Java Programming Tutorial

Graphics Programming Exercises

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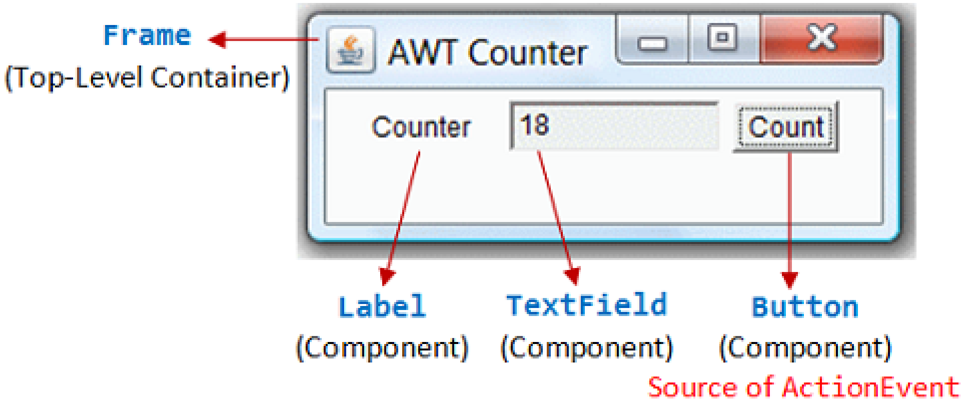
1. AWT GUI Applications/Applets

1.1 Ex: AWTCounter



Write an AWT GUI application (called `AWTCounter`) as shown in the Figure. Each time the "Count" button is clicked, the counter value shall increase by 1.

The program has three components:

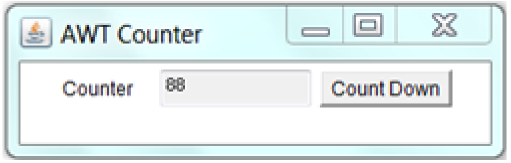
1. a `java.awt.Label` "`Counter`";
2. a non-editable `java.awt.TextField` to display the counter value; and
3. a `java.awt.Button` "`Count`".

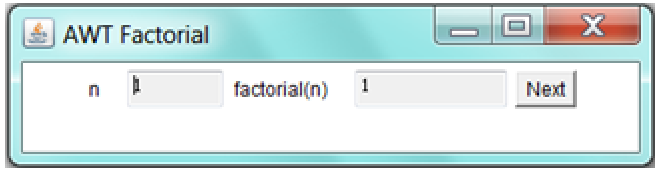
The components are placed inside the top-level AWT container `java.awt.Frame`, arranged in `FlowLayout`.

```
import java.awt.*;         // Using AWT's containers and components
import java.awt.event.*;   // Using AWT's event classes and listener interfaces

// An AWT GUI program inherits the top-level container java.awt.Frame
public class AWTCounter extends Frame implements ActionListener {
   private Label lblCount;     // Declare component Label
   private TextField tfCount;  // Declare component TextField
   private Button btnCount;    // Declare component Button
   private int count = 0;      // counter's value

   // Constructor to setup UI components and event handlers
   public AWTCounter () {
      setLayout(new FlowLayout());
         // "super" Frame sets layout to FlowLayout, which arranges
         //  Components from left-to-right, then top-to-bottom.

      lblCount = new Label("Counter"); // Construct component Label
      add(lblCount);                   // "super" Frame adds Label

      tfCount = new TextField(count + "", 10); // Construct component TextField
      tfCount.setEditable(false);       // read-only
      add(tfCount);                     // "super" Frame adds TextField

      btnCount = new Button("Count");   // Construct component Button
      add(btnCount);                    // "super" Frame adds Button
      btnCount.addActionListener(this);
         // btnCount is the source object that fires ActionEvent when clicked.
         // The source add "this" instance as an ActionEvent listener, which provides
         //  an ActionEvent handler called actionPerformed().
         // Clicking btnCount invokes actionPerformed().

      setSize(250, 100);       // "super" Frame sets initial size
      setTitle("AWT Counter"); // "super" Frame sets title
      setVisible(true);        // show "super" Frame
   }

   // ActionEvent handler - Called back when the button is clicked.
   @Override
   public void actionPerformed(ActionEvent evt) {
      ++count;                     // Incrase the counter value
      tfCount.setText(count + ""); // Display on the TextField
                                   // setText() takes a String
   }

   // The entry main() method
   public static void main(String[] args) {
      // Invoke the constructor by allocating an anonymous instance
      new AWTCounter();
   }
}
```

You have to use control-c, or "close" the CMD shell, or hit the "terminate" button on Eclipse's Console to terminate the program. This is because the program does not process the `WindowEvent` fired by the "window-close" button.

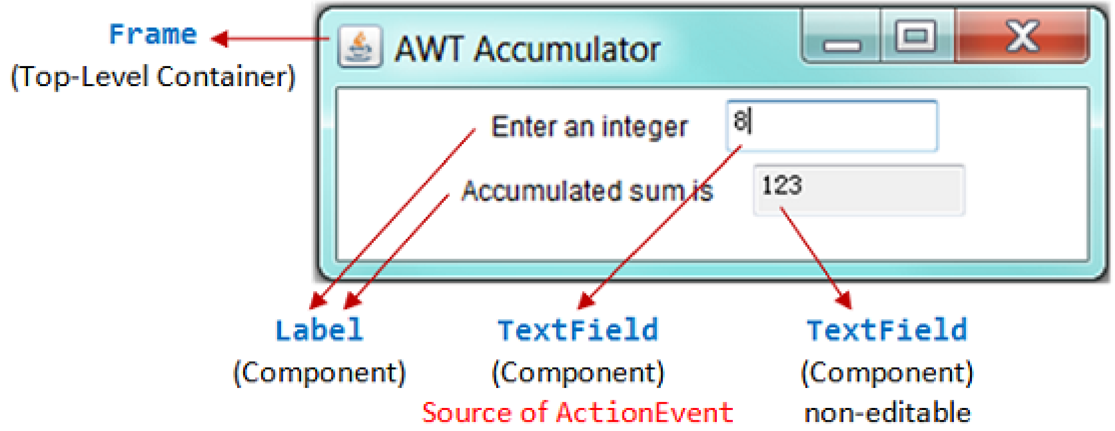
TRY:





