```java
package com.eimacs.lab05;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;
/**
 *
 * @author IMACS Curriculum Development Group
 * @version 2.0 January 14, 2015
 */
public abstract class Action
{
    /**
     * Class constructor
     */
    public Action()
    {
    }
    public abstract void execute( Turtle t, Graphics g );
}

```

```java
package com.eimacs.lab05;

/**
 * Models a point in a plane
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class APPoint
{
  private double myX;
  private double myY;

  public APPoint( double x, double y )
  {
    myX = x;
    myY = y;
  }

  public double getX() { return myX; }
  public double getY() { return myY; }
  public void setX( double x ) { myX = x; }
  public void setY( double y ) { myY = y; }
}

```

```
package com.eimacs.lab05;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;
/**
 * 
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class MoveBack extends Action
{
   private int mySteps;
   public MoveBack(int step)
   {
     mySteps=step;
   }
   public String toString()
   {
       return "Back "+mySteps+"";
   }
   public void execute( Turtle t, Graphics g )
   {
     APPoint p = t.getPosition();
     double h = Math.toRadians( t.getHeading() );

     APPoint newPoint = new APPoint( p.getX() - mySteps * Math.sin( h ),
                                     p.getY() + mySteps * Math.cos( h ) );

     t.lineTo( newPoint, g );
   }

}
```

```java
package com.eimacs.lab05;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;

/**
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class MoveForward extends Action
{
   private int mySteps;
  public MoveForward(int step)
   {

     mySteps=step;
   }
   public String toString()
   {
       return "Forward "+mySteps+"";
   }

 public void execute( Turtle t, Graphics g )
   {
     APPoint p = t.getPosition();
     double h = Math.toRadians( t.getHeading() );

     APPoint newPoint = new APPoint( p.getX() + mySteps * Math.sin( h ),
                                     p.getY() - mySteps * Math.cos( h ) );

     t.lineTo( newPoint, g );
}}
```

```java
package com.eimacs.lab05;

import java.awt.Graphics;

import com.eimacs.lab05gui.Turtle;
public class RepeatAction extends Action {
    private int nRepeats;
    private TurtleProgram myTurtleProgram;

    public RepeatAction(int n, TurtleProgram t) {
        nRepeats = n;
        myTurtleProgram = t;
    }

    public void execute(Turtle t, Graphics g) {
        for (int i = 0; i < nRepeats; i++)
            myTurtleProgram.execute(t, g);
    }

    public String toString() {
        String n = "Repeat " + nRepeats + "";
        n += "\n";
        n += "[";
        n += myTurtleProgram.toString();
        n += "\n";
        n += "]";
        return n;
    }
}

```

```java
package com.eimacs.lab05;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;

/**
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class TurnLeft extends Action
{
   private double myAngle;
   public TurnLeft(double angle)
   {
     myAngle=angle;
   }
   public String toString()
   {
       return "Left "+myAngle+"";
   }
   public void execute( Turtle t, Graphics g )
   {
     t.setHeading( t.getHeading() - myAngle );
   }
}
```

```
package com.eimacs.lab05;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;
/**
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class TurnRight extends Action
{
   private double myAngle;
   public TurnRight(double angle)
   {
     myAngle=angle;
   }
   public String toString()
   {
       return "Right "+myAngle+"";
   }
   public void execute( Turtle t, Graphics g )
   {
     t.setHeading( t.getHeading() + myAngle );
   }
}
```

```java
package com.eimacs.lab05;

import java.util.ArrayList;
import com.eimacs.lab05gui.Turtle;
import java.awt.Graphics;
/**
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class TurtleProgram
{  private ArrayList<Action> myActions;
private boolean isValid;
  public TurtleProgram()
  {
      myActions=new ArrayList<Action>();
      isValid=false;
  }
 public void setIsValid(boolean b)
 {
     isValid=b;
 }
  public void addAction(Action a)
  {
      myActions.add(a);
      isValid=false;
  }
  public String toString()
  {
      String ans="";
      if(myActions.size()==0)
      return ans;
      ans+= myActions.get(0);
      for(int i=1; i<myActions.size();i++)
      {
          ans+="\n";
          ans+=myActions.get(i);
      }
      return ans;
  }
 public void execute(Turtle t, Graphics g)
 {
     if (isValid)
         {for(Action a: myActions)
     {
         a.execute(t, g);
     }}
 }
public void showTurtle( Turtle t, Graphics g )
{
  int[] xCoords=new int[3];
  int[] yCoords=new int[3];
  APPoint p = t.getPosition();
  double h = Math.toRadians( t.getHeading());
  APPoint bl=new APPoint(p.getX() - 30 * Math.sin( h+Math.toRadians(15)),
               p.getY() + 30 * Math.cos( h+Math.toRadians(15) ) );
  APPoint br=new APPoint(p.getX() - 30 * Math.sin( h -Math.toRadians(15)),
               p.getY() + 30 * Math.cos( h -Math.toRadians(15)) );

  xCoords[0]=(int)p.getX();
  yCoords[0]=(int)p.getY();
  xCoords[1]=(int)bl.getX();
  yCoords[1]=(int)bl.getY();
  xCoords[2]=(int)br.getX();
  yCoords[2]=(int)br.getY();
  g.drawPolygon(xCoords, yCoords, 3);
}
}

