

Program Structures and Algorithms
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GITHUB LINK:

<https://github.com/basupatil1213/INFO6205/tree/main/src/main/java/edu/neu/coe/info6205/randomwalk>

Task:

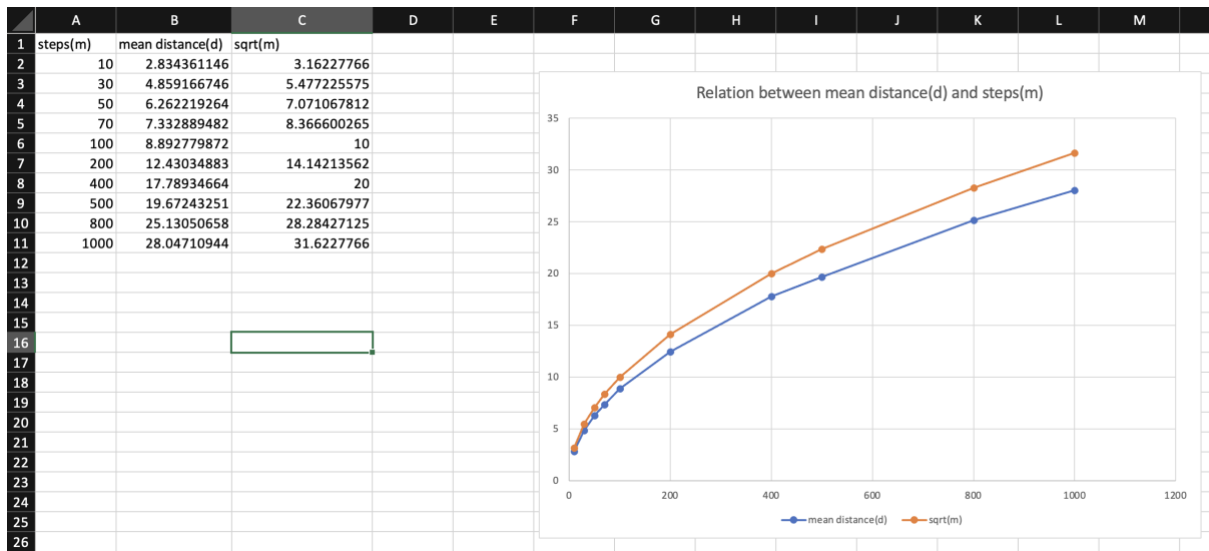
Implementing the random walk algorithm to establish a connection between the number of steps a drunken man has taken and the Euclidean distance (d) that the man covered during the process. The Euclidean distance (d) between two points (0,0) and (x,y) is calculated using the formula $\sqrt{(x-0)^2 + (y-0)^2}$.

Relationship Conclusion:

1. Let's assume that the points he has covered to take n steps is $p_1, p_2, p_3, \dots, p_n$.
2. The distance covered will be $d = p_1 + p_2 + p_3 + \dots + p_n$ assuming we are calculating it for 1 dimension.
3. The value for p can be 1 or -1 and as we are choosing value randomly both values have a equal chance of being chosen. From this we can say the mean distance would be zero
 $\langle d \rangle = \langle p_1 \rangle + \langle p_2 \rangle + \langle p_3 \rangle + \dots + \langle p_n \rangle = 0 + 0 + 0 + \dots + 0 = 0$
4. To avoid this, the average square of the mean distance is calculated by adding the squares of the averages. Here square of p_k will be 1 and a product of two different p value would like to be 1 or -1. This leads to:
 $\langle d^2 \rangle = (p_1 + p_2 + \dots + p_n)^2 = \langle p_1^2 \rangle + \langle p_2^2 \rangle + \dots + \langle p_n^2 \rangle + 2(\langle p_1 p_2 \rangle + \langle p_1 p_3 \rangle + \dots + \langle p_2 p_n \rangle)$
As $(p_k)^2$ is 1 and the average of the products of two different p value is 0 (as the product is equally likely to be -1 or +1)
 $\langle d^2 \rangle = \langle p_1^2 \rangle + \langle p_2^2 \rangle + \dots + \langle p_n^2 \rangle + 2(\langle p_1 p_2 \rangle + \dots + \langle p_2 p_n \rangle) = 1 + 1 + 1 + \dots + 1$
 $\langle d^2 \rangle = n$ where n is the number of steps
So if we take root on both sides result would be
 $d = \sqrt{n}$ and it holds true for 2 dimension also.

Evidence to support that conclusion:

Upon multiple iterations of the above experiment, I could derive a relationship between d and n which is $d = l * \sqrt{m}$ where m is the No. of steps. Since the value of l is unity, we can say that $d = \sqrt{m}$. below is the screenshot of the graph and the values of Number of steps taken(m) and the Euclidean distance (d) and the square root of m.