1. Modify the program (called `AWTCounterDown`) to count down, with an initial value of 88, as shown.
2. Modify the program (called `AWTFactorial`) to display n and factorial of n, as shown. Clicking the "Next" button shall increase n by 1. n shall begin at 1.

1.2 Ex: AWTAccumulator



Write an AWT GUI application called `AWTAccumulator`, which has four components:

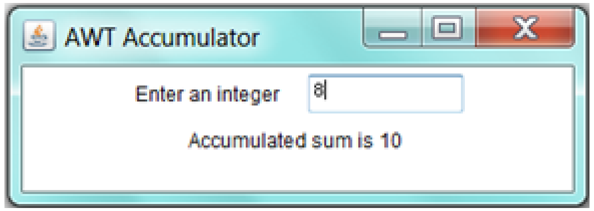
1. a `java.awt.Label` "Enter an integer and press enter";
2. an input `java.awt.TextField`;
3. a `java.awt.Label` "The accumulated sum is", and
4. a protected (read-only) `java.awt.TextField` for displaying the accumulated sum.

The four GUI components are placed inside a container `java.awt.Frame`, arranged in `FlowLayout`. The program shall accumulate the numbers entered into the input `TextField`, and display the accumulated sum on the display `TextField`.

```
import java.awt.*;       // Using AWT's containers and components
import java.awt.event.*; // Using AWT's event classes and listener interfaces

// A GUI program inherits the top-level Container java.awt.Frame
public class AWTAccumulator extends Frame implements ActionListener {
   private Label lblInput;     // Declare input Label
   private Label lblOutput;    // Declare output Label
   private TextField tfInput;  // Declare input TextField
   private TextField tfOutput; // Declare output display TextField
   private int sum = 0;        // The accumulated sum, init to 0
```

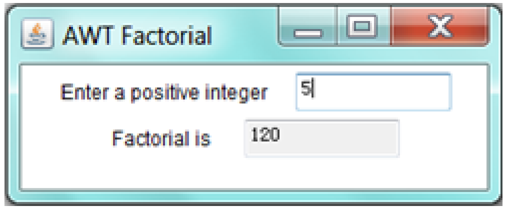
```java

   // Constructor to setup the UI components and event handlers
   public AWTAccumulator() {
      setLayout(new FlowLayout()); // "super" Frame sets to FlowLayout

      lblInput = new Label("Enter an integer"); // Construct component Label
      add(lblInput);  // "super" Frame adds the Label

      tfInput = new TextField(10);  // Construct component TextField
      add(tfInput);   // "super" Frame adds the TextField

      tfInput.addActionListener(this);
         // tfInput is a source that fires ActionEvent when entered.
         // The source add "this" instance as a ActionEvent listener, which provides
         //  an ActionEvent handler called actionPerformed().
         // Hitting enter on tfInput invokes actionPerformed().

      lblOutput = new Label("Accumulated sum is");  // Construct component Label
      add(lblOutput);  // "super" Frame adds Label

      tfOutput = new TextField(10); // Construct component TextField
      tfOutput.setEditable(false);  // read-only
      add(tfOutput);   // "super" Frame adds TextField

      setTitle("AWT Accumulator"); // "super" Frame sets title
      setSize(350, 120);    // "super" Frame sets initial size
      setVisible(true);     // "super" Frame shows
   }

   // The entry main() method
   public static void main(String[] args) {
      // Invoke the constructor by allocating an anonymous instance
      new AWTAccumulator();
   }

   // ActionEvent handler - Called back when enter key was hit on TextField.
   @Override
   public void actionPerformed(ActionEvent evt) {
      int numberIn = Integer.parseInt(tfInput.getText());
               // Get the String entered, convert to int
      sum += numberIn;      // Accumulate numbers entered into sum
      tfInput.setText("");  // Clear input TextField
      tfOutput.setText("" + sum); // Display sum on the output TextField, convert int to String
   }
}
```

TRY:



Enter an integer 8

Accumulated sum is 10



Enter a positive integer 5

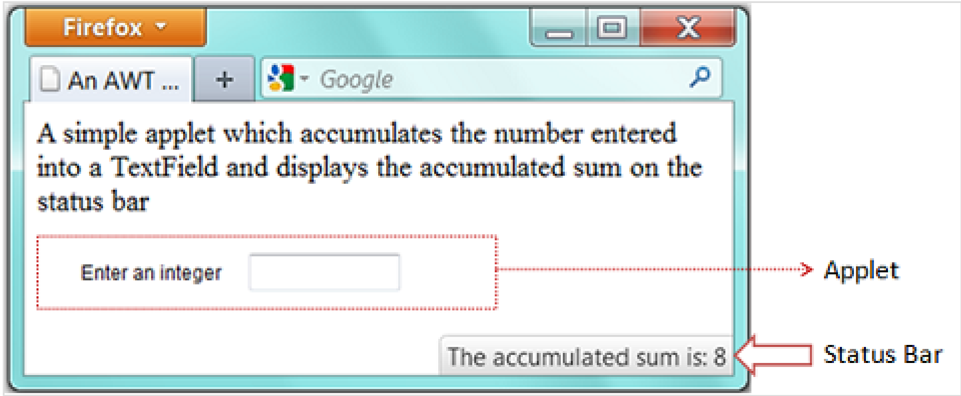
Factorial is 120

1. Modify the program (called `AWTAccumulatorLabel`) to display the sum using a `Label` instead of a protected `TextField`, as shown.
2. Modify the program (called `AWTFactorialTextField`) to display the factorial of the input number, as shown.

1.3 Ex: `AWTAccumulatorApplet`

An Java *applet* is a graphics program run inside a browser. Write a Java applet (called `AWTAccumulatorApplet`) which contains:

1. a `label` "Enter an integer:",
2. a `TextField` for user to enter a number.
3. The applet shall accumulate all the integers entered and show it on the status bar of the browser's window.



A simple applet which accumulates the number entered into a TextField and displays the accumulated sum on the status bar

Enter an integer

The accumulated sum is: 8

```
import java.applet.Applet;
import java.awt.*;        // Using AWT's containers and components
import java.awt.event.*;  // Using AWT's event classes and listener interfaces

// An applet extends java.applet.Applet
public class AWTAccumulatorApplet extends Applet implements ActionListener {
   private TextField tfInput;   // The input TextField
   private int sum = 0;         // The accumulated sum, init to 0

   // init() runs when the applet is loaded. Setup the UI components and event handlers.
   public void init() {
      add(new Label("Enter an integer"));  // anonymous Label

      tfInput = new TextField(10);
      add(tfInput);
      tfInput.addActionListener(this);
         // Hitting enter key on tfInput invokes actionPerformed()
   }

   // ActionEvent handler - Called back when enter key was hit on TextField.
   public void actionPerformed( ActionEvent evt) {
      int numberIn = Integer.parseInt(evt.getActionCommand());
         // getActionCommand() returns the String entered.
      sum += numberIn;
      tfInput.setText("");  // Clear input TextField
      showStatus("The accumulated sum is: " + sum);
         // show the sum on the status bar of the browser's window
   }
}
```

Note that:

- An applet extends from `java.applet.Applet`, whereas a standalone GUI application extends from `java.awt.Frame`. You cannot `setTitle()` and `setSize()` on Applet.
- Applet uses `init()` to create the GUI, while standalone GUI application uses the constructor (invoked in `main()`).

HTML codes: AWTAccumulatorApplet.html

Applet runs inside a web browser. A separate HTML script (says `AWTAccumulatorApplet.html`) is required, which uses an <applet> tag to embed the applet as follows:

```
<html>
<head>
  <title>An AWT Applet</title>
</head>
<body>
  <p>A simple applet which accumulates the number entered into
  a TextField and displays the accumulated sum on the status bar</p>
  <applet code="AWTAccumulatorApplet.class" width="300" height="60">
  </applet>
</body>
</html>
```

TRY:

1. Modify the applet to run the "Counter" application (as in `AWTCounter`).
2. Modify the applet to run the "Factorial" application (as in `AWTFactorial`).

2. Event-Handling

2.1 Ex: WindowEvent and WindowListener

Modify the `AWTCounter` program (called `AWTCounterWithClose`) to process the "Window-Close" button.

```
public class AWTCounterWithClose extends Frame
      implements ActionListener, WindowListener {
   ......

   // Constructor
   public AWTCounterWithClose () {
      ......
      addWindowListener(this);
        // "super" Frame fires WindowEvent.
        // "super" Frame add "this" instance as the WindowEvent listener
      ......
   }
   ......

   // WindowEvent handlers
   @Override
   public void windowClosing(WindowEvent evt) {
      System.exit(0);  // Terminate the program
   }

   // Not used, but need to provide an empty body to compile
   @Override public void windowOpened(WindowEvent evt) { }
   @Override public void windowClosed(WindowEvent evt) { }
   @Override public void windowIconified(WindowEvent evt) { }
   @Override public void windowDeiconified(WindowEvent evt) { }
   @Override public void windowActivated(WindowEvent evt) { }
   @Override public void windowDeactivated(WindowEvent evt) { }
}
```

3. Inner Class - Named and Anonymous

Compared with the `AWTCounter`, the following programs `AWTCounterNamedInnerClass` and `AWTCounterAnonymousInnerClass` use "named inner classes" and "anonymous inner classes", respectively, as the `ActionEvent` listener instead of "`this`" object.

A named inner class as the event listener: AWTCounterNamedInnerClass.java

```
import java.awt.*;        // Using AWT's components and containers
import java.awt.event.*;  // Using AWT's event classes and listener interfaces

public class AWTCounterNamedInnerClass extends Frame {
   // This class is NOT the listener, hence, it does not implement ActionListener

   private TextField tfCount;
   privete Button btnCount;
   private int count = 0;

   // Constructor to setup the UI components and event handlers
   public AWTCounterNamedInnerClass () {
      setLayout(new FlowLayout());  // "super" Frame sets to FlowLayout
      add(new Label("Counter"));    // anonymous Label
      tfCount = new TextField(count + "", 10);
      tfCount.setEditable(false);   // read-only
      add(tfCount);                 // "super" Frame adds tfCount

      btnCount = new Button("Count");
      add(btnCount);                // "super" Frame adds btnCount

      // Construct an anonymous instance of inner class BtnListener as
      //  listener to the source btnCount.
      btnCount.addActionListener(new BtnListener());

      setSize(250, 100);
      setTitle("AWT Counter");
      setVisible(true);    // show it
   }

   public static void main(String[] args) {
      new AWTCounterNamedInnerClass();
   }

   // A named inner class to be used as listener of ActionEvent
   // This inner class can access private variables of the outer class, such as count and tfCount.
   private class BtnListener implements ActionListener {
      @Override
      public void actionPerformed(ActionEvent evt) {
         ++count;
         tfCount.setText(count + "");
      }
   }
}
```

Explanation

- An inner class called `BtnListener` is defined, to be used as listener for the `ActionEvent` fired by the `Button btnCount`. Since `BtnListener` is an `ActionEvent` listener, it has to implement `ActionListener` interface and provide implementation to the `actionPerformed()` method declared in the interface.
- Although instance variables `tfCount`, `count` are `private`, the inner class `BtnListener` has access to them. This is the sole reason why an inner class is used instead of an ordinary outer class.
- An anonymous instance of `BtnListener` is constructed via statement "`new BtnListener()`". The `Button btnCount` registers this anonymous instance as a listener to its `ActionEvent` via `btnCount.addActionListener(new BtnListener())`.

An anonymous Inner class as the event listener: AWTCounterAnonymousInnerClass.java

```
import java.awt.*;       // Using AWT's components and containers
import java.awt.event.*; // Using AWT's event classes and listener interfaces

public class AWTCounterAnonymousInnerClass extends Frame {
   // This class is NOT the listener, hence, it does not implement ActionListener

   private TextField tfCount;
   private Button btnCount;
   private int count = 0;

   // Constructor to setup the UI components and event handlers
   public AWTCounterAnonymousInnerClass () {
      setLayout(new FlowLayout());  // "super" Frame sets to FlowLayout
      add(new Label("Counter"));    // anonymous Label
      tfCount = new TextField(count + "", 10);
      tfCount.setEditable(false);   // read-only
      add(tfCount);                 // "super" Frame adds tfCount

      Button btnCount = new Button("Count");
      add(btnCount);                // "super" Frame adds btnCount

      // Construct an anonymous instance of an anonymous class as
      //  listener to the source btnCount
      btnCount.addActionListener(new ActionListener() {
         @Override
         public void actionPerformed(ActionEvent evt) {
            ++count;
            tfCount.setText(count + "");
         }
      });

      setSize(250, 100);
      setTitle("AWT Counter");
      setVisible(true);   // show it
   }

   public static void main(String[] args) {
      new AWTCounterAnonymousInnerClass();
   }
}
```

Explanation

- An anonymous instance of an anonymous inner class is defined via

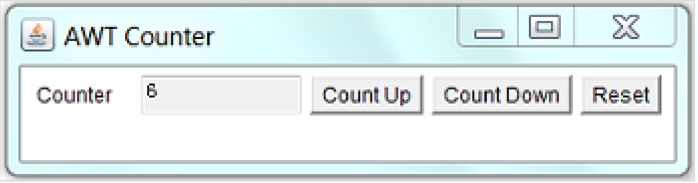
```
new ActionListener() { ... }
```

- The compiler creates an anonymous inner class called $*n* (where *n* is a running number of inner classes) as follows:

```
class $n implements ActionListener() { .... }
new $n()
```

Notes: Observe the output files produced by the Java compiler. Named inner class is named "`OuterClassName$InnerClassName.class`" and anonymous inner class is named "`OuterClassName$n.class`".

TRY:



1. Modify all the earlier programs to use (i) a named inner class; (ii) an anonymous inner class as the `ActionEvent` listener.
2. Modify `AWTCount` (called `AWTCounter3Buttons`) to include two additional buttons for counting down and reset the count value. Use (i) "`this`" class as listener for all the 3 buttons; (ii) use one named inner class as listener for all the 3 buttons; (iii) use an anonymous inner class as listener for

each button.

Hints for (i) and (ii): `You can use event.getActionCommend()` to retrieve the label of the button that has fired the event.

```
@Override
public void actionPerformed(ActionEvent evt) {
   String btnLabel = evt.getActionCommand();
       // event.getActionCommand() returns the button's label
   if (btnLabel.equals("Count Up")) {
      ......
   } else if (btnLabel.equals("Count Down")) {
      ......
   } else {
      ......
   }
   ......
}
```

4. Swing GUI Applications

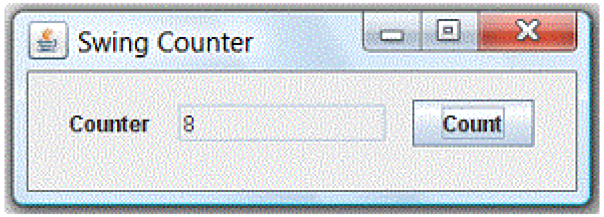
4.1 Ex: Converting from AWT to Swing

Convert all the previous AWT exercises (`AWTCounter`, `AWTAccumulator`, `AWTFactorial`, etc.) to Swing applications (called `SwingCounter`, `SwingAccumulator`, `SwingFactorial`, etc.).

