

Program Structures & Algorithms

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Assignment – 1

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Task –

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.

Output –

To conclude the statement that if the relationship exists between d and n , I executed the code for a range of (1 to 40) with each step being repeated for 1000 experiments. After that, I averaged the value for each step. Since the program was executed a total of 40×1000 times i.e. 40000 times, we can use this analysis to establish the relationship between d and n .

```
RandomWalk
" C:\Program Files\Java\jdk-17.0.1\bin\java.exe" ...
1 steps: 1.0
2 steps: 1.1949955113493875
3 steps: 1.5813743312816086
4 steps: 1.7537481756967397
5 steps: 2.0415063571806815
6 steps: 2.1503329047872417
7 steps: 2.365548977569699
8 steps: 2.4926316579820798
9 steps: 2.667157337849413
10 steps: 2.8149875846424863
11 steps: 2.9666331173349696
12 steps: 3.072712705936333
13 steps: 3.1865701660993198
14 steps: 3.3292400029529055
15 steps: 3.48789341522936
16 steps: 3.552893352638858
17 steps: 3.6946355783870355
18 steps: 3.7652237660776606
19 steps: 3.8714838521438257
20 steps: 3.9758066186422707
21 steps: 4.073898583821127
22 steps: 4.181438675788506
23 steps: 4.300385797686698
24 steps: 4.348342170926502
25 steps: 4.460324738393786
26 steps: 4.525371094571468
27 steps: 4.5811889218602095
```

```
27 steps: 4.5811889218602095
28 steps: 4.67897307497899
29 steps: 4.8922854950561225
30 steps: 4.766151467067548
31 steps: 4.9842556367411825
32 steps: 4.8387979385802
33 steps: 5.12580421248435
34 steps: 5.1557396139877465
35 steps: 5.2859428927389
36 steps: 5.2925421804493125
37 steps: 5.495829655184239
38 steps: 5.482600418568215
39 steps: 5.637871050035273
40 steps: 5.417399939275727
Disconnected from the target VM, address: '127.0.0.1:51265', transport: 'socket'
```

Relationship Conclusion –

We can conclude the following relationship –

$$\text{Average Euclidean Distance} \propto \sqrt{\text{Number of Steps}}$$

or

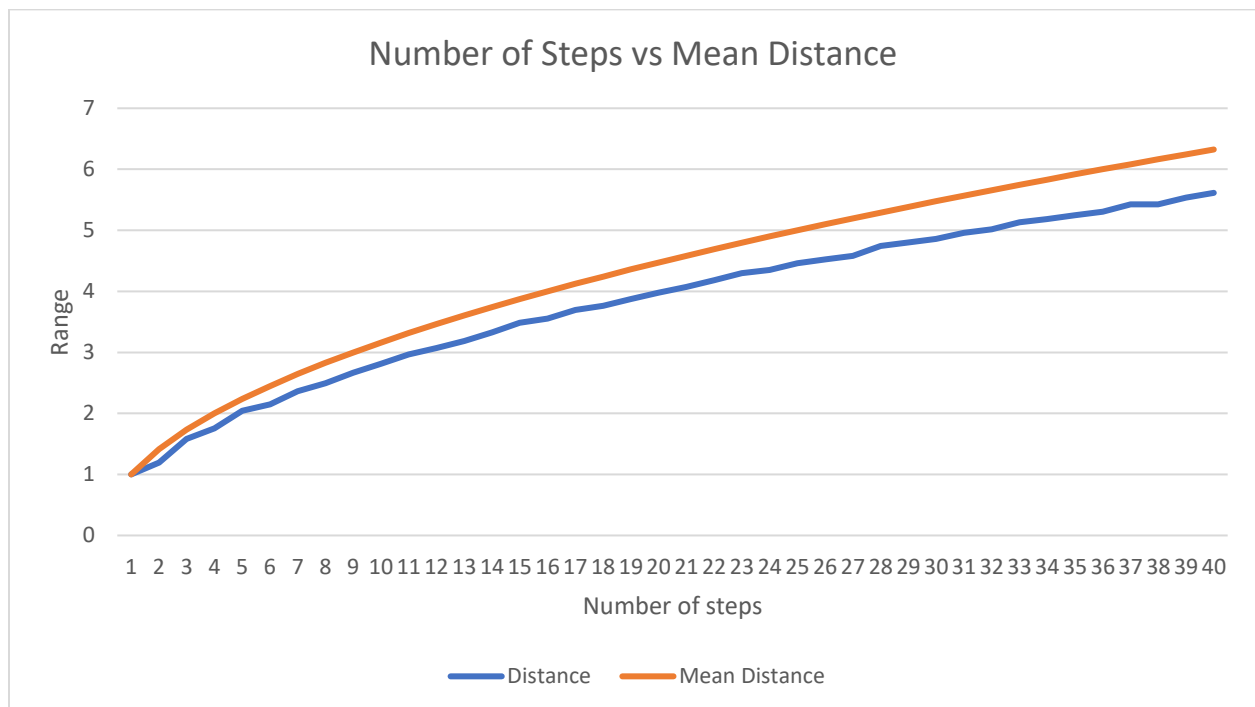
$$\text{Average Euclidean Distance} = k * \sqrt{\text{Number of Steps}}$$

$$\text{Where } k = 0.8865675444083764 \text{ or } \sqrt{\pi}/2$$

We will see this in the below evidence.

Evidence –

The graph plotted below between mean distance & no. of steps shows that the drunk man moves about the square root of the number of steps(n).



From above we can see that as the value of n increases, the distance walked by drunken man is very close to the mean distance. Hence, we can conclude that Euclidean Distance is proportional to the square root of the number of steps.

$$\text{Average Euclidean Distance} = k * \sqrt{\text{Number of Steps}}$$

To calculate the value of k, taking the ratio between the Euclidean distance and the sqrt root gives a value of 0.8865675.

Unit Test Result –

Here is a screenshot of unit test results.

