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Program Structures & Algorithms

Spring 2021

Assignment No. 1

- **Task**

Our primary task is to deduce the relationship between Mean distance D and N number of steps taken by the drunken man in the random walk experiment.

Steps followed to achieve this are:

1. I cloned the git repository INFO6205.
2. Implemented the incomplete functions **move()**, **randomWalk()**,
And **distance()** in the RandomWalk.java file.
3. Used Euclidian distance formula to calculate the distance from the origin.
4. Executed the file and got the below output.

- **Output**

In order to test different N values with varying experiments in a single run, I modified the main function a little bit, as mentioned on the canvas assignment page.

Sample outputs:

1. Tested with different N values from (1 to 20) for 200 experiments.
2. Tested with different N values from (2 to 20) even numbers for 200 experiments.
3. Tested with different N values from (21 to 81) odd numbers for 200 experiments.

```
Run: RandomWalk x
"D:\Program Files\Java\jdk1.8.0_45\bin\java.exe" ...
1 steps: 1.0 over 200 experiments
2 steps: 1.3048885271170707 over 200 experiments
3 steps: 1.6020665112249173 over 200 experiments
4 steps: 1.8368037692711354 over 200 experiments
5 steps: 2.0045406697086507 over 200 experiments
6 steps: 2.049581109740522 over 200 experiments
7 steps: 2.404369053784782 over 200 experiments
8 steps: 2.325545564977654 over 200 experiments
9 steps: 2.570802955139422 over 200 experiments
10 steps: 2.8667640858855696 over 200 experiments
11 steps: 2.9123671369196287 over 200 experiments
12 steps: 3.0202029456722426 over 200 experiments
13 steps: 3.1197677865460753 over 200 experiments
14 steps: 3.2895063746167152 over 200 experiments
15 steps: 3.408158784563594 over 200 experiments
16 steps: 3.342973593514902 over 200 experiments
17 steps: 3.718939248111641 over 200 experiments
18 steps: 3.453385638008559 over 200 experiments
19 steps: 3.9610085165223956 over 200 experiments
20 steps: 4.135429564655086 over 200 experiments

Process finished with exit code 0
```

```
"D:\Program Files\Java\jdk1.8.0_45\bin\java.exe" ...
2 steps: 1.19710678118655 over 200 experiments
4 steps: 1.8009614209575318 over 200 experiments
6 steps: 2.0965864256475863 over 200 experiments
8 steps: 2.4157063411242237 over 200 experiments
10 steps: 2.8113951451740165 over 200 experiments
12 steps: 3.2592817066051163 over 200 experiments
14 steps: 3.357426448848146 over 200 experiments
16 steps: 3.609706584829216 over 200 experiments
18 steps: 3.751166753020251 over 200 experiments
20 steps: 3.9294760506087125 over 200 experiments
22 steps: 4.150630634342928 over 200 experiments
24 steps: 4.400004141904811 over 200 experiments
26 steps: 4.443691828665221 over 200 experiments
28 steps: 4.717818313168046 over 200 experiments
30 steps: 5.130531383741715 over 200 experiments
32 steps: 4.829946809787753 over 200 experiments
34 steps: 4.805038173901113 over 200 experiments
36 steps: 5.367383030841803 over 200 experiments
38 steps: 5.70439733829455 over 200 experiments
40 steps: 5.405836159638711 over 200 experiments

Process finished with exit code 0
```

```
"D:\Program Files\Java\jdk1.8.0_45\bin\java.exe" ...
41 steps: 5.6221921053427755 over 200 experiments
43 steps: 5.82307051864532 over 200 experiments
45 steps: 6.042798508652295 over 200 experiments
47 steps: 6.279484101425554 over 200 experiments
49 steps: 6.149155857935957 over 200 experiments
51 steps: 6.295102216555281 over 200 experiments
53 steps: 6.520712120980972 over 200 experiments
55 steps: 6.934191767061001 over 200 experiments
57 steps: 6.583830930514473 over 200 experiments
59 steps: 6.537033636467331 over 200 experiments
61 steps: 7.134667406303286 over 200 experiments
63 steps: 6.934724105204344 over 200 experiments
65 steps: 7.147915205974697 over 200 experiments
67 steps: 7.4079029319812095 over 200 experiments|
69 steps: 6.848301446393217 over 200 experiments
71 steps: 7.4201282146249685 over 200 experiments
73 steps: 7.28419856898928 over 200 experiments
75 steps: 7.592349059980995 over 200 experiments
77 steps: 7.835704000048795 over 200 experiments
79 steps: 8.316468006643323 over 200 experiments
81 steps: 8.339824924338455 over 200 experiments

Process finished with exit code 0
```

- **Relationship Conclusion:**

After testing with different N values for various M experiments, it appears to be D is directly proportional to the Square root of N.

$$D \propto \sqrt{N} + V$$

Where:

D is the Mean distance

N is the number of Steps.