Notes:

- Swing Components are kept in package `javax.swing`. They begin with a prefix "`J`", e.g., `JButton`, `JLabel`, `JFrame`.
- Swing Components are to be added onto the `ContentPane` of the top-level container `JFrame`. You can retrieve the `ContentPane` via method `getContentPane()` from a `JFrame`.

```
Container cp = getContentPane();  // of JFrame
cp.setLayout(......);
cp.add(......);
```



For example, SwingCounter.java:

```
import java.awt.*;       // Using AWT's layouts
import java.awt.event.*; // Using AWT's event classes and listener interfaces
import javax.swing.*;    // Using Swing components and containers

// A Swing application extends javax.swing.JFrame (instead of java.awt.Frame)
public class SwingCounter extends JFrame {
   private JTextField tfCount;
         // Use Swing's JTextField instead of AWT's TextField
   private JButton btnCount;
         // Using Swing's JButton instead of AWT's Button
   private int count = 0;

   public SwingCounter () {
      // Get the content-pane of top-level container Jframe
      // Components are added onto content pane
      Container cp = getContentPane();
      cp.setLayout(new FlowLayout());

      cp.add(new JLabel("Counter"));
      tfCount = new JTextField(count + "", 10);
      tfCount.setEditable(false);
      tfCount.setHorizontalAlignment(JTextField.RIGHT);
      cp.add(tfCount);

      btnCount = new JButton("Count");
      cp.add(btnCount);
      btnCount.addActionListener(new ActionListener() {
        @Override
         public void actionPerformed(ActionEvent evt) {
            ++count;
            tfCount.setText(count + "");
         }
      });

      setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
         // Exit program if Jframe's close-window button clicked
      setSize(300, 100);
      setTitle("Swing Counter");
      setVisible(true);    // show it
   }

   public static void main(String[] args) {
      // Recommended to run the GUI construction in
      //  Event Dispatching thread for thread-safet operations
      SwingUtilities.invokeLater(new Runnable() {
         @Override
         public void run() {
            new SwingCounter(); // Let the constructor does the job
         }
      });
   }
}
```

4.2 Ex: SWingAdder

Write a Swing application called SwingAdder as shown. The "ADD" button adds the two integers and display the result. The "CLEAR" button shall clear all the text fields.

Hints: Set the content-pane to 4x2 GridLayout. The components are added from left-to-right, top-to-bottom.

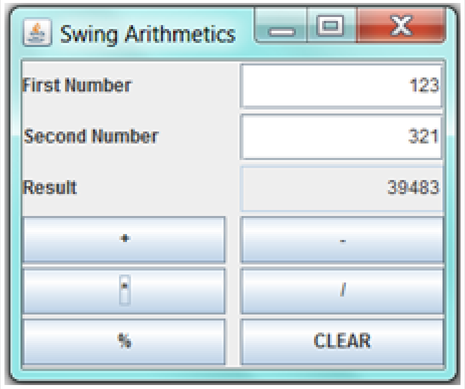
```
import java.awt.*;        // Using AWT's layouts
import java.awt.event.*;  // Using AWT's event classes and listener interfaces
import javax.swing.*;     // Using Swing's components and container

// A Swing application extends from javax.swing.JFrame
public class SwingAdder extends JFrame {
   private JTextField tfNumber1, tfNumber2, tfResult;
   private JButton btnAdd, btnClear;
```

```
    private int number1, number2, result;

    // Constructor to set up UI components and event handlers
    public SwingAdder() {
       // Swing components should be added to the content-pane of the JFrame.
       Container cp = getContentPane();
       // Set this Container to grid layout of 4 rows and 2 columns
       cp.setLayout(new GridLayout(4, 2, 10, 3));

       // Components are added from left-to-right, top-to-bottom
       cp.add(new JLabel("First Number "));     // at (1, 1)
       tfNumber1 = new JTextField(10);
       tfNumber1.setHorizontalAlignment(JTextField.RIGHT);
       cp.add(tfNumber1);                       // at (1, 2)
       .......
       .......

       btnAdd = new JButton("ADD");
       cp.add(btnAdd);                         // at (4, 1)
       btnAdd.addActionListener(new ActionListener() {
          @Override
          public void actionPerformed(ActionEvent evt) {
             number1 = Integer.parseInt(tfNumber1.getText());
             ......
          }
       });

       btnClear = new JButton("CLEAR");
       cp.add();                                // at (4, 2)
       btnClear.addActionListener(new ActionListener() {
          @Override
          public void actionPerformed(ActionEvent evt) {
             ......
          }
       });

       setDefaultCloseOperation(EXIT_ON_CLOSE); // for the "window-close" button
       setTitle("Swing Adder");
       setSize(300, 170);
```

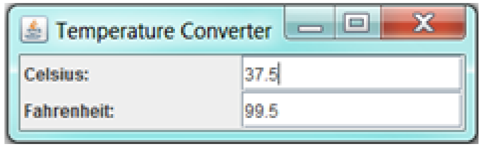
```
      setVisible(true);
   }

   // The entry main() method
   public static void main(String[] args) {
      // For thread safety, use the event-dispatching thread to construct UI
      javax.swing.SwingUtilities.invokeLater(new Runnable() {
         @Override
         public void run() {
            new SwingAdder(); // Let the constructor does the job
         }
      });
   }
}
```

TRY:

1. Modify the above exercise (called `SwingArithmetics`) to include buttons "+", "-", "*", "/", "%" (remainder) and "`CLEAR`" as shown.



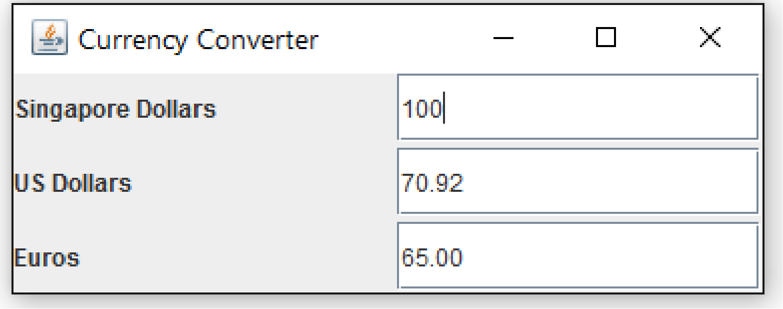
4.3 Ex: `SwingTemperatureConverter`



Write a GUI program called `SwingTemperatureConverter` to convert temperature values between Celsius and Fahrenheit. User can enter either the Celsius or the Fahrenheit value, in floating-point number.

