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Program Structures &Algorithms

Fall2021

Assignment No.1

Task

This assignment will begin to build your algorithmic skills. It will also give you some experience with random number generation in Java.

An important example of a practical experiment is called the "random walk" experiment.

Imagine a drunken man who, starting out leaning against a lamp post in the middle of an open space, takes a series of steps of the same length: 1 meter. The direction of these steps is randomly chosen from North, South, East or West. **After n steps, how far (*d*), generally speaking, is the man from the lamp post?** Note that *d* is the Euclidean distance of the man from the lamp-post.

It turns out that there is a relationship between *d* and *n* which is typically applicable to many different types of stochastic (randomized) experiments. Your task is to implement the code for the experiment and, most importantly, to **deduce the relationship**.

Please clone/pull from the class repository and work on *RandomWalk.java* and *RandomWalkTest.java* each of package *randomwalk* and each under the appropriate source directory. [You may have to remove other java files from the classpath in order to allow the whole project to compile. In IntelliJ/IDEA you can do this for entire packages by right-clicking and choosing "Mark Directory As... Excluded"]. Once you have all the unit tests running, you can do the experiment by running *RandomWalk* as a main program (provide the value of *n* as the first argument).

For this particular assignment, it is **necessary but *not* sufficient** to ensure that the unit tests all run. You must demonstrate via image files, graphs, whatever, what experiments you made in order to come up with the required expression. You will run the experiment for at least six values of *n* and will run each of these at least ten times. That's to say, you will run the program *at least* 60 separate times. Feel free to change the main program so that it will run all your experiments in one shot instead of 60 different runs.

Your submission should include:

1. Your **conclusion** about the relationship between *d* and *n*;
2. Your **evidence** to support that relationship (screen shot and/or graph and/or spreadsheet);
3. Your **code** (*RandomWalk.java* plus anything else that you changed or created);
4. A **screen shot** of the unit tests all passing.

Please note: for this assignment, you do not need to set up github and push your files, as described in the general instructions for submission (Submitting Assignments). Note also that common sense should tell you how d varies with l. Don't spend a lot of time agonizing over this aspect of the assignment. What we are primarily interested in is how d varies with n.

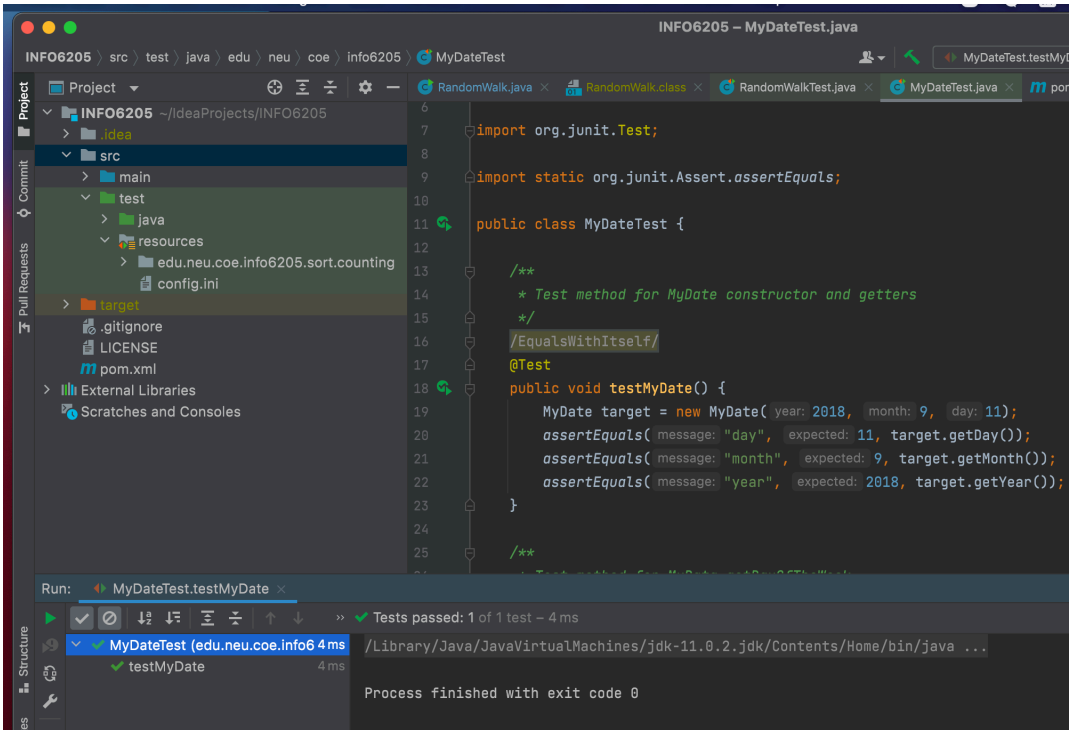
Relationship

d=$\sqrt{n}$, the distance is equal to the square root of steps the drunk takes.