Unit Test Screenshots:

Project Files: INFO6205 - /Desktop/MastersClasses/PSA-ROBIN_HILLYAR

Run: RandomWalkTest (edu.neu) 481 ms

Tests passed: 6 of 6 tests - 481 ms

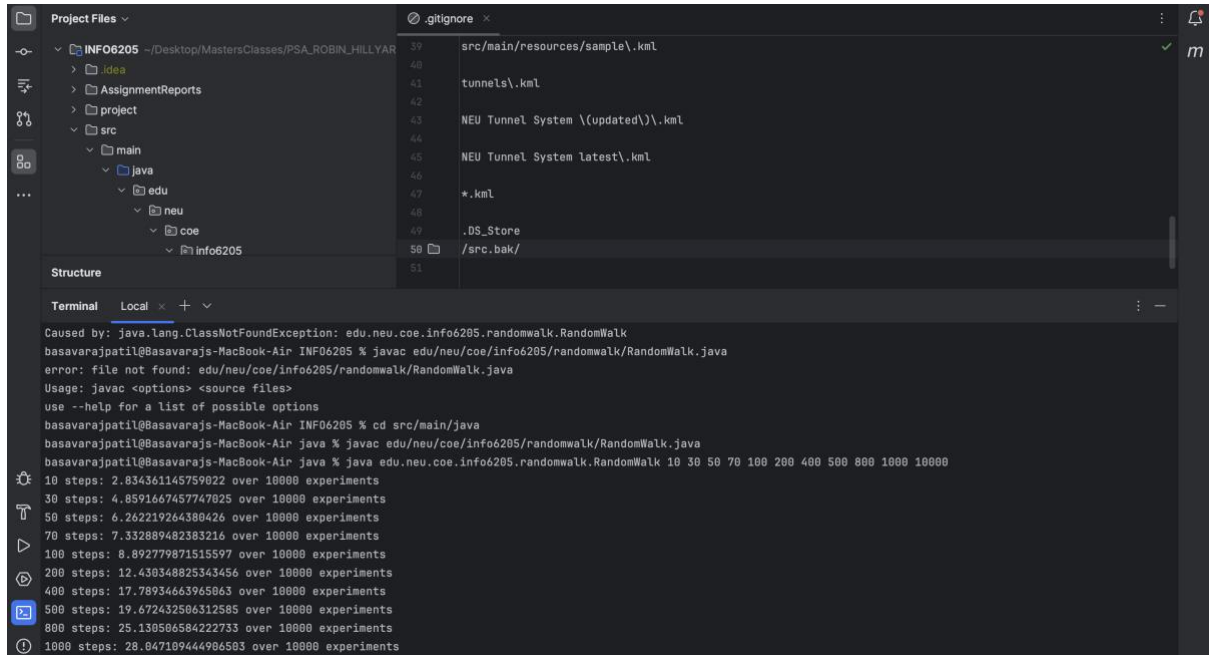
Process finished with exit code 0

```

89  * @return the mean distance
90  */
91  3 usages 1 xiaohuanlin
92  public static double randomWalkMulti(int m, int n) {
93      double totalDistance = 0;
94      for (int i = 0; i < n; i++) {
95          RandomWalk walk = new RandomWalk();
96          walk.randomWalk(m);
97          totalDistance = totalDistance + walk.distance();
98      }
99  }

```

Custom m value output:



The screenshot shows an IDE interface with three main panels:

- Project Files:** Displays the project structure. The root is `INFO6205`, which contains `idea`, `AssignmentReports`, `project`, and `src`. The `src` directory contains `main`, which in turn contains `java`, `edu`, `neu`, `coe`, and `info6205`.
- .gitignore:** A file listing ignored paths: `src/main/resources/sample*.kml`, `tunnels*.kml`, `NEU Tunnel System \(\updated\)\.kml`, `NEU Tunnel System latest*.kml`, `*.kml`, `.DS_Store`, and `/src.bak/`.
- Terminal:** Shows the execution of Java code. The output indicates a `ClassNotFoundException` for `edu.neu.coe.info6205.randomwalk.RandomWalk`. The user then runs `javac edu/neu/coe/info6205/randomwalk/RandomWalk.java` and `java edu.neu.coe.info6205.randomwalk.RandomWalk 10 30 50 70 100 200 400 500 800 1000 10000`. The output shows the results of 10,000 experiments for each step count, with the final result for 10,000 steps being `28.047109444906503`.

```
Caused by: java.lang.ClassNotFoundException: edu.neu.coe.info6205.randomwalk.RandomWalk
basavarajpatil@Basavarajs-MacBook-Air INFO6205 % javac edu/neu/coe/info6205/randomwalk/RandomWalk.java
error: file not found: edu/neu/coe/info6205/randomwalk/RandomWalk.java
Usage: javac <options> <source files>
use --help for a list of possible options
basavarajpatil@Basavarajs-MacBook-Air INFO6205 % cd src/main/java
basavarajpatil@Basavarajs-MacBook-Air % javac edu/neu/coe/info6205/randomwalk/RandomWalk.java
basavarajpatil@Basavarajs-MacBook-Air % java edu.neu.coe.info6205.randomwalk.RandomWalk 10 30 50 70 100 200 400 500 800 1000 10000
10 steps: 2.834361145759022 over 10000 experiments
30 steps: 4.8591667457747025 over 10000 experiments
50 steps: 6.262219264380426 over 10000 experiments
70 steps: 7.332889482383216 over 10000 experiments
100 steps: 8.092779871515597 over 10000 experiments
200 steps: 12.430348025343456 over 10000 experiments
400 steps: 17.78934663965063 over 10000 experiments
500 steps: 19.672432506312585 over 10000 experiments
800 steps: 25.130506584222733 over 10000 experiments
1000 steps: 28.047109444906503 over 10000 experiments
```