

Random Walk

CS 2104 Homework Assignment 2

60 points

The Problem. A *random walk* is a stochastic process in which a particle moves one step at a time from state to state in a structured space. For us, the state space will be \mathbb{Z} , the set of integers. The particle starts in an initial state $S_0 \in \mathbb{Z}$. If, after $i \geq 0$ steps, the particle is in state S_i , then in step $i + 1$, it moves to state $S_i + 1$ with probability p and to state $S_i - 1$ with probability q ; it cannot stand still. Of course, $p + q = 1$. If $S_0 = 5$ and $0 < p < 1$, then the sequence 5, 4, 3, 4, 3, 2, 3, 2, 3, 4 is a possible sequence of states for the particle if it moves 9 times.

The Assignment. This assignment is to be done by the two assigned partners as a unit. The assignment is to write a program that will simulate a random walk for a given number of steps and that will compute certain statistics for the random walk. The program will be written in Java, C, or C++ and submitted in accordance with the programming assignment guidelines found at the course web site.

The parameters for a simulation come from standard input as a single line of parameters, consisting of (1) the initial state S_0 ; (2) the value of p ; and (3) the number of steps to simulate. For example, the parameter line

```
5 0.40 9
```

specifies a simulation starting at $S_0 = 5$ and running for 9 steps, with $p = 0.40$ and $q = 0.60$.

The output of the simulation goes to standard output. First, S_0 is printed. As the simulation proceeds, each new state is printed, one state per line. After that, the maximum state attained, the minimum state attained, and the average of all states (including the initial state) are printed, as in the following sample output:

```
5
4
3
4
3
2
3
2
3
4
Maximum 5
Minimum 2
Average 3.3
```

Random Numbers. To complete the program, you will need a source of random numbers. Each of the programming languages has at least one pseudorandom number generator, which you are welcome to use for this purpose. The CBB group in the Department of Computer Science has a true hardware random number generator that you can also use. Browse to

`http://bioinformatics.cs.vt.edu:51234`

and you will get 256 random numbers (32-bit signed integers). Each time you read the URL, you get a new sequence of random numbers. If you know how to retrieve web pages from inside a program, then you will be able to use these true random numbers.

Submission. The submission for this assignment must be according to the program assignment guidelines at the course web site. Each partnership uploads a single submission. The program source should be clearly commented and include the names of both partners. Your submission must be uploaded to Moodle by 11:00 PM on Tuesday, February 3.