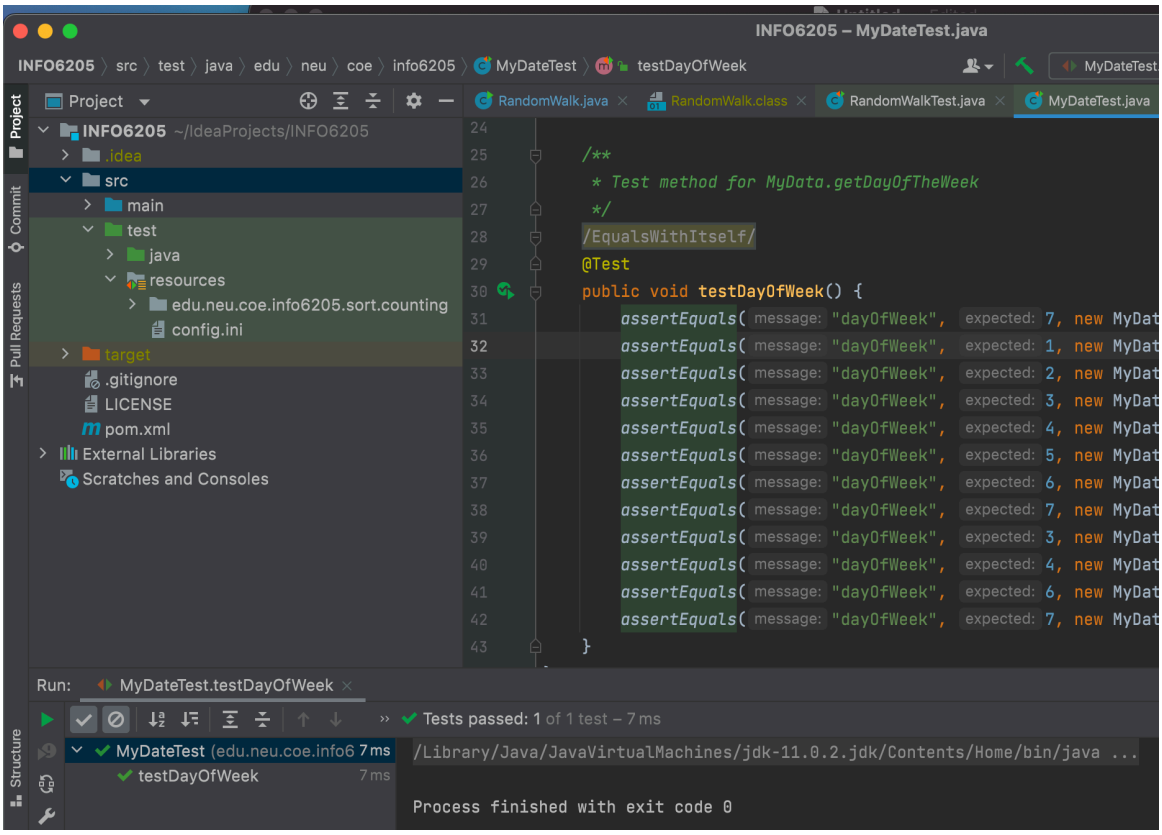
Evidence

Code:
https://github.com/slowpeace2020/INFO6205/blob/Fall2021/src/main/java/edu/neu/coe/info6205/randomwalk/RandomWalk.java