```

```java
package com.eimacs.lab05gui;

import com.eimacs.lab05.*;

/**
 *
 * @author Naomi Spargo
 * @version 1.0 February 18, 2017
 */
public class Lab05Runner
{
    private static TurtleWindow theTurtleWindow;
    /**
     * The main method
     *
     * @param args the command line arguments
     */
    public static TurtleWindow getTurtleWindow()
    {
        return theTurtleWindow;
    }
    public static void main( String[] args )
    {

        theTurtleWindow = new TurtleWindow();
    }

}

```

```java
package com.eimacs.lab05gui;

import com.eimacs.lab05.APPoint;
import java.awt.Graphics;

public class Turtle {
    private APPoint myPosition;
    private double myHeading;

    public Turtle() {
        myPosition = new APPoint(0, 0);
        myHeading = 0;
    }

    public APPoint getPosition() {
        return myPosition;
    }

    public double getHeading() {
        return myHeading;
    }

    public void setHeading(double d) {
        myHeading = d;
    }

    public void lineTo(APPoint newPoint, Graphics g) {
        g.drawLine((int) myPosition.getX(), (int) myPosition.getY(),
                   (int) newPoint.getX(), (int) newPoint.getY());
        myPosition = newPoint;
    }
}

```

```java
package com.eimacs.lab05gui;

import java.awt.event.ActionEvent;

import javax.swing.JOptionPane;

/**
 *
 * @author IMACS Curriculum Development Group
 * @version 2.0 January 14, 2015
 */
public class TurtleController extends TurtleProgrammer
{

    private TurtlePlane myTurtlePlane;
    /**
     * Class constructor
     */
    public TurtleController(TurtlePlane turtleplane)
    {

        myTurtlePlane=turtleplane;
        myTurtlePlane.setTurtleController(this);
        initialize();
    }

    /**
     * Gets this TurtleController's program
     *
     * @return this TurtleController's program
     */
    private String getInput( String prompt )
    {
      return JOptionPane.showInputDialog( this, prompt );
    }

    /**
     * Overrides ActionListener's actionPerformed method
     *
     * @param e  the event provoking an action to be performed
     */
    public void actionPerformed( ActionEvent e )
    {

          String actionName = e.getActionCommand();

          if ( "Execute".equals( actionName ) )
            getTurtleProgram().setIsValid( true );
        else
          super.actionPerformed( e );

        executeProgram();

    }


    /**
     * The class initializer
     */
    private void initialize()
    {
        //add control buttons
        addButton( "Execute" );
        addButton( "Reset" );
    }

    /**
     * Adds a button to this TurtleController
     *
     * @param buttonName  the name (and action command) of the button
     */


    public void executeProgram()
    {
      myTurtlePlane.drawPlane();
    }
}

```

```java
package com.eimacs.lab05gui;

import com.eimacs.lab05.APPoint;
import java.awt.Color;
import java.awt.Dimension;
import java.awt.Graphics;
import javax.swing.BorderFactory;
import javax.swing.JPanel;

public class TurtlePlane extends JPanel
{
  private TurtleController myTurtleController;

  public TurtlePlane()
  {
    setBorder( BorderFactory.createLoweredBevelBorder() );
    setBackground( Color.decode( "0xEDFFED" ) );
    setPreferredSize( new Dimension( 300, 400 ) );
  }

  public void drawPlane()
  {
    repaint();
  }

  public void paintMe( Graphics g )
  {
    Turtle t = new Turtle();

    APPoint startPoint = t.getPosition();
    startPoint.setX( 150 );
    startPoint.setY( 200 );

    myTurtleController.getTurtleProgram().execute( t, g );
    myTurtleController.getTurtleProgram().showTurtle(t,g);
  }

  public void paintComponent( Graphics g )
  {
    super.paintComponent( g );
    paintMe( g );
  }

  public void setTurtleController( TurtleController tc )
  {
    myTurtleController = tc;
  }
}
```

```
package com.eimacs.lab05gui;

import com.eimacs.lab05.*;
import com.eimacs.lab05.TurtleProgram;
import java.awt.Color;
import java.awt.Dimension;
import java.awt.FlowLayout;
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;
import javax.swing.BorderFactory;
import javax.swing.JButton;
import javax.swing.JOptionPane;
import javax.swing.JPanel;
import javax.swing.JScrollPane;
import javax.swing.JTextArea;

/**
 *
 * @author IMACS Curriculum Development Group
 * @version 2.0 January 14, 2015
 */
public class TurtleProgrammer extends JPanel implements ActionListener {
    /** This TurtleProgrammer's program display area */
    private JTextArea myProgramDisplay;
    /** This TurtleProgrammer's program */
    private TurtleProgram myTurtleProgram;
    private TurtlePlane myTurtlePlane;

    /**
     * Class constructor
     */
    public TurtleProgrammer() {
        setLayout(new FlowLayout());
        setBorder(BorderFactory.createRaisedBevelBorder());
        setBackground(Color.gray);
        setPreferredSize(new Dimension(190, 350));
        initialize();
    }

    /**
     * Gets this TurtleProgrammer's program
     *
     * @return this TurtleProgrammer's program
     */
    private String getInput(String prompt) {
        return JOptionPane.showInputDialog(this, prompt);
    }

    public TurtleProgram getTurtleProgram() {
        return myTurtleProgram;
    }

    /**
     * Overrides ActionListener's actionPerformed method
     *
     * @param e
     *            the event provoking an action to be performed
     */
    public void actionPerformed(ActionEvent e) {
        String actionName = e.getActionCommand();
        if ("Forward".equals(actionName)) {
            String input = getInput("How many steps?");
            if (input != null && !input.trim().equals("")) {
                int steps = Integer.parseInt(input);
                myTurtleProgram.addAction(new MoveForward(steps));
            }
        } else if ("Back".equals(actionName)) {
            String input = getInput("How many steps?");
            if (input != null && !input.trim().equals("")) {
                int steps = Integer.parseInt(input);
                myTurtleProgram.addAction(new MoveBack(steps));
            }
        } else if ("Left".equals(actionName)) {
            String input = getInput("How many degrees?");
            if (input != null && !input.trim().equals("")) {
                double degrees = Double.parseDouble(input);
                myTurtleProgram.addAction(new TurnLeft(degrees));
            }
        } else if ("Right".equals(actionName)) {
            String input = getInput("How many degrees?");
            if (input != null && !input.trim().equals("")) {
                double degrees = Double.parseDouble(input);
                myTurtleProgram.addAction(new TurnRight(degrees));
            }
        } else if ("Reset".equals(actionName)) {
            myTurtleProgram = new TurtleProgram();

        } else if ("Repeat".equals(actionName)) {
            String input = getInput("How many times?");
            Lab05Runner.getTurtleWindow().incNDepth();
            if (input != null && !input.trim().equals("")) {
                int repeats = Integer.parseInt(input);
                new TurtleRepeaterDialog(repeats, myTurtleProgram);

            }
        } else {
```

```java
            JOptionPane.showMessageDialog(this, actionName);
        }

        displayProgram();

    }

    /**
     * The class initializer
     */
    private void initialize() {
        myTurtleProgram = new TurtleProgram();

        // add action buttons
        String[] buttons = { "Forward", "Back", "Left", "Right", "Repeat" };
        for (String bName : buttons)
            addButton(bName);

        // add text area for displaying the program
        myProgramDisplay = new JTextArea(12, 10);
        myProgramDisplay.setEditable(false);
        JScrollPane areaScrollPane = new JScrollPane(myProgramDisplay);
        areaScrollPane.setVerticalScrollBarPolicy
(JScrollPane.VERTICAL_SCROLLBAR_ALWAYS);
        add(areaScrollPane);

        // add control buttons

    }

    /**
     * Adds a button to this TurtleProgrammer
     *
     * @param buttonName
     *            the name (and action command) of the button
     */
    public void addButton(String buttonName) {
        JButton newButton = new JButton(buttonName);
        newButton.setActionCommand(buttonName);
        newButton.addActionListener(this);
        add(newButton);
    }

    public void displayProgram() {
        myProgramDisplay.setText(myTurtleProgram.toString());
    }

}
```

```java
package com.eimacs.lab05gui;

import java.awt.event.ActionEvent;

import com.eimacs.lab05.Action;
import com.eimacs.lab05.RepeatAction;
import com.eimacs.lab05.TurtleProgram;

public class TurtleRepeater extends TurtleProgrammer {
    private TurtleRepeaterDialog myDialog;
    private TurtleProgram parentProgram;
    int nRepeats;

    public TurtleRepeater(TurtleRepeaterDialog trd, TurtleProgram tp, int n) {
        myDialog = trd;
        parentProgram = tp;
        nRepeats = n;
        this.addButton("Done");
        this.addButton("Reset");
    }

    public void saveRepeat() {
        TurtleProgram tp = this.getTurtleProgram();
        tp.setIsValid(true);
        Action a = new RepeatAction(nRepeats, tp);
        parentProgram.addAction(a);
    }

    public void actionPerformed(ActionEvent e) {

        String actionName = e.getActionCommand();

        if ("Done".equals(actionName)) {
            this.saveRepeat();
            Lab05Runner.getTurtleWindow().decNDepth();
            myDialog.dispose();
        } else
            super.actionPerformed(e);
    }
}

