occurs on a UI component (e.g. a `JButton`) the button calls `this method` of all of its registered listeners
What should it do?

- Every time the user clicks a button, the button will call the `actionPerformed` method of the GUI object.
- The GUI object therefore needs to:
  - Work out which button was pushed
  - Do the appropriate thing
Which button was pushed?

- The `ActionEvent` object contains this information and it can be obtained using `e.getActionCommand()`.

- Each button has an “action command”
  - The default “action command” is simply the label on the button, or
  - (Better) the programmer can set the action command on construction of the button.
What should our GUI do?

```java
public void actionPerformed(ActionEvent e) {
    String s = e.getActionCommand();
    switch (s.charAt(0)) {
        case '+':
            case '-':
            case '*':
            case '/': doOperation(s);
                break;
        case 'E': doEnter(s);
            break;
        default: processDigitOrDecimal(s);
    }
}
```
Processing digits

- Extract the currently displayed string from the JLabel that is the display
  String curr = display.getText();
- Perform some processing to decide how the display should be updated, and then set some new text
  display.setText(update);
Processing logic

- Logic is surprisingly involved!
  - If display at maximum length, do nothing
  - If button pressed was “.” and display already contains a “.” do nothing
  - If display currently “0”
    - If button pushed was a digit then replace the 0
    - If button pushed was “.” then append it to the 0
  - Otherwise
    - Append the string to the current display
Regular Expressions

- A regular expression, often called a pattern, is an expression that describes a set of strings.
- The IEEE POSIX Basic Regular Expressions (BRE) standard can be used to denote regular expressions.
RE examples

- [ab6] matches a or b or 6
- [a-z] matches any lower case letter from a to z
- [a-z]* matches any sequence of zero or more lower case letters
- [a]*b[0-9]* matches aaab04324324, b, ab999 etc
- a-[c]* matches a followed by - followed by zero or more c characters
String.matches

- public boolean matches(String regex)

  - Tells whether or not this string matches the given regular expression.
  - Regular expressions in Java use the Posix standard
A simple test program for experimenting with REs

String s = "aaabbb";

if (s.matches("[a]*[b]*")) {
    System.out.println("matches");
} else {
    System.out.println("does not match");
}