

Program Structures and Algorithms
Spring 2024

NAME: Basavaraj Patil

NUID: 002675476

GITHUB LINK:

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

Task:

