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Program Structures & Algorithms

Fall 2021

Assignment No. 01

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**.

Relationship Conclusion:

$$d \approx \sqrt{n}$$

Evidence to support the conclusion:

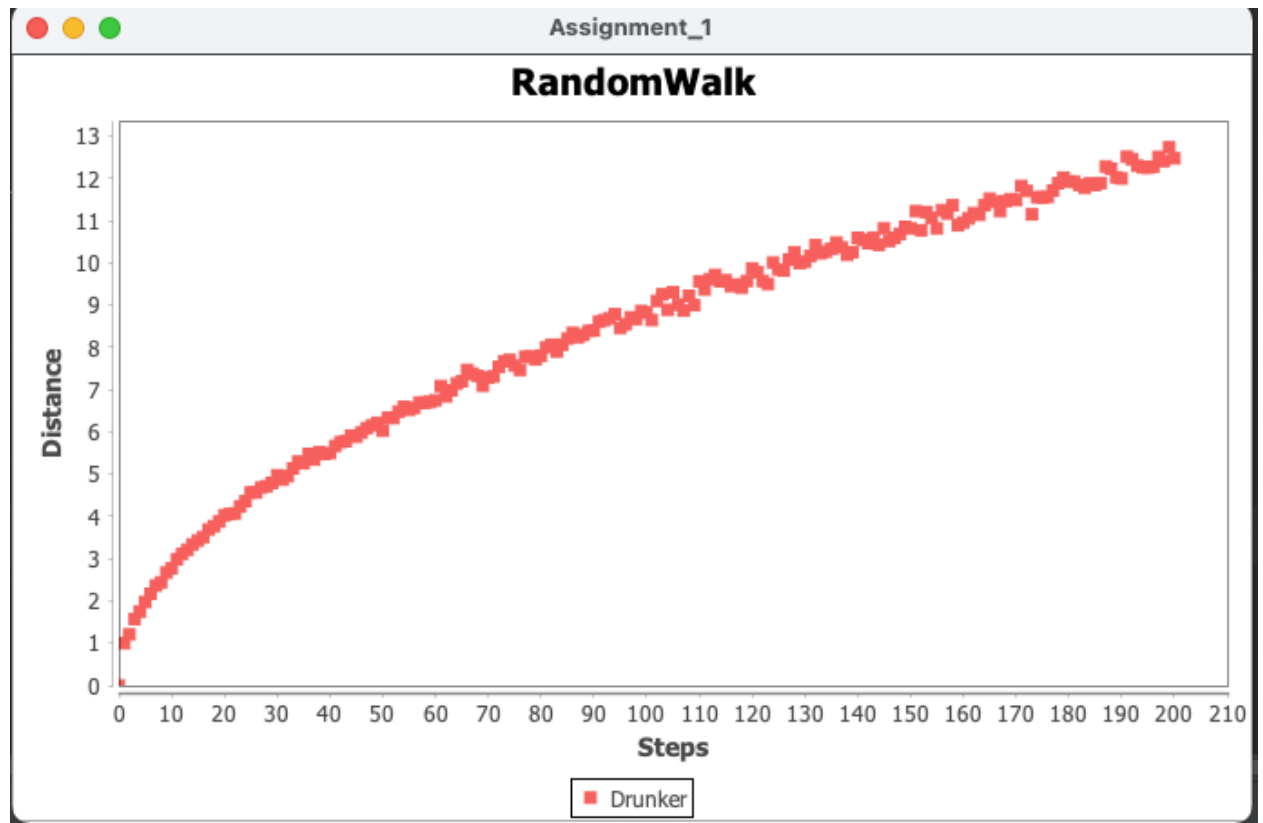
1. Output

```
/Users/haoyanghu/Library/Java/JavaVirtualMachines/openjdk-16.0.2/Contents/Home/bin/java ...
i = NO.1
n = 1 d = 1.0 over 1000 experiments
-----
i = NO.2
n = 2 d = 1.156177848998418 over 1000 experiments
-----
i = NO.3
n = 3 d = 1.5423319960574213 over 1000 experiments
-----
i = NO.4
n = 4 d = 1.732751072348133 over 1000 experiments
-----
i = NO.5
n = 5 d = 2.0146975442837953 over 1000 experiments
-----
i = NO.6
n = 6 d = 2.213435531607005 over 1000 experiments
-----
i = NO.7
n = 7 d = 2.391100898301874 over 1000 experiments
-----
i = NO.8
n = 8 d = 2.44444715677882 over 1000 experiments
```

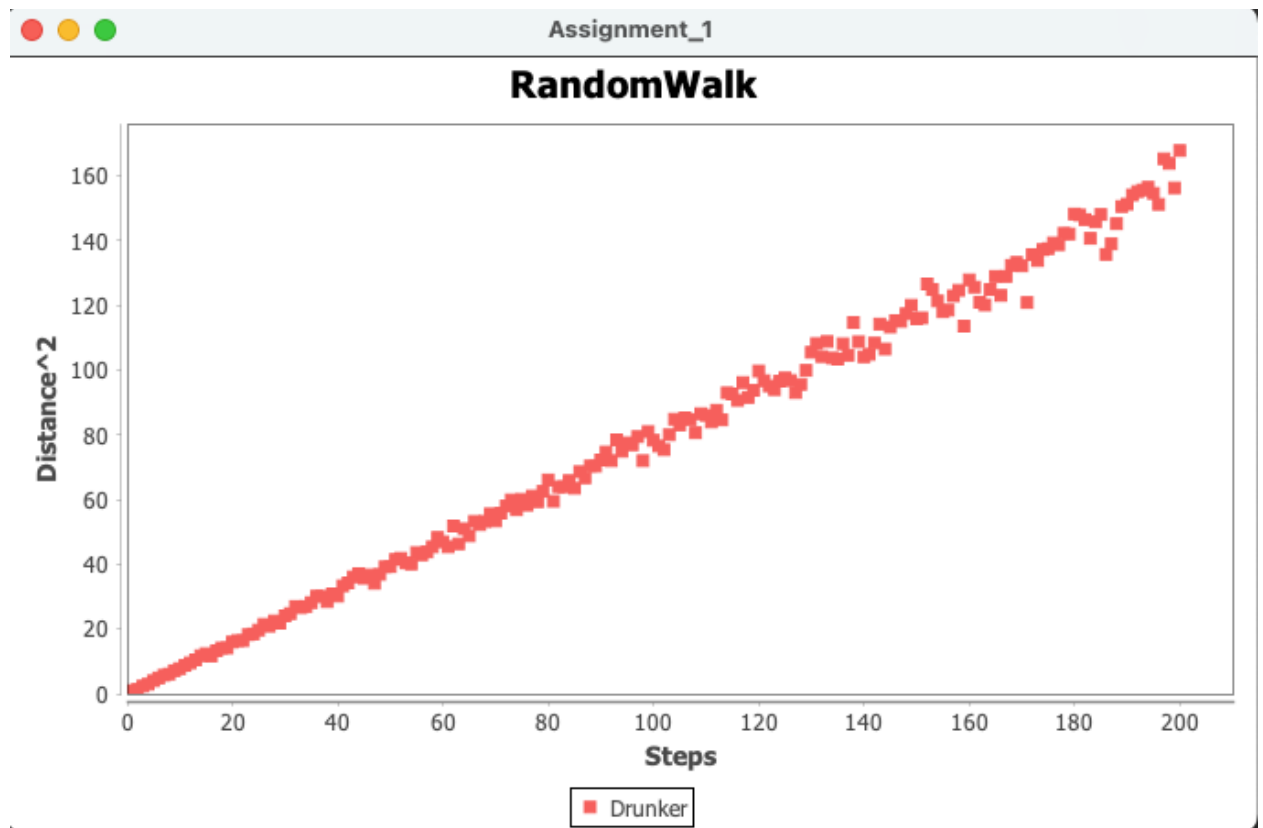
```
Run: RandomWalk
n = 193 d = 12.479644657845677 over 1000 experiments
-----
i = NO.194
n = 194 d = 12.512323251941158 over 1000 experiments
-----
i = NO.195
n = 195 d = 12.43783939739739 over 1000 experiments
-----
i = NO.196
n = 196 d = 12.297749752781987 over 1000 experiments
-----
i = NO.197
n = 197 d = 12.857789379587627 over 1000 experiments
-----
i = NO.198
n = 198 d = 12.80336356647824 over 1000 experiments
-----
i = NO.199
n = 199 d = 12.50395608791609 over 1000 experiments
-----
i = NO.200
n = 200 d = 12.956569832827755 over 1000 experiments
-----
```

2. Graphical Representation

Relationship between n and d :



Relationship between n and d^2 :



It is like a linear function which through the two coordinates $(0, 0)$ and $(1, 1)$, so the relationship conclusion is $d \approx \sqrt{n}$

◦ Unit tests result:

```
✓ Tests passed: 6 of 6 tests - 253 ms
RandomWalkTest (edu.neu.coe.info6205.rand:253 ms)
  ✓ testRandomWalk2 86 ms
  ✓ testMove0 3 ms
  ✓ testMove1 3 ms
  ✓ testMove2 4 ms
  ✓ testMove3 2 ms
  ✓ testRandomWalk 156 ms
/Users/haoyanghu/Library/Java/JavaVirtualMachines/openjdk-16.0.2/Contents/Home/bin/java ...
Process finished with exit code 0
```