Hints: To display a floating-point number in a specific format (e.g., 1 decimal place), use the `static` method `String.format()`, which has the same form as `printf()`. For example, `String.format("%.1f", 1.234)` returns String `"1.2"`.

4.4 Ex: SwingCurrencyConverter



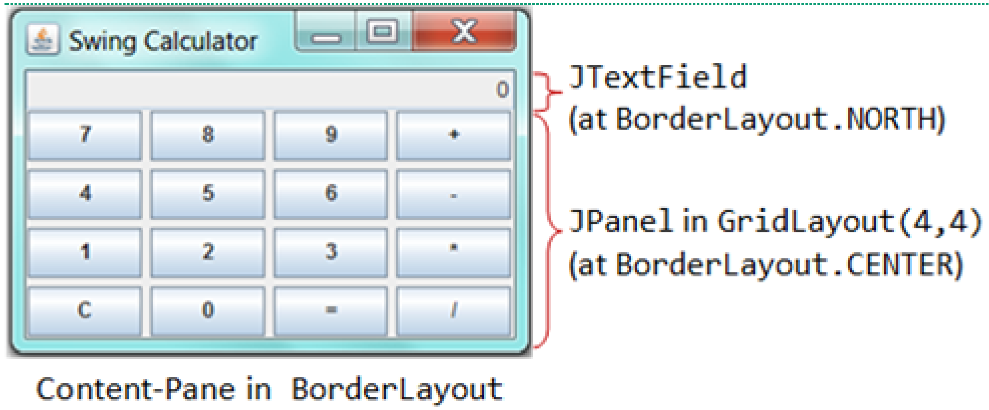
Singapore Dollars 100

US Dollars 70.92

Euros 65.00

Write a simple currency converter, as shown in the figure. User can enter the amount of "Singapore Dollars", "US Dollars", or "Euros", in floating-point number. The converted values shall be displayed to 2 decimal places. Assume that 1 USD = 1.41 SGD, 1 USD = 0.92 Euro, 1 SGD = 0.65 Euro.

4.5 Ex: SwingCalculator



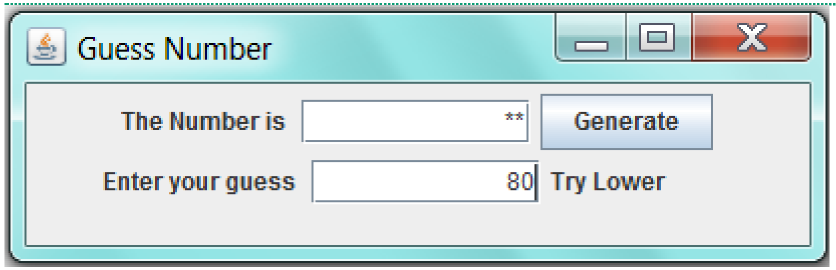
Implement a simple calculator (called `SwingCalculator`) as shown.

Hints:

- Set the `ContentPane` to `BorderLayout`. Add a `JTextField` (`tfDisplay`) to the `NORHT`. Add a `JPanel` (`panelButtons`) to the `CENTER`. Set the `JPanel` to `GridLayout` of 4x4, and add the 16 buttons.
- All the number buttons can share the same listener as they can be processed with the same codes. Use `event.getActionCommand()` to get the label of the button that fires the event.
- The operator buttons "+", "-", "*", "/", "%" and "=" can share a common listener.
- Use an anonymous inner class for "`C`" button.
- You need to keep track of the *previous* operator. For example in "1 + 2 =", the current operator is "=", while the *previous* operator is "+". Perform the operation specified by the previous operator.

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;   // Using Swing's components and containers

// A Swing application extends from javax.swing.JFrame
public class SwingCalculator extends JFrame {
   private JTextField tfDisplay;
   private int result = 0;           // the result so far
   private String numberInStr = ""; // the number entered as String
   private char previousOpr = ' ';  // the previous operator
   private char currentOpr = ' ';   // the current operator

   // Constructor to setup the UI components and event handlers
   public SwingCalculator() {
      // TODO: Setup the UI
      // ......
   }

   // Number buttons listener (inner class)
   class NumberBtnListener implements ActionListener {
      @Override
      public void actionPerformed(ActionEvent evt) {
         numberInStr += evt.getActionCommand();
         tfDisplay.setText(numberInStr);
      }
   }
   // Operator buttons listener (inner class)
   class OprBtnListener implements ActionListener {
      @Override
      public void actionPerformed(ActionEvent evt) {
         previousOpr = currentOpr;  // save
         currentOpr = evt.getActionCommand().charAt(0);
         // TODO: Processing logic
         // ......
      }
   }
}
```

4.6 Ex: SwingNumberGuess



The Number is **

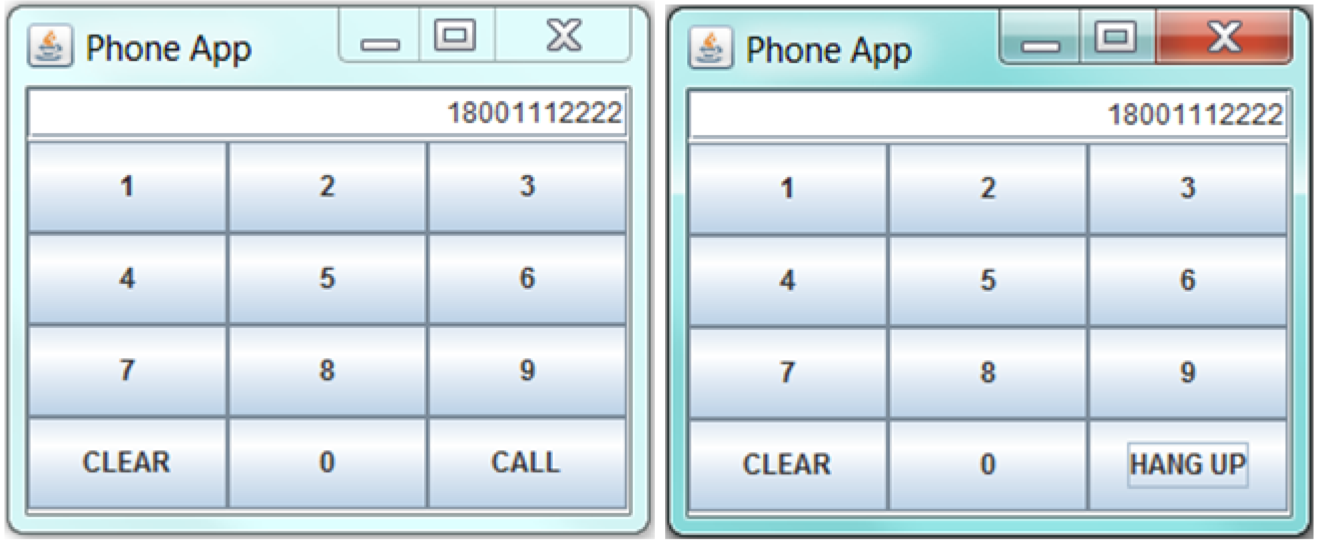
Enter your guess 80 Try Lower

Write a number guessing game in Swing (as shown in the Figure). The program shall generate a random number between 1 to 100. It shall mask out the random number generated and output "Yot Got it", "Try Higher" or "Try Lower" depending on the user's input.

Hints:

- You can use `Math.random()` to generate a random number in `double` in the range of `[0.0, 1.0)`.

4.7 Ex: SwingPhoneApp



Write a Software Phone App using Java Swing as illustrated in the figure. The user enters the phone number and pushes the "CALL" button to start a phone call. Once the call is started, the label of the "CALL" button changes to "HANG UP". When the user hangs up, the display is cleared.

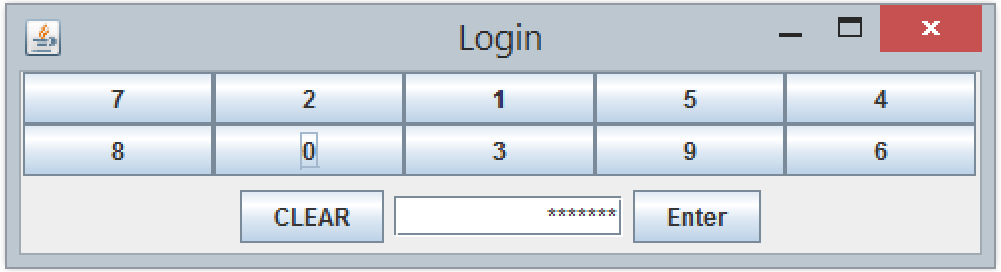
Assume that the following 2 methods are available for handling phone call:

```
public void call(String phoneNumber);  // to make a phone call with the phoneNumber
public void hangup();  // to terminate the existing call
```

Hints:

- Use a 10-element `JButton` array to hold the 10 numeric buttons. Construct a common instance of a named inner class as the `ActionListener` for the 10 numeric buttons.
- Use a `boolean` flag (says `isCalling`) to keep track of the status.

4.8 Ex: `SwingLoginPanel`

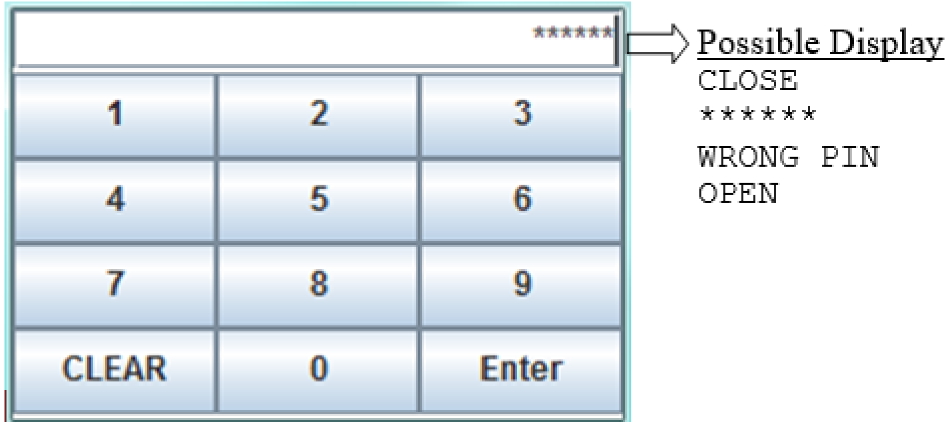


A Java Swing application has a login page as shown in the Figure. Users are required to enter the correct passcode to start the application. The system uses a scramble keypad with a randomly allocated set of numbers from 0 to 9. The display shall show "Enter passcode" initially, and show an asterisk (*) for each number entered. Upon pushing the "Enter" button, the system verifies the passcode. If the passcode is correct, the system invokes a method called `startApp()` to start the application. Otherwise, it displays "Wrong passcode". The "Clear" button shall clear the display.

Assume that the following methods are available:

```
public String getPasscode(); // return the passcode
public void startApp();      // Start the application
public void shuffleArray(int[] array)
   // Shuffle (Randomize) the given int array, e.g.,
   // int[] numbers = {1, 2, 3, 4, 5};
   // shuffleArray(numbers); // randomize the elements
```

4.9 Ex: SwingLock



Write a Java Swing application for an electronic lock as shown in the figure. The display shall show the state of either "CLOSE" or "OPEN". In the "CLOSE" state, the user types his PIN followed by the "Enter" key to unlock the system. The display shall show an asterisk (*) for each number entered. The display shall show "WRONG PIN" if the PIN is incorrect. The "Clear" button clears the number entered (if any), locks the system and sets the display to "CLOSE".

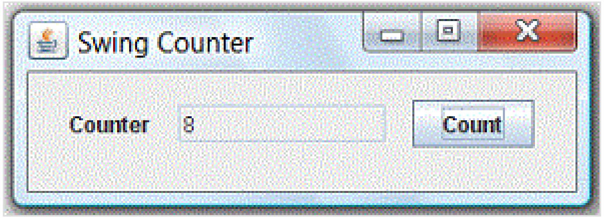
Assume that the following methods are available:

```
public boolean checkPIN(String PIN);  // return true for correct PIN
public void unlock();   // Unlock the system
public void lock();     // Lock the system
```

Hints:

- Use a 10-element `JButton` array to hold the 10 numberic buttons. Construct a common instance of a named inner class as their `ActionListener`.
- Use a `boolean` flag (says `isLocked`) to keep track of the status.

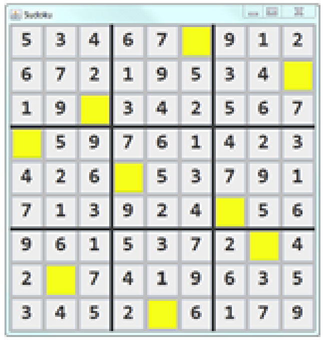
4.10 Ex: Using Eclipse/NetBeans GUI Builder



Write the `SwingCounter` using Eclipse/NetBeans' GUI builder. Read the respecctive section in "Eclipse How-To" or "NetBeans Hot-To".

Study the code generated by Eclispse/NetBeans.

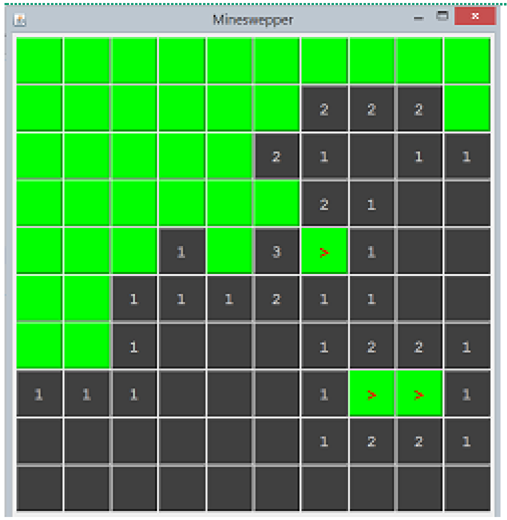
4.11 Ex: Sudoku



5	3	4	6	7	🟨	9	1	2
6	7	2	1	9	5	3	4	🟨
1	9	🟨	3	4	2	5	6	7
🟨	5	9	7	6	1	4	2	3
4	2	6	🟨	5	3	7	9	1
7	1	3	9	2	4	🟨	5	6
9	6	1	5	3	7	2	🟨	4
2	🟨	7	4	1	9	6	3	5
3	4	5	2	🟨	6	1	7	9

See the Sudoku Article.

4.12 Ex: Mine Sweeper

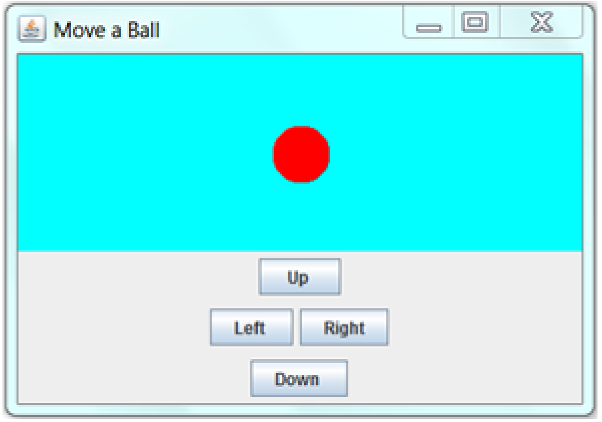


🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
🟩	🟩	🟩	🟩	🟩	🟩	2	2	2	🟩
🟩	🟩	🟩	🟩	🟩	2	1		1	1
🟩	🟩	🟩	🟩	🟩	🟩	2	1		
🟩	🟩	🟩	1	🟩	3	>	1		
🟩	🟩	1	1	1	2	1	1		
🟩	🟩	1				1	2	2	1
1	1	1				1	>	>	1
						1	2	2	1

See the Mine Sweeper Article.

5. Custom Graphics

5.1 Ex: MoveABall



Study the "Move-a-line" program. Modifying the program to move a ball in response to up/down/left/right buttons, as well as the 4 arrow keys, as shown.

5.2 Ex: TicTacToe

See the Mine Sweeper Article.

REFERENCES & RESOURCES

Latest version tested: JDK 1.8.0
Last modified: April, 2016

Feedback, comments, corrections, and errata can be sent to Chua Hock-Chuan (ehchua@ntu.edu.sg) | HOME