## CS1110, 3 March 2009

## Two topics: elementary graphics (for A5); loops

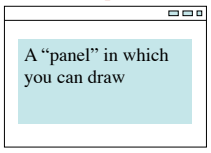
Start reading Sec. 2.3.8 and chapter 7 on loops.
The lectures on the ProgramLive CD can be a big help.

**Assignment A5** out today: graphics, loops, recursion
- Official due date: Wednesday Mar 11 at 11:59pm
- *Recommended* completion date: Sunday, because …

• **Prelim 2**: Thursday March 12, 7:30pm, *Uris Auditorium*
- *not* the same place as last time
- study guide coming out soon



## Graphical User Interfaces (GUIs): graphics.




A JFrame, with a "panel" on which you can draw

On the panel, each pair (x,y) indicates a "pixel" or picture element.

*For Assignment 5*, you need to understand that x-coordinates increase rightwards, and y-coordinates increase downwards.

(0,0) (1,0) (2,0) …
(0,1) (1,1) (2,1) …
(0,2) (1,2) (2,2) …
…



```
import javax.swing.*; import java.awt.*;
jframe= new JFrame("Turtle window");
jpanel= new JPanel();
jframe.getContentPane().add(jpanel, BorderLayout.CENTER);
jframe.pack();
jframe.setVisible(true);
graphics= jpanel.getGraphics(); // contains methods to draw on jpanel
// Draw line from (10, 10) to (50, 40).
graphics.drawLine(10,10,50, 40);

// Draw rectangle: top-left point (2, 5), width 40, height 60
graphics.drawRect(2, 5, 40, 60);

 // Draw string "this" at (40, 30)
 graphics.drawString("this", 40, 30);

 // set the pen color to red
 graphics.setColor(Color.red);

 // Store the current color in c
 Color c= graphics.getColor();
```

You don't have to learn all this now (unless you want to). We will be telling you more about later. For more on graphics, see class Graphics in the Java API and page 1-5 in the CD ProgramLive. For more on GUIs, read chapter 17. The corresponding part of the CD is arguably even more helpful.



## Assignment A5: drawing with a Turtle

We have written a class Turtle, an instance of which maintains:
- point (x, y): where the "Turtle" is
- angle: the direction the Turtle faces
- a pen color
- whether the pen is up or down

90 degrees
180 degrees
0 degrees
270 degrees

Class Turtle has methods for moving a Turtle around, drawing as it goes.

Draw equilateral triangle with side lengths 30; turtle ending up at starting point and facing the same direction:

```
forward(30);   addAngle(120);
forward(30);   addAngle(120);
forward(30);   addAngle(120);
```

In A5, write methods to draw shapes and spirals, and draw things using recursive procedures.



## From recursion to loops: doing things repeatedly

We write programs to make computers do things.
We often want to make them do things *multiple times*.

1. Perform *n* trials or get *n* samples.
   - A5: draw a triangle six times to make a hexagon
   - Run a protein-folding simulation for 10^6 time steps
2. Process each item in a given String, Vector, or other "list"
   - Compute aggregate statistics for a dataset, such as the mean, median, standard deviation, etc.
   - Send everyone in a certain (Facebook) group an individual appointment time
3. Do something an unknown number of times
   - ALVINN, the van that learned to drive itself, continuously watched human driving behavior and adjusted its model accordingly



## From recursion to loops: doing things repeatedly

We've talked about *recursion*.
Alternatives: for-loops, and a generalization, while-loops

1. Perform *n* trials or get *n* samples.
   - for (int t=1; t<= n; t= t+1) { <do whatever> }
2. Process each item in a given String, Vector, or other "list"
   - for (int i=0; i< s.length(); i= i+1) { <check s.charAt(i)> }
   - <set things up>;
     while (stuff still to do) {
       <process current item>;
       <prepare for next item>;
     }
3. Do something an unknown number of times
   - similar while-loop to the one above

## The for loop, for processing a range of integers

```
x= 0;
// add the squares of ints
// in range 2..200 to x
x= x + 2*2;
x= x + 3*3;
…
x= x + 200*200;
```

for each number i in the range 2..200, add i*i to x.

**loop counter**: i
**initialization**: **int** i= 2;
**loop condition**: i <= 200;
**increment**: i= i + 1
**repetend or body**: { x= x + i*i; }

**The for-loop:**

```
for (int i= 2; i <= 200; i= i +1) {
   x= x + i*i;
}
```

**repetend**: the thing to be repeated.
The block:

{ x= x + i*i; }

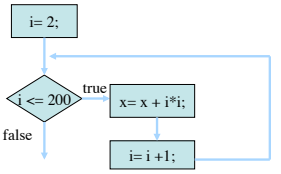


## Execution of the for-loop

**The for-loop:**

```
for (int i= 2; i <= 200; i= i +1) {
   x= x + i*i;
}
```

**loop counter**: i
**initialization**: **int** i= 2;
**loop condition**: i <= 200;
**increment**: i= i + 1
**repetend or body**: { x= x + i; }




To execute the for-loop.
1. Execute initialization.
2. If loop condition false, terminate execution.
3. Execute repetend.
4. Execute increment, repeat from step 2.

**Called a "flow chart"**



## Note on ranges.

2..5 contains 2, 3, 4, 5. It contains 5+1 – 2 = 4 values
2..4 contains 2, 3, 4. It contains 4+1 – 2 = 4 values
2..3 contains 2, 3. It contains 3+1 – 2 = 2 values
2..2 contains 2. It contains 2+1 – 2 = 1 values
2..1 contains . It contains 1+1 – 2 = 0 values

The number of values in **m..n** is **n+1 – m**.

In the notation m..n, we require always, without saying it, that

**m <= n + 1** .

If m = n + 1, the range has 0 values.



## The pattern for processing range of integers:

**range a..b-1**

```
for (int i= a; i < b; i= i + 1) {
   Process integer i;
}
```

```
// Print indices of all '/'s in String s
// inv: Indices of '/'s in s[0..s.i-1]
for (int i= 0; i < s.length(); i= i +1) {
   if (s.charAt(i) == '/')
      System.out.println(i);
}
// Indices of '/'s in s[0..s.length()-1]
// printed
```

**range c..d**

```
for (int i= c; i <= d; i= i + 1) {
   Process integer i;
}
```

```
// Store in double var. v the sum
//      1/1   + 1/2 + …+ 1/n
v= 0;
// inv: 1/1   + 1/2 + …+ 1/(i-1)
for (int i= 1; i <= n; i= i +1) {
      v= v + 1.0 / i;
}
// v= 1/1   + 1/2 + …+ 1/n
```



## Loops are often not easy to develop or understand.

Our goal: Provide you with a methodology for the development of loops that process a range of integers.

1. Separate your concerns —focus on one thing at a time.
2. Make small steps toward completing the loop.
3. Don't introduce a new variable without a good reason.
4. Keep program simple.



## Try these problems, first by hand, and then checking with DrJava.

1. Set c to the number of chars is String s that are digits (in 0..9).
2. Store in res a copy of String s but with no blanks.
3. Store in res a copy of String s but with adjacent duplicates removed.
4. Set boolean v to the value of "no integer in 2..n–1 divides x".
5. Set boolean v to the value of "every element in Vector v is an object of class JFrame".
6. Add up the squares of the odd integers in the range m..n.