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Program Structures & Algorithms

Fall 2021

Assignment No. 1

⊙ 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**.

- Conclusion about the relationship between d and n
- Evidence to support that relationship
- Code
- Screenshot of unit tests

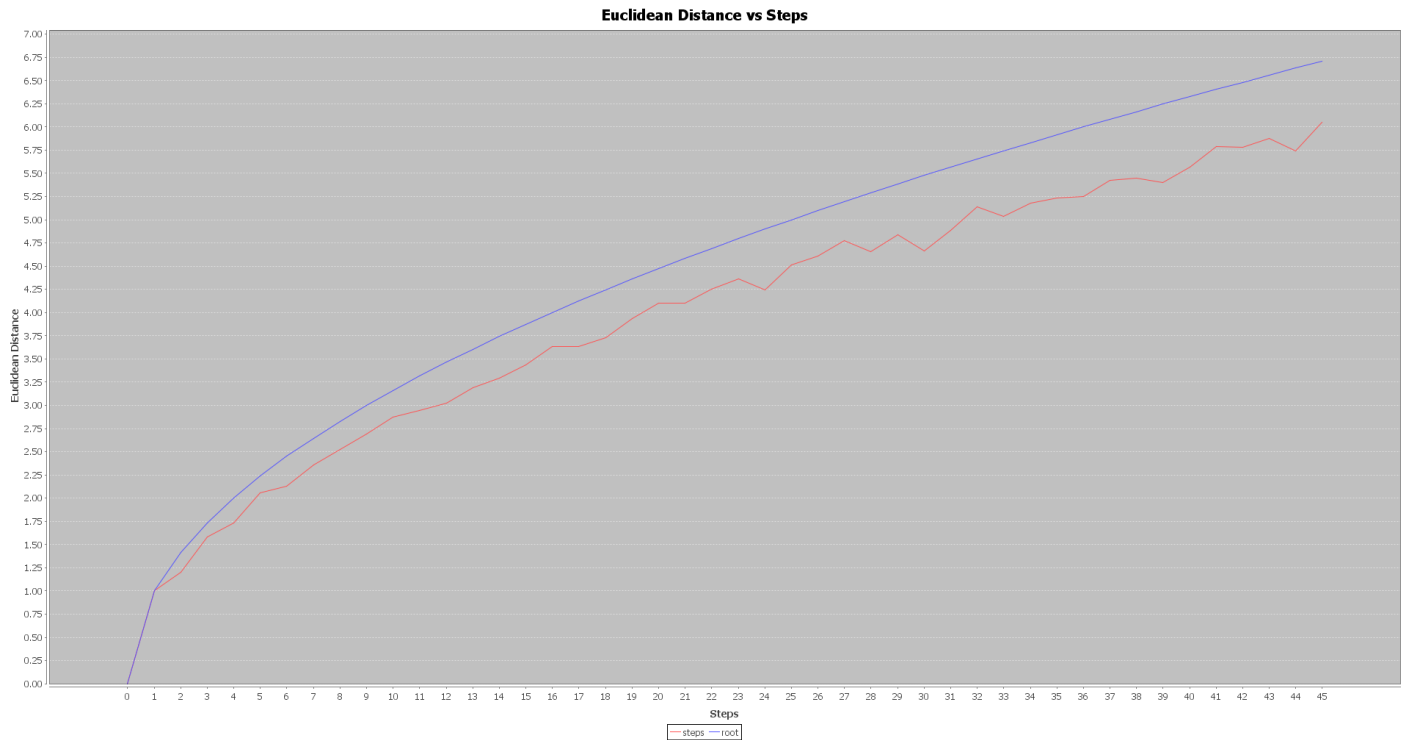
⊙ Relationship Conclusion:

- $d \approx \sqrt{n}$

d = Euclidean Distance

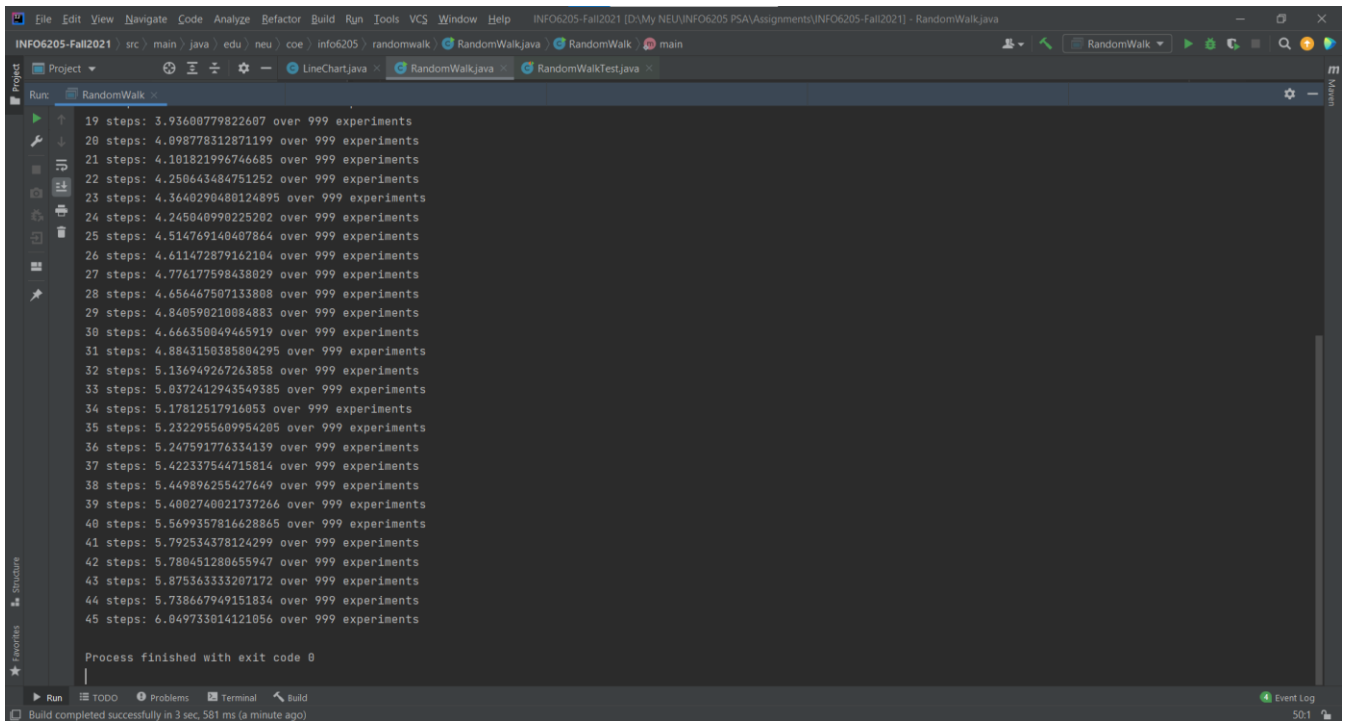
n = Number of Steps

◉ Evidence to support the conclusion:



1. Output (Snapshot of Code output in the terminal):

```
INFO6205-Fall2021 [src] main java edu neu coe info6205 randomwalk RandomWalk.java RandomWalk RandomWalkTest.java main
Run: RandomWalk x
"C:\Program Files\Java\jdk1.8.0_291\bin\java.exe" ...
0 steps: 0.0 over 999 experiments
1 steps: 1.0 over 999 experiments
2 steps: 1.2002237438096766 over 999 experiments
3 steps: 1.5808702938787944 over 999 experiments
4 steps: 1.7317580115108189 over 999 experiments
5 steps: 2.0603366277463313 over 999 experiments
6 steps: 2.132285663882757 over 999 experiments
7 steps: 2.3545891571077284 over 999 experiments
8 steps: 2.5223714122379897 over 999 experiments
9 steps: 2.6932256366345 over 999 experiments
10 steps: 2.869894634230611 over 999 experiments
11 steps: 2.9472113350198708 over 999 experiments
12 steps: 3.027464279084122 over 999 experiments
13 steps: 3.193567211620477 over 999 experiments
14 steps: 3.2938273321296707 over 999 experiments
15 steps: 3.433271186316122 over 999 experiments
16 steps: 3.6340964540774885 over 999 experiments
17 steps: 3.634675255041197 over 999 experiments
18 steps: 3.72703399393582 over 999 experiments
19 steps: 3.93600779822607 over 999 experiments
20 steps: 4.098778312871199 over 999 experiments
21 steps: 4.101821996746685 over 999 experiments
22 steps: 4.250443484751252 over 999 experiments
23 steps: 4.3640290480124895 over 999 experiments
24 steps: 4.245040998225202 over 999 experiments
25 steps: 4.514769140407864 over 999 experiments
26 steps: 4.6114728797162104 over 999 experiments
27 steps: 4.776177598438029 over 999 experiments
28 steps: 4.656467507133808 over 999 experiments
Build completed successfully in 3 sec, 581 ms (a minute ago)
```



```
INFO6205-Fall2021 [D:\My NEU\INFO6205 PSA\Assignments\INFO6205-Fall2021] - RandomWalk.java
src \ main \ java \ edu \ neu \ coe \ info6205 \ randomwalk \ RandomWalk.java \ RandomWalk \ main
Run: RandomWalk
19 steps: 3.93600779822607 over 999 experiments
20 steps: 4.898778312871199 over 999 experiments
21 steps: 4.181821996746685 over 999 experiments
22 steps: 4.250643484751252 over 999 experiments
23 steps: 4.3640290480124895 over 999 experiments
24 steps: 4.245040990225202 over 999 experiments
25 steps: 4.514769140407864 over 999 experiments
26 steps: 4.611472879162104 over 999 experiments
27 steps: 4.776177598438029 over 999 experiments
28 steps: 4.656467507133808 over 999 experiments
29 steps: 4.840590210084883 over 999 experiments
30 steps: 4.666350049465919 over 999 experiments
31 steps: 4.8843150385804295 over 999 experiments
32 steps: 5.136949267263858 over 999 experiments
33 steps: 5.0372412943549385 over 999 experiments
34 steps: 5.17812517916053 over 999 experiments
35 steps: 5.2322955609954205 over 999 experiments
36 steps: 5.247591776334139 over 999 experiments
37 steps: 5.422337544715814 over 999 experiments
38 steps: 5.449896255427649 over 999 experiments
39 steps: 5.4002740021737266 over 999 experiments
40 steps: 5.5699357816628865 over 999 experiments
41 steps: 5.792534378124299 over 999 experiments
42 steps: 5.780451280655947 over 999 experiments
43 steps: 5.875363333207172 over 999 experiments
44 steps: 5.738667949151834 over 999 experiments
45 steps: 6.049733014121056 over 999 experiments
Process finished with exit code 0
Run | TODO | Problems | Terminal | Build
Build completed successfully in 3 sec, 581 ms (a minute ago)
```

2. Graphical Representation(Observations from experiments should be tabulated and analyzed by plotting graphs(usually in excel) to arrive on the relationship conclusion)

- I've plotted graph using JFreeChart framework, I did not use excel separately to store my n and d values, instead I computed and analyzed the relationship in the java program itself. There was a lot errors in the distance, and I was able to conclude that it is somewhere near $\text{root}(n)$.

	A	B	C	D
1	Steps	Mean Distance	d=sqrt(n)	No of Experiments
2	0	0	0	999
3	1	1	1	999
4	2	1.238428471	1.4142136	999
5	3	1.58586213	1.7320508	999
6	4	1.760367958	2	999
7	5	2.002321351	2.236068	999
8	6	2.139422831	2.4494897	999
9	7	2.357786963	2.6457513	999
10	8	2.476075714	2.8284271	999
11	9	2.692375736	3	999
12	10	2.743769507	3.1622777	999
13	11	2.94266497	3.3166248	999
14	12	3.129744959	3.4641016	999
15	13	3.188978833	3.6055513	999
16	14	3.341791599	3.7416574	999
17	15	3.514766974	3.8729833	999
18	16	3.631529894	4	999
19	17	3.673500572	4.1231056	999
20	18	3.831038323	4.2426407	999
21	19	3.891384571	4.3588989	999
22	20	4.041374358	4.472136	999
23	21	4.002332021	4.5825757	999
24	22	4.245532248	4.6904158	999
25	23	4.254422083	4.7958315	999
26	24	4.39034724	4.8989795	999
27	25	4.351062462	5	999
28	26	4.468504437	5.0990195	999
29	27	4.584308435	5.1961524	999
30	28	4.775706424	5.2915026	999
31	29	4.738802396	5.3851648	999
32	30	4.851732966	5.4772256	999
33	31	4.925415141	5.5677644	999
34	32	5.06407529	5.6568542	999
35	33	5.215494412	5.7445626	999
36	34	5.155422905	5.8309519	999
37	35	5.186627991	5.9160798	999
38	36	5.251515166	6	999
39	37	5.331112444	6.0827625	999
40	38	5.366775088	6.164414	999
41	39	5.472002862	6.244998	999
42	40	5.64863556	6.3245553	999
43	41	5.721377047	6.4031242	999
44	42	5.781758567	6.4807407	999
45	43	5.812175234	6.5574385	999
46	44	5.804526995	6.6332496	999
47	45	5.695023254	6.7082039	999

◉ Unit tests result:(Snapshot of successful unit test run)

