`TurtleGraphics`: A Lightweight Toolkit for Simple Graphics Programming

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Problem Statement
Beginning students find it difficult to do graphics in their Java programs. There are several basic challenges:

1. They must set up a frame or applet in which to paint their images.
2. They must deal with a forgetful bitmap. Consequently, they must maintain extra state to refresh this bitmap.
3. They must deal with a coordinate system that does not behave like the conventional Cartesian system.

Each of these challenges requires beginning students to master some fairly advanced concepts before they can do something as simple as drawing a spiral.

Solution Overview
`TurtleGraphics` [Lambert03] is a package that supports simple turtle graphics of the kind found in many LOGO-based systems. The primary user classes in the package form a set of various types of pens (`StandardPen`, `RainbowPen`, `WigglePen`, `WiggleRainbowPen`, and `BackwardPen`). Each type of pen implements the `Pen` interface. Thus, each type of pen recognizes the same standard messages, such as `home`, `up`, `down`, `move`, `moveTo`, `turn`, `setColor`, `setDirection`, `setWidth`, and `drawString`.

To write a program with `TurtleGraphics`, the student instantiates a pen within the `main` method and sends the pen a set of the appropriate messages. A graphics window containing the pen's drawing is automatically displayed. The refresh of this drawing is also automatic.

In addition to solving the problems mentioned earlier, `TurtleGraphics` allows students to instantiate an object and send it messages immediately. Moreover, students can immediately see the power of behavioral polymorphism, because different types of pens recognize the same messages.

Experience with the Solution

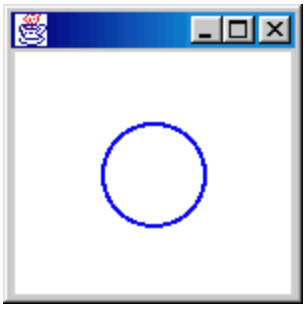
We developed `TurtleGraphics` for use in our widely adopted AP textbook, so we have no experience with its use at the college level. Users' reports of `TurtleGraphics` have been uniformly positive.

Here is a program that uses `TurtleGraphics`, followed by a screen shot of its output:

```
import TurtleGraphics.*;

public class Draw100gon{

   public static void main(String[] args){
      Pen p = new StandardPen(); // Can use any other class of pen here, too
      p.setColor(Color.pink);
      p.up();
      p.move(25);
      p.turn(90);
      p.move(0.8);
      p.down();
      for (int i = 1; i <= 100; i++)
         p.turn(3.6);
         p.move(1.6);
      }
   }
}
```



Complete documentation and downloads of `TurtleGraphics` are available at www.cs.wwu.edu/martin, scroll down to “Open source software packages.”