```

```java
package com.eimacs.lab05gui;

import com.eimacs.lab05.TurtleProgram;
import java.awt.FlowLayout;
import javax.swing.JDialog;
import javax.swing.JPanel;
import static javax.swing.WindowConstants.DISPOSE_ON_CLOSE;

public class TurtleRepeaterDialog extends JDialog {
    private TurtleRepeater myTurtleRepeater;

    public TurtleRepeaterDialog(int nTimes, TurtleProgram tp) {
        super(Lab05Runner.getTurtleWindow(), "Repeater!", true);
        myTurtleRepeater = new TurtleRepeater(this, tp, nTimes);
        initialize();
    }

    private void initialize() {
        JPanel layoutPanel = new JPanel();
        layoutPanel.setLayout(new FlowLayout());
        layoutPanel.add(myTurtleRepeater);
        getContentPane().add(layoutPanel);
        setDefaultCloseOperation(DISPOSE_ON_CLOSE);
        pack();
        setSize(200, 390);
        int nd = Lab05Runner.getTurtleWindow().getNDepth();
        setLocation(40 + 25 * nd, 40 + 25 * nd);
        setVisible(true);

    }
}
```

```java
package com.eimacs.lab05gui;

import java.awt.FlowLayout;
import javax.swing.JFrame;
import javax.swing.JPanel;

/**
 *
 * @author IMACS Curriculum Development Group
 * @version 2.0 January 14, 2015
 */
public class TurtleWindow extends JFrame
{
    /** This TurtleWindow's TurtleController */
    private TurtleController myTurtleController;
    private TurtlePlane myTurtlePlane;
    private int nDepth;
    /**
     * Class constructor
     */
    public TurtleWindow()
    {
        super( "AP Lab 05" );
        myTurtlePlane= new TurtlePlane();
        myTurtleController = new TurtleController(myTurtlePlane);
        nDepth=-1;
        initialize();
    }

    /**
     * The class initializer
     */
    private void initialize()
    {
        JPanel layoutPanel = new JPanel();
        layoutPanel.setLayout( new FlowLayout() );
        layoutPanel.add( myTurtlePlane );
        layoutPanel.add( myTurtleController );

        getContentPane().add( layoutPanel );

        setDefaultCloseOperation( EXIT_ON_CLOSE );
        pack();
        setSize( 500, 440 );
        setLocationRelativeTo( null );
        setVisible( true );
    }
    public int getNDepth()
    {
        return nDepth;
    }
    public void incNDepth()
    {
        nDepth+=1;
    }
    public void decNDepth()
    {
        nDepth-=1;
    }
}

```