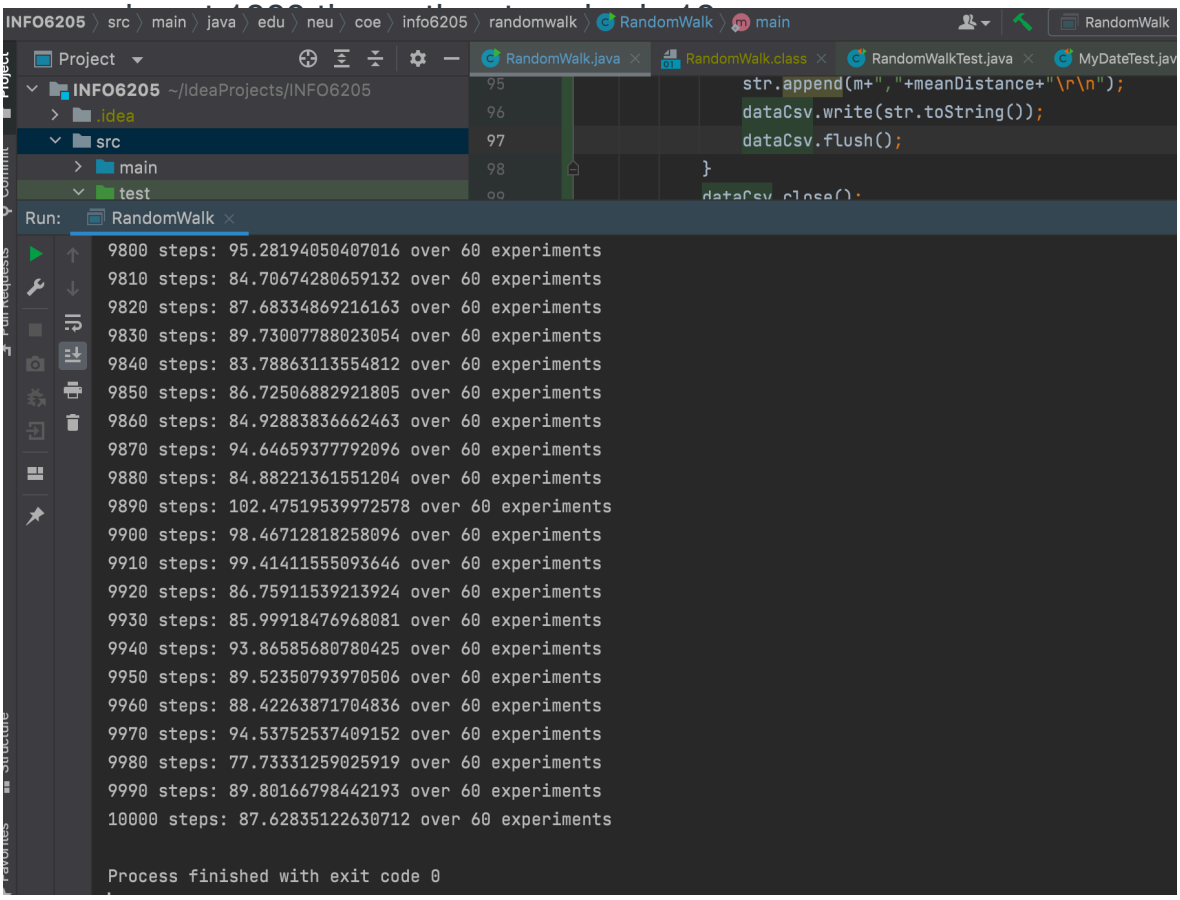
Unit tests



(graph 1. Unit test method testMyDate)



(graph 2. Unit test method testDayOfWeek)

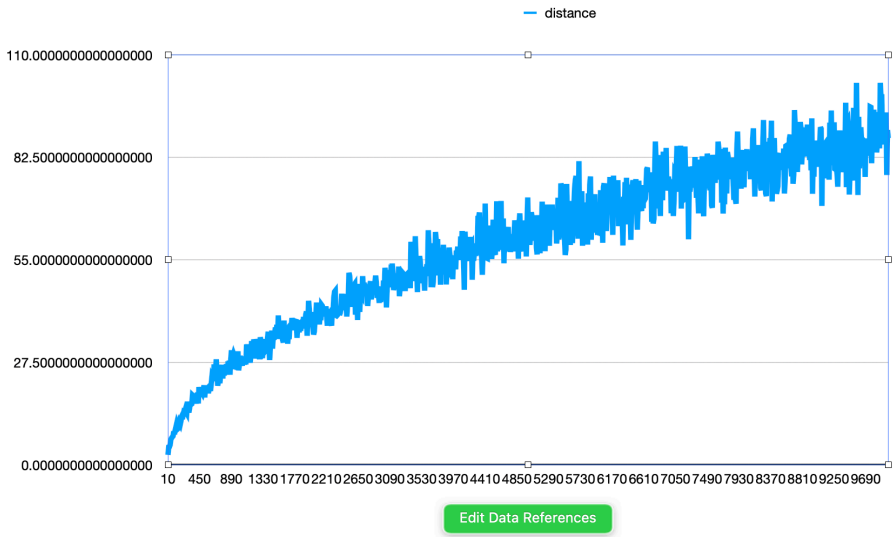


(graph 3. experiment 1000 times)

Csv data
Write the experimental results into csv, and draw a graph to show the relationship between distance and steps.

randomwalk_data

steps	distance
10	2.6415202439395100
20	4.7601932142401100
30	4.821911318227040
40	5.335740692515340
50	6.790453296744300
60	7.173253269976880
70	7.457145154335150
80	7.692659509688900
90	8.959996948315310
100	8.162874423459710
110	9.323694147768840
120	10.106376295792700
130	10.959830309956100
140	10.313460898791800
150	9.693543763652370
160	9.863725390718070
170	11.207664332271800
180	10.82131747809350
190	11.73997497172280
200	13.01966690482170

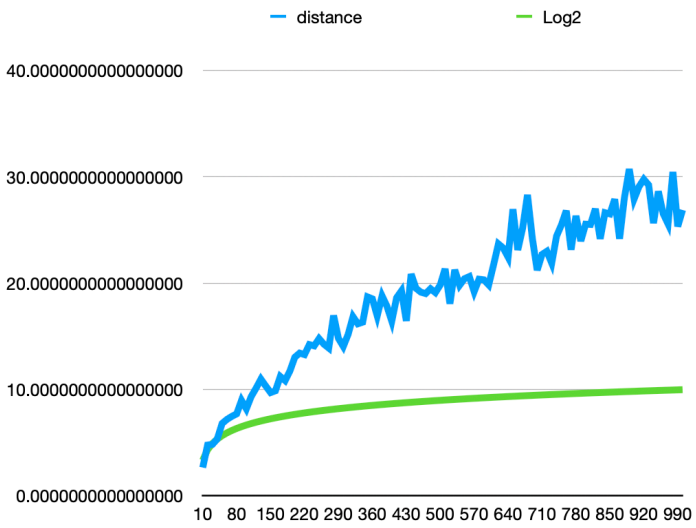


(graph 4. Experiments result chart)

From the graph 4, we could see that there is a positive correlationship between the distance and steps, and the line chart in the coordinate are similar the log function. So I guess the relationship between them is the logarithm function. And I add another column data.

Table 1

steps	distance	Log2
10	2.641520243939510	3.32192809488736
20	4.760193214240110	4.32192809488736
30	4.821911318227040	4.90689059560852
40	5.335740692515340	5.32192809488736
50	6.790453296744300	5.64385618977472
60	7.173253269976880	5.90689059560852
70	7.457145154335150	6.12928301694497
80	7.692659509688900	6.32192809488736
90	8.959996948315310	6.49185309632967
100	8.162874423459710	6.64385618977473
110	9.323694147768840	6.78135971352466
120	10.10637629579270	6.90689059560852
130	10.95983030995610	7.02236781302845
140	10.31346089879180	7.12928301694497



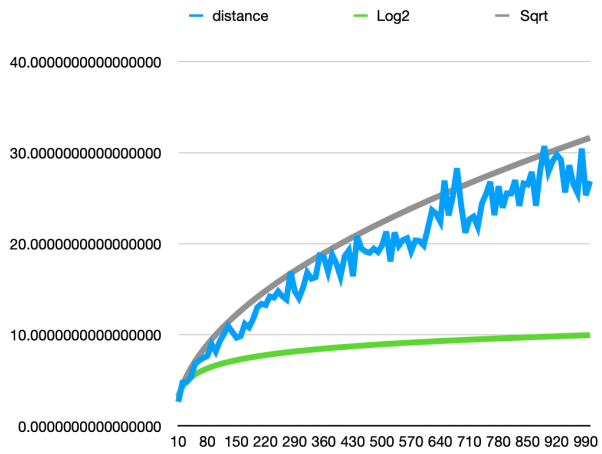
(graph 5. Experiments result chart with lgn)

In the graph 5, we can see that the log function fits the experimental data very well at the beginning, but as the number of steps increases, the difference between the results becomes larger and larger, so this guess is not true.

Is there any other function image shape that matches the experiential result? Maybe be square root function can be.

Table 1

steps	distance	Log2	Sqrt
10	2.641520243939510	3.32192809488736	3.16227766016838
20	4.760193214240110	4.32192809488736	4.47213595499958
30	4.821911318227040	4.90689059560852	5.47722557505166
40	5.335740692515340	5.32192809488736	6.32455532033676
50	6.790453296744300	5.64385618977472	7.07106781186548
60	7.173253269976880	5.90689059560852	7.74596669241483
70	7.457145154335150	6.12928301694497	8.36660026534076
80	7.692659509688900	6.32192809488736	8.94427190999916
90	8.959996948315310	6.49185309632967	9.48683298050514
100	8.162874423459710	6.64385618977473	10
110	9.323694147768840	6.78135971352466	10.4880884817015
120	10.10637629579270	6.90689059560852	10.9544511501033
130	10.95983030995610	7.02236781302845	11.4017542509914
140	10.31346089879180	7.12928301694497	11.8321595661992
150	9.693543763652370	7.22881869049588	12.2474487139159



(graph 6. Experiments result chart with lgn and sqrt)

As can be seen from the graph 6, the experiments result and sqrt function are roughly coincident.

Conclusion

So, we guess :

$$d=\sqrt{n}$$