CS100J, Spring 2001 Project 5

Due Thursday 4/5

1. Objective

Completing all tasks in this assignment will help you:

- discover the power and usefulness of arrays!
- create and use arrays of primitive types and objects

First skim, and then, carefully read the *entire* assignment before starting any tasks!

2. Tic Tac Toe

Write a program that plays tic tac toe, as you did in Project 3. But, this time use arrays to help remove redundant code. You do not need to write separate classes, however. Print out your code, a sample session where neither player wins, and one session where one player wins.

3. Simulation

Rewrite the simulation program of Project 4 to handle many workers and trays. Of course, you will need to use arrays of these objects to help. To generalize your code, prompt the user to input the desired number of trays and workers for the current simulation. Print out your code and a sample session with 10 workers and trays.

4. Insertion Sort

Do Problem 5 on page 455 of Savitch. Print out your program and a session that demonstrates how your program sorts the following data sets:

- 1, 20, 2, 30, 3, 10
- -1, -2, 13
- 0

5. Mathematical Arrays

5.1 Complex Numbers

When you take the square root of a negative number, such as $\sqrt{-4}$, you run into trouble. Why? Try 2×2 and $(-2) \times (-2)$: neither gives -4! Both products give you 4. To get -4, mathematicians devised a special quantity called the ***imaginary number*** i, where $i = \sqrt{-1}$. Using i, you could rewrite $\sqrt{-4}$ as $(\sqrt{4})(\sqrt{-1}) = (\sqrt{4})(i) = 2i$. A ***complex number*** combines real numbers with imaginary numbers as a convenient system to avoid writing square-root notation. For instance, the complex number $2 + 3i$ would really mean $2 + \sqrt{-9}$.

5.2 Complex Arithmetic

There are a number of rules, but you will focus on just addition for now. To add two complex numbers, use this formula: $(a + bi) + (c + di) = (a + c) + (b + d)i$.

5.3 Java and Complex Numbers

Sure enough, no one made a class for complex numbers as part of Java's standard distribution. See *http://java.sun.com/j2se/1.3/docs/api/index.html* if you don't believe me. But, you could very easily write a **`Complex`** class to represent a complex number with fields for the imaginary component, real component, and methods to help perform complex arithmetic.

5.4 Arrays of Complex Numbers

An ***upper triangle array*** is a ragged array that stores the elements above, and including, the main diagonal of an array. For example, the following square array of complex numbers contains an upper triangle array, as shown below:

1 + i	2 - i	0 - i
9 + 7i	-8 - 4i	7 + 0i
0 - 6i	4 + 2i	1 + 3i

square array

1 + i	2 - i	0 - i
	-8 - 4i	7 + 0i
		1 + 3i

upper triangle array

The ***size*** of the upper triangular array refers to size of the original square array. When adding two arrays of the same dimensions, you add each corresponding element together using the rules of complex arithmetic. For instance,

$$\begin{bmatrix} 1 & 2i \\ 1-3i & 0 \end{bmatrix} + \begin{bmatrix} 2i & -2i \\ 1 & i \end{bmatrix} = \begin{bmatrix} 1+2i & 0 \\ 2-3i & i \end{bmatrix}.$$

5.5 What You Actually Need To Do

Write a class **`Complex`** that represents a complex number. You will include methods for adding two complex numbers and printing a complex number (hint: use **`toString`**). You will need to supply a constructor for creating a complex number with automatically chosen random integer components with values between -9 and 9, inclusive. Note that you might need more than constructors to assist with other methods and classes.

In **`main`**, write a program that adds two upper triangular arrays of random complex numbers (-9 to 9, inclusive) using your **`Complex`** class. All the arrays must be stored as ragged, column-major arrays in Java. Prompt the user for the size of the arrays to generate and add. Demonstrate your program with arrays sizes 1, 2, and 3.

6. Submitting Your Work

Submit a title sheet, table of contents, all programs, and output indicated in this assignment. Follow the submission guidelines stated on the Projects page for CS100J. Number all pages to help the graders find each portion of the assignment.