V is the Variance

- **Evidence to support the conclusion:**

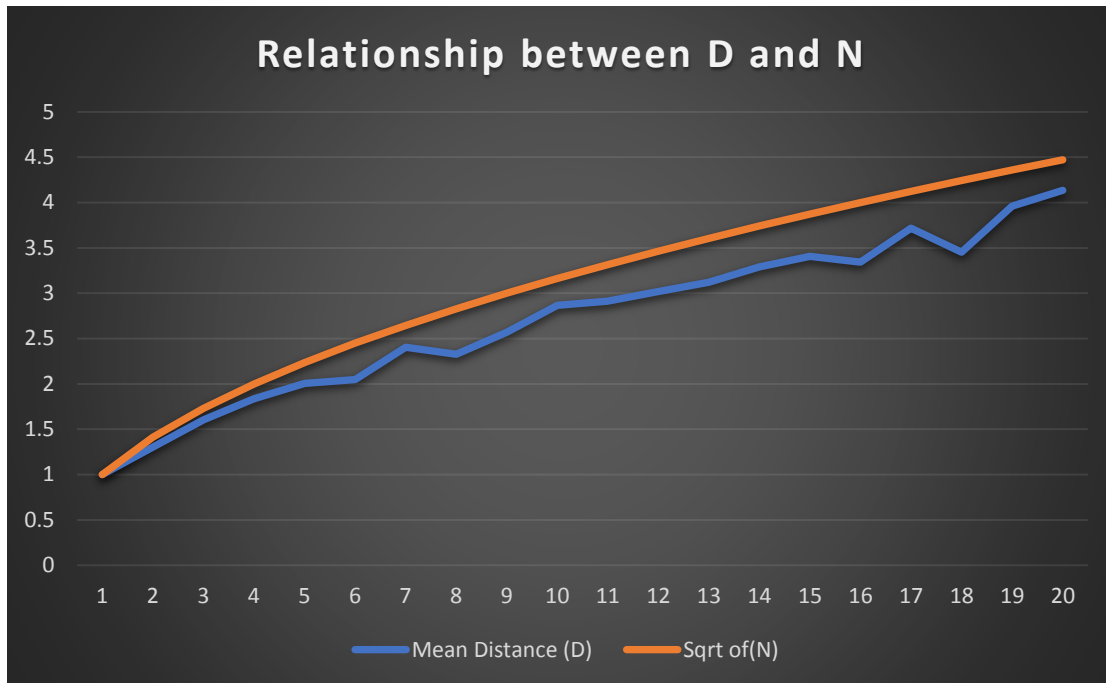
After plotting the data points in excel and analyzing D and N closely, it looks like D increases when the number of steps increases, which means the man is going away from the origin. Also, Distance D is approximately less than or equal to the squared root of N.

Sample data for N (1 to 20) with 200 experiments

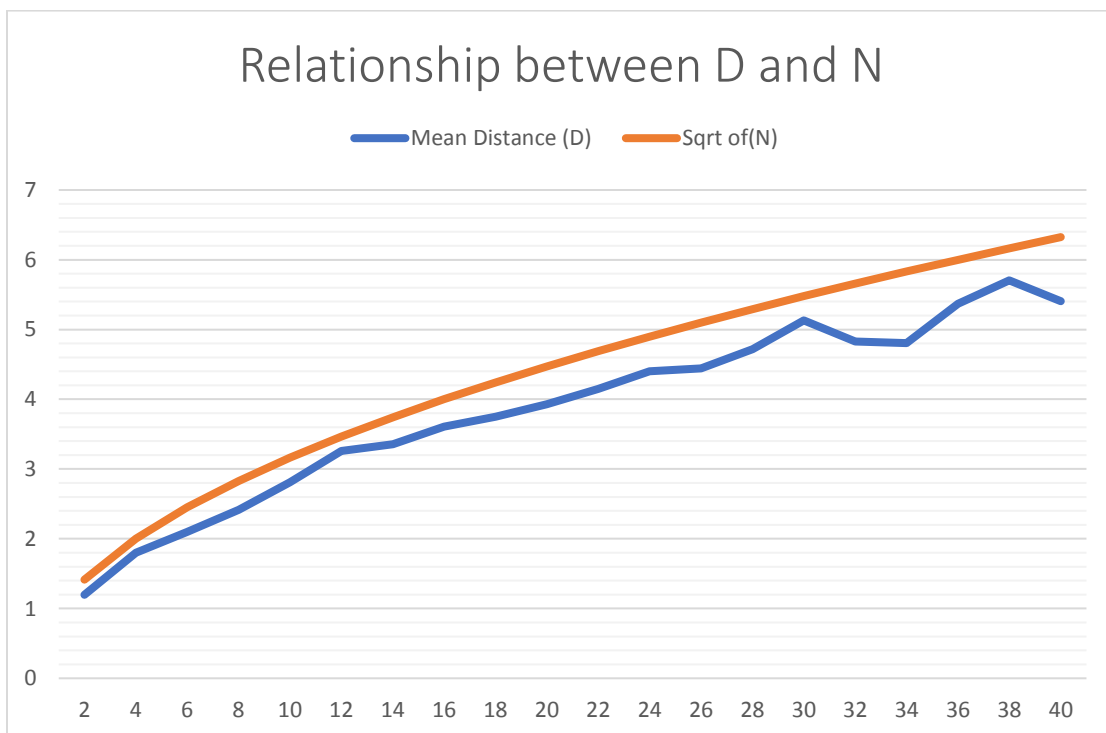
Steps (N)	Mean Distance (D)	No. of Experiments	Sqrt of(N)
1	1	200	1
2	1.304888527	200	1.414213562
3	1.602066511	200	1.732050808
4	1.836803769	200	2
5	2.00454067	200	2.236067977
6	2.04958111	200	2.449489743
7	2.404369054	200	2.645751311
8	2.325545565	200	2.828427125
9	2.570802955	200	3
10	2.866764086	200	3.16227766
11	2.912367137	200	3.31662479
12	3.020202946	200	3.464101615
13	3.119767787	200	3.605551275
14	3.289506375	200	3.741657387
15	3.408158785	200	3.872983346
16	3.342973594	200	4
17	3.718939248	200	4.123105626
18	3.453385638	200	4.242640687
19	3.961008517	200	4.358898944
20	4.135429565	200	4.472135955

*For other N values please check the Excel file attached.

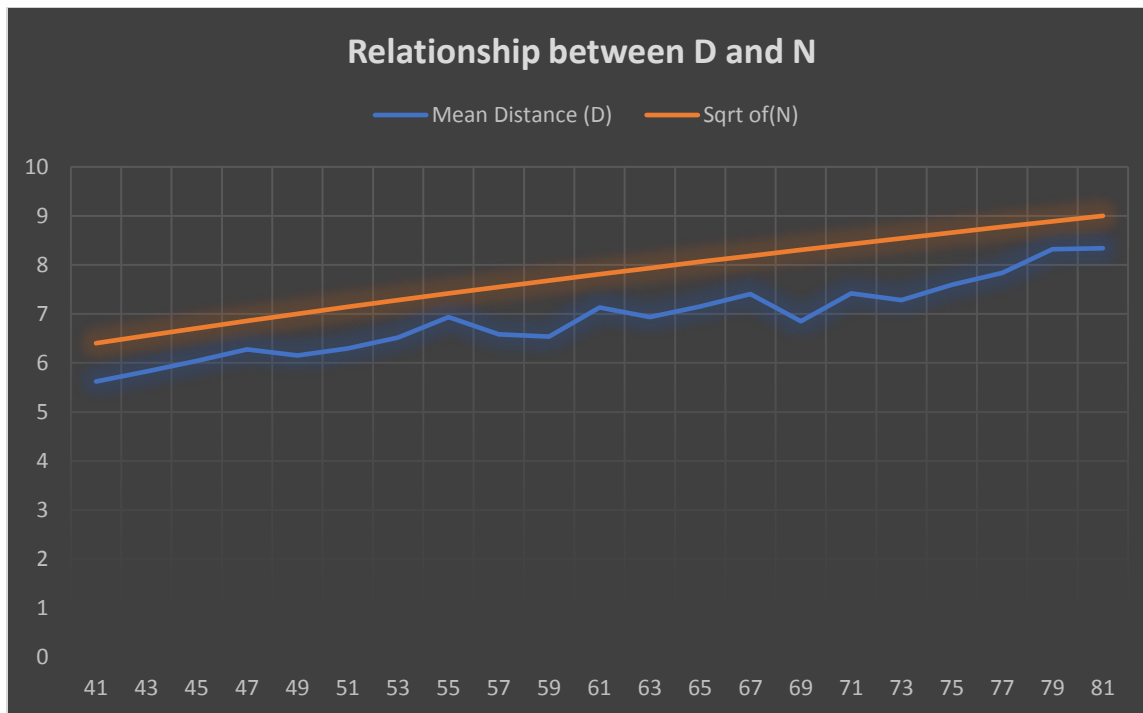
- Graphical representation:



i) N (1 to 20)



ii) N (2 to 40) Even numbers



iii) N (41 to 81) Odd numbers

- Unit tests result:

