

Program Structures and Algorithms (INFO 6205) Summer 2022  
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### Assignment 1-Random Walk

#### Tasks:

- Find the distance between origin and the destination of the drunk man who 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.
- Fill the missing code
- Find the relationship between d and n (Evidence to support that relationship)
- Screen shot of the unit tests all passing

How d varies with n?

d- It is the Euclidean Distance of the man from the lamp-post.

N- It is the number of steps.

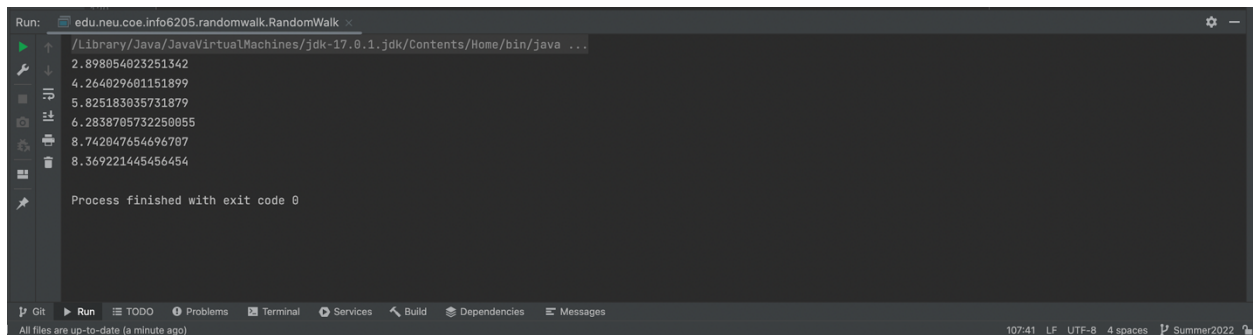
N values taken for the experiment are [10,20,40,60,80,100] and each experiment is run 30 times.

#### Relationship Conclusion

$D = \sqrt{N} + \text{value (uncertain)}$

We can conclude that D is equal to the square root of the number of steps taken by the drunk man and (plus or minus) an uncertain value.

#### Sample Output:

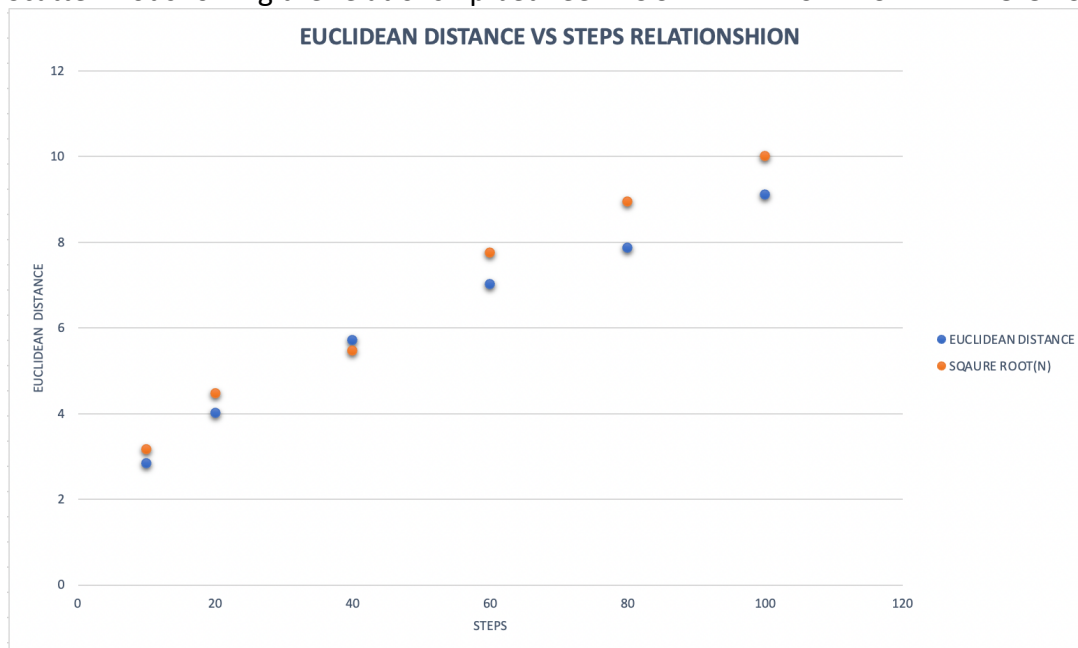


```
Run: edu.neu.coe.info6205.randomwalk.RandomWalk
/Library/Java/JavaVirtualMachines/jdk-17.0.1.jdk/Contents/Home/bin/java ...
2.898054023251342
4.264029601151899
5.825183035731879
6.2838705732250055
8.742047654696707
8.369221445456454
Process finished with exit code 0
```

STEPS AND DISTANCES (RUN 10 TIMES OVER DIFFERENT RANDOM VALUES)  
Evidence to support the relationship conclusion given above.

Steps	Cycles	Euclidean d1	Euclidean d2	Euclidean d3	Euclidean d4	Euclidean d5		
10	30	3.099622542	2.898054023	3.019621543	2.5477328	3.165573627		
20	30	3.939096292	4.264029601	4.548163301	4.275434853	4.035686087		
40	30	6.025669708	5.825183036	5.441492937	5.54916118	5.196864348		
60	30	7.727427487	6.283870573	7.388004497	5.707405826	7.625510459		
80	30	8.255620969	8.742047655	7.747258414	7.161248654	7.267029743		
100	30	8.866979387	8.369221445	11.34697337	9.104792196	8.780477414		
Steps	Cycles	Euclidean d6	Euclidean d7	Euclidean d8	Euclidean d9	Euclidean d10	Average	SQRT(N)
10	30	2.644306011	2.717343365	2.418926517	3.078280704	2.764354565	2.83538	3.16
20	30	3.638269901	4.189548749	3.477408686	3.812270561	3.986244456	4.016615249	4.47
40	30	6.654849288	5.583436179	5.084190426	5.978391931	5.825531728	5.716477076	5.47
60	30	7.458038653	6.722234882	7.497974307	6.378466944	7.335232965	7.012416659	7.745
80	30	7.640238535	9.613004865	8.024220993	6.771200835	7.455827719	7.867769838	8.94
100	30	8.434106355	9.178138745	8.499741621	9.630806727	8.902925304	9.111416257	10

Scatter Plot showing the relationship between EUCLIDEAN DISTANCE AND NO OF STEPS



## UNIT TEST CASES RESULTS

```

Run: RandomWalkTest
Tests passed: 6 of 6 tests - 178 ms
RandomWalkTest (edu.neu.coe..178 ms)
  testRandomWalk2 5 ms
  testMove0 1 ms
  testMove1 1 ms
  testMove2 1 ms
  testMove3 0 ms
  testRandomWalk 170 ms
Process finished with exit code 0
  
```

Tests passed: 6 (moments ago)

