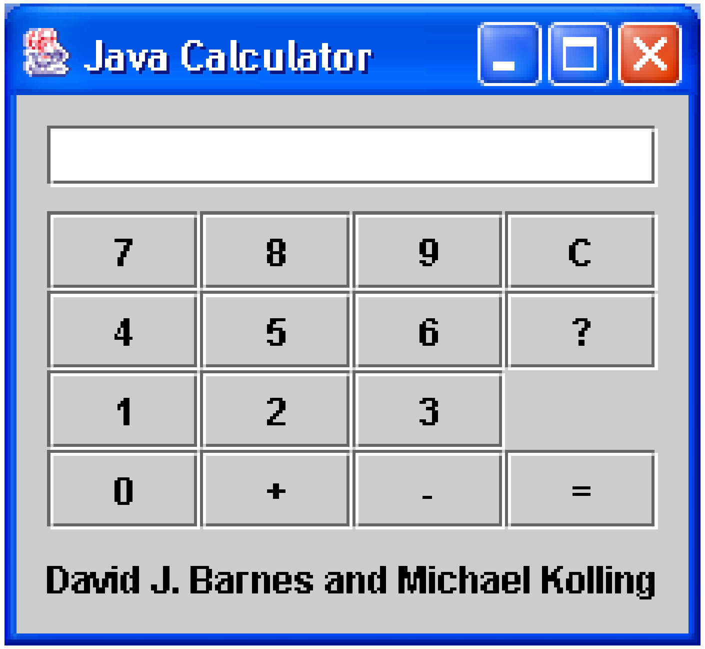
A Calculator Project

- This will be our first exposure to building a Graphical User Interface (GUI) in Java
- The functions of the calculator are self-evident



- The Calculator class creates a UserInterface Class and a CalcEngine Class
- We will learn how to create objects such as Buttons and respond to the event that the button was pressed

Calculator Class

```
/**
 * The main class of a simple calculator. Create one of these and you'll
 * get the calculator on screen.
 * @author David J. Barnes and Michael Kolling
 * @version 31 July 2000
 */
public class Calculator
{
    private CalcEngine engine;
    private UserInterface gui;

    /**
     * Create a new calculator and show it.
     */
    public Calculator()
    {
        engine = new CalcEngine();
        gui = new UserInterface(engine);
    }

    /**
     * In case the window was closed, show it again.
     */
    public void show()
    {
        gui.setVisible(true);
    }
}
```

Highlights of Building a GUI - 1

- The Layout Components
  - The outer component is a Jframe
  - A Jpanel has a border layout has five areas: NORTH, EAST, SOUTH, WEST, and CENTER
  - The buttons on the calculator are arranged in a 4x4 grid layout
- Objects placed in the layout
  - The display of the numeric value is a JTextField
  - The buttons are, not surprisingly, JButton objects
  - The message at the bottom is a JLabel

Highlights of Building a GUI - 2

- Each Button has an actionListener attached to it; the events listen for button presses
- actionPerformed uses the button label to separate out button presses and handles each button press accordingly
- Think ahead and try to predict how each of these button presses will be handled
  - Buttons 0..9
  - Buttons + and –
  - The = Button
  - The C (clear) button
  - The ? Button

The GUI - 1

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

public class UserInterface
    implements ActionListener
{
    private CalcEngine calc;
    private boolean showingAuthor;

    private JFrame frame;
    private JTextField display;
    private JLabel status;

    /**
     * Create a user interface for a given calcEngine.
     */
    public UserInterface(CalcEngine engine)
    {
        calc = engine;
        showingAuthor = true;
        makeFrame();
        frame.setVisible(true);
    }
  // methods go here
}
```

The GUI - 2

```
/**
 * Make this interface visible again. (Has no effect if it is already
 * visible.)
 */
public void setVisible(boolean visible)
{
    frame.setVisible(visible);
}

/**
 * Make the frame for the user interface.
 */
private void makeFrame()
{
    frame = new JFrame(calc.getTitle());

    JPanel contentPane = (JPanel)frame.getContentPane();
    contentPane.setLayout(new BorderLayout(8, 8));
    contentPane.setBorder(new EmptyBorder( 10, 10, 10, 10));

    display = new JTextField();
    contentPane.add(display, BorderLayout.NORTH);

    JPanel buttonPanel = new JPanel(new GridLayout(4, 4));
        addButton(buttonPanel, "7");
        addButton(buttonPanel, "8");
        addButton(buttonPanel, "9");
        addButton(buttonPanel, "C");
```

The GUI - 3

```
        addButton(buttonPanel, "4");
        addButton(buttonPanel, "5");
        addButton(buttonPanel, "6");
        addButton(buttonPanel, "?");

        addButton(buttonPanel, "1");
        addButton(buttonPanel, "2");
        addButton(buttonPanel, "3");
        buttonPanel.add(new JLabel(" "));

        addButton(buttonPanel, "0");
        addButton(buttonPanel, "+");
        addButton(buttonPanel, "-");
        addButton(buttonPanel, "=");

    contentPane.add(buttonPanel, BorderLayout.CENTER);
    status = new JLabel(calc.getAuthor());
    contentPane.add(status, BorderLayout.SOUTH);
    frame.pack();
}

private void addButton(Container panel, String buttonText)
{
    JButton button = new JButton(buttonText);
    button.addActionListener(this);
    panel.add(button);
}
```

The GUI - 4

```
public void actionPerformed(ActionEvent event)
{   String command = event.getActionCommand();
    if(command.equals("0") ||
       command.equals("1") ||
       command.equals("2") ||
       command.equals("3") ||
       command.equals("4") ||
       command.equals("5") ||
       command.equals("6") ||
       command.equals("7") ||
       command.equals("8") ||
       command.equals("9"))
    {
        int number = Integer.parseInt(command);
        calc.numberPressed(number);
    }
    else if(command.equals("+"))
        calc.plus();
    else if(command.equals("-"))
        calc.minus();
    else if(command.equals("="))
        calc.equals();
    else if(command.equals("C"))
        calc.clear();
    else if(command.equals("?"))
        showInfo();
    redisplay();
}
```

```
/**
 * Update the interface display to show the current value of the
 * calculator.
 */
private void redisplay()
{
    display.setText("" + calc.getDisplayValue());
}

/**
 * Toggle the info display in the calculator's status area between the
 * author and version information.
 */
private void showInfo()
{
    if(showingAuthor)
        status.setText(calc.getVersion());
    else
        status.setText(calc.getAuthor());

    showingAuthor = !showingAuthor;
}
```

The GUI - 5

The Event Handlers - 1

- The model of a calculation
  - Numeric operations have the form
    `<leftOperand> <operation> <lastOperand>`
  - We have to remember the leftOperand and the operation while the lastOperand is fetched
  - The value that is displayed is held in displayValue
- Now be very specific
- What happens when a digit key is pressed?

The Event Handlers – 2

- Buttons + and –
- The = button (this takes some thought)
- The C (clear) button
- A question: how is a chain calculation, such as 2 + 3 + 4 + 5 =, handled?

Calculator Engine - 1

```
/**
 * The main part of the calculator doing the calculations.
 * @author  David J. Barnes and Michael Kolling
 * @version 1.0
 */
public class CalcEngine
{
    // The calculator's state is maintained in three fields:
    //     buildingDisplayValue, haveLeftOperand, and lastOperator.
    // Are we already building a value in the display, or will the
    // next digit be the first of a new one?
    private boolean buildingDisplayValue;
    // Has a left operand already been entered (or calculated)?
    private boolean haveLeftOperand;
    // The most recent operator that was entered.
    private char lastOperator;
    // The current value (to be) shown in the display.
    private int displayValue;
    // The value of an existing left operand.
    private int leftOperand;

    /**
     * Create a CalcEngine instance.
     */
    public CalcEngine()
    {   clear();   }
    // methods go here
}
```

Calculator Engine - 2

```
/**
 * Return the value that should currently be displayed
 * on the calculator display.
 */
public int getDisplayValue()
{
    return displayValue;
}

/**
 * A number button was pressed.
 * Either start a new operand, or incorporate this number as
 * the least significant digit of an existing one.
 */
public void numberPressed(int number)
{
    if(buildingDisplayValue) {
        // Incorporate this digit.
        displayValue = displayValue*10 + number;
    }
    else {
        // Start building a new number.
        displayValue = number;
        buildingDisplayValue = true;
    }
}
```

Calculator Engine - 3

```
/**
 * The 'plus' button was pressed.
 */
public void plus()
{   applyOperator('+');  }

/**
 * The 'minus' button was pressed.
 */
public void minus()
{   applyOperator('-');  }

/**
 * The '=' button was pressed.
 */
public void equals()
{   // This should completes the building of a second operand,
    // so ensure that we really have a left operand, an operator
    // and a right operand.
    if(haveLeftOperand &&
            lastOperator != '?' &&
            buildingDisplayValue) {
        calculateResult();
        lastOperator = '?';
        buildingDisplayValue = false;
    }
    else {  keySequenceError();   }
}
```

Calculator Engine - 4

```
/**
 * The 'C' (clear) button was pressed.
 * Reset everything to a starting state.
 */
public void clear()
{
    lastOperator = '?';
    haveLeftOperand = false;
    buildingDisplayValue = false;
    displayValue = 0;
}

/**
 * Return the title of this calculation engine.
 */
public String getTitle()
{
    return "Java Calculator";
}

/**
 * Return the author of this engine.
 */
public String getAuthor()
{
    return "David J. Barnes and Michael Kolling";
}
```

Calculator Engine - 5

```
public String getVersion()
{  return "Version 1.0";  }

/**
 * Combine leftOperand, lastOperator, and the
 * current display value.
 * The result becomes both the leftOperand and
 * the new display value.
 */
private void calculateResult()
{
    switch(lastOperator) {
        case '+':
            displayValue = leftOperand + displayValue;
            haveLeftOperand = true;
            leftOperand = displayValue;
            break;
        case '-':
            displayValue = leftOperand - displayValue;
            haveLeftOperand = true;
            leftOperand = displayValue;
            break;
        default:
            keySequenceError();
            break;
    }
}
```

```
/**
 * Apply the given operator.
 */
private void applyOperator(char operator)
{
    // If we are not in the process of building a new operator
    // then it is an error, unless we have just calculated a
    // result using '='.
    if(!buildingDisplayValue &&
                !(haveLeftOperand && lastOperator == '?')) {
        keySequenceError();
        return;
    }

    if(lastOperator != '?') {
        // First apply the previous operator.
        calculateResult();
    }
    else {
        // The displayValue now becomes the left operand of this
        // new operator.
        haveLeftOperand = true;
        leftOperand = displayValue;
    }
    lastOperator = operator;
    buildingDisplayValue = false;
}
```

Calculator Engine - 6

```
/**
 * Report an error in the sequence of keys that was pressed.
 */
private void keySequenceError()
{
    System.out.println("A key sequence error has occurred.");
    // Reset everything.
    clear();
}
```

Calculator Engine – 7

Lab 15 – A Binary Calculator

- Binary numerals only contain digits 0 and 1 so there are only two digit buttons
- There is only one operation, +, and the equal key to complete a calculation
- What differs most from the previous calculator is that there are two types of clear:
  - CA (clear all) resets all fields to start an entire new calculation
  - C (clear) only resets the current operand, any left operand and operation are retained

Binary Addition

- The basic operations
  0 + 0 = 0, 0 + 1 = 1, 1 + 0 = 1,
  1 + 1 = 10   this mean 0 and carry 1 to the left
- Examples, with the decimal values at the right

```
   1 0 1 1 0 1 (45)
+    1 0 1 1 0 (22)
-----------------
 1 0 0 0 0 1 1 (67)


   1 1 1 1 1 1 (63)
+    1 1 1 1 1 (31)
-----------------
 1 0 1 1 1 1 0 (94)
```