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INFO 6205
Program Structures & Algorithms
Spring 2019
Assignment 1

The purpose of this assignment is to implement the main method of RandomWalk.java and then deduct the relationship among the variables (distance ***d***, number of steps ***n***, and step length ***l***) using the computed data from stochastic experiments.

After implementing the program, testing the cases and running out the data, I figured out the arithmetic relationship between the variables: $d = l * \sqrt{n}$, and my statement is as follows.

I. Implementation and Testing

In this random walk case, after a man randomly moved n steps with a specific step length l and got to the point (x, y), the Euclidean distance ***d*** of the current position from the origin post (0, 0) can be calculated as: $\mathrm{d} = \sqrt{(x-0)^2 + (y-0)^2}$, and the current position (x, y) is related to the moved steps ***n*** and each step's length ***l***.

In order to explore the relationship deeper, I needed to implement and run out the data, and then observe the arithmetic relationship. I set 5 different step lengths, and in each group of data with a fixed step, set 5 different step numbers, so with given step length and step number, the program would run 10000 times and calculate the mean of the distance (the reason why I let the man randomly walk 10000 times with each given (n, l) value pair and get the mean value of distance is to make the result more accurate). So, after the sufficient experiments, I figured out the data as Table 1 follows:

Step Length (l)	Step Number (n)	Avg Distance (d)
1	100	8.812
1	200	12.527
1	400	17.675
1	800	24.909
1	1600	35.282
2	100	17.729
2	200	24.803
2	400	35.317
2	800	50.251
2	1600	71.205
4	100	35.095
4	200	49.989
4	400	71.059
4	800	101.12
4	1600	141.484

8	100	70.323
8	200	100.303
8	400	142.127
8	800	202.573
8	1600	285.767
16	100	142.652
16	200	200.515
16	400	285.399
16	800	397.348
16	1600	564.852

Table 1 Computed Data by Program

II. Observation and Verification

According to the computed data shown as Table 1, I firstly found the linear relationship between distance ***d*** and step length ***l***, that is, with a same step number, distance ***n*** grows linearly as the step length ***l*** grows. For example, take the first two grey rows in Table 1, the data shows that with the same step number 100, distance 17.729 is nearly 2 times of 8.812, just as the times relation between step length 1 and 2.

Then, I figured out the potential relationship between distance ***d*** and step number ***n***, which is the square root of ***n*** maybe in the linear relationship with ***d***. For instance, take the first grey row, distance 8.812 is not that different with the square root of step number $\sqrt{100}$ (i.e. 10).

So, with the above two observed relationships, I supposed that the relationship between three variables is: $d = l * \sqrt{n}$, and I verified the guess by calculating the value of the equation using the computed data, and the result is shown as Table 2.

Step Length (l)	**Step Number (n)**	**Distance (d)**	$l * \sqrt{n}$
1	100	8.812	10.00
1	200	12.527	14.14
1	400	17.675	20.00
1	800	24.909	28.28
1	1600	35.282	40.00
2	100	17.729	20.00
2	200	24.803	28.28
2	400	35.317	40.00
2	800	50.251	56.57
2	1600	71.205	80.00
4	100	35.095	40.00
4	200	49.989	56.57
4	400	71.059	80.00
4	800	101.12	113.14
4	1600	141.484	160.00
8	100	70.323	80.00
8	200	100.303	113.14
8	400	142.127	160.00

8	800	202.573	226.27
8	1600	285.767	320.00
16	100	142.652	160.00
16	200	200.515	226.27
16	400	285.399	320.00
16	800	397.348	452.55
16	1600	564.852	640.00

Table 2 Computed Data Combined with Calculated Result

III. Conclusion

As Table 2 shows, my hypothesis is correct, because for each line, distance d and the result of $l * \sqrt{n}$ is nearly the same, so I came out the expression between the variables: $d = l * \sqrt{n}$.