13:30 LF UTF-8 4 spaces Summer2022

CODE

```

1 package edu.neu.coe.info205.randomwalk;
2
3 import java.util.Random;
4 import java.util.Scanner;
5 import java.io.IOException;
6
7
8
9
10
11
12 12 usages  A vladhaurin v1 *
13 public class RandomWalk {
14
15     3 usages
16     private int x = 0;
17
18     3 usages
19     private int y = 0;
20
21
22     2 usages
23     private final Random random = new Random();
24
25     /**
26      * Private method to move the current position, that's to say the drunkard moves
27      *
28      * @param dx the distance he moves in the x direction
29      * @param dy the distance he moves in the y direction
30      */
31
32     1 usage  A vladhaurin v1 *
33     private void move(int dx, int dy) {
34         // FIXME do move by replacing the following code
35         // Randomly walk n RandomWalk()
36
37         xxxxxx;
38         y+=dy;
39
40         // throw new RuntimeException("Not implemented");
41     } // END
42
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44 }
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46 /**
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```

INFO@205  src main java edu neu cs Info@205 randomwalk RandomWalk.java RandomWalkTest.java
NewProjectAppRandomWalkSteps
INFO@205  src
src
21 // RandomWalk dx the distance he moves in the x direction
22 // RandomWalk dy the distance he moves in the y direction
23 //
24 //
25 // Usage: java RandomWalk n
26 private void move(int dx, int dy) {
27     // FIXME do move by replacing the following code
28     // RandomWalk walk = new RandomWalk();
29     // walk.move(dx, dy);
30     // throw new RuntimeException("Not implemented");
31     // END
32 }
33 //
34 // Perform a random walk of n steps
35 //
36 // RandomWalk n the number of steps the drunkard takes
37 //
38 // Usage: java RandomWalk n
39 private void randomWalk(int n) {
40     // FIXME
41     for (int i = 0; i < n; i++)
42     {
43         randomMove();
44     }
45     // END
46 }
47 //
48 // Private method to generate a random move according to the rules of the situation.
49 // That's to say, moves can be (+1, 0) or (0, +1).
50 //
51 // Usage: java RandomWalk
52 private void randomMove() {
53     boolean is = random.nextBoolean();
54     int step = random.nextBoolean() ? 1 : -1;

```

The screenshot shows the IntelliJ IDEA IDE with a Java file named `INFO6205 - RandomWalk.java`. The code implements a random walk simulation. It includes comments explaining the rules of movement (left or right) and the calculation of distance from the origin. The `randomMove()` method uses `Math.random()` to determine the direction. The `distance()` method calculates the Euclidean distance from the origin. Finally, the `main` method performs multiple experiments and returns the mean distance.

```

1 // INFO: RandomWalk steps
2 package info6205;
3 import java.util.*;
4
5 /**
6  * A class which simulates a drunkard's random walk.
7  */
8 public class RandomWalk {
9     // Private method to generate a random move according to the rules of the situation.
10    // That is to say, moves can be (-1, 0) or (0, +1).
11    //
12    // Usage: <drunkard>.randomMove()
13    private void randomMove() {
14        boolean ns = random.nextBoolean();
15        int step = random.nextInt(2) % 2 == 0 ? -1 : 1;
16        move(ns > step ? 0, ns > 0 ? 0 : step);
17    }
18
19    //
20    // Method to compute the distance from the origin (the lamp-post where the drunkard starts) to his current position.
21    // Returns the (Euclidean) distance from the origin to the current position.
22    //
23    // Usage: <drunkard>.distance()
24    public double distance() {
25        // FIXME
26        return Math.sqrt(Math.pow(x, 2) + Math.pow(y, 2));
27        // return 0.0;
28        // END
29    }
30
31    //
32    // Perform multiple random walk experiments, returning the mean distance.
33    //
34    // Returns the number of steps for each experiment
35    // Returns the number of experiments to run
36    // Returns the mean distance
37    //
38    // Usage: <drunkard>.walkExperiments(n)
39    public double walkExperiments(int n) {
40        // ...
41    }
42 }

```

The status bar at the bottom indicates "Tests passed: 6 (today 2:23 AM)", "65% (49 chars)", "UTF-8", "4 spaces", and "Summer2022".

```
INFO205  src  main  java  edu  neu  coe  info205  randomwalk  RandomWalk  main  edu.neu.coe.info205.randomwalk.RandomWalk
NewtonApproximation.java  RandomWalk.java
RandomWalk.steps  0 results  T  A  C  C  W  X
A: staschuerlin
88  public static void main(String[] args) {
89
90      List steps = new ArrayList<>();
91      double answer[] = new double[steps.size()];
92      int n = 10;
93      for (int i = 0; i < steps.size(); i++)
94      {
95          double meanDistance = randomWalkMulti(steps[i], n);
96          answer[i] = meanDistance;
97      }
98      for (int i = 0; i < answer.length; i++)
99      {
100          System.out.println(answer[i]);
101      }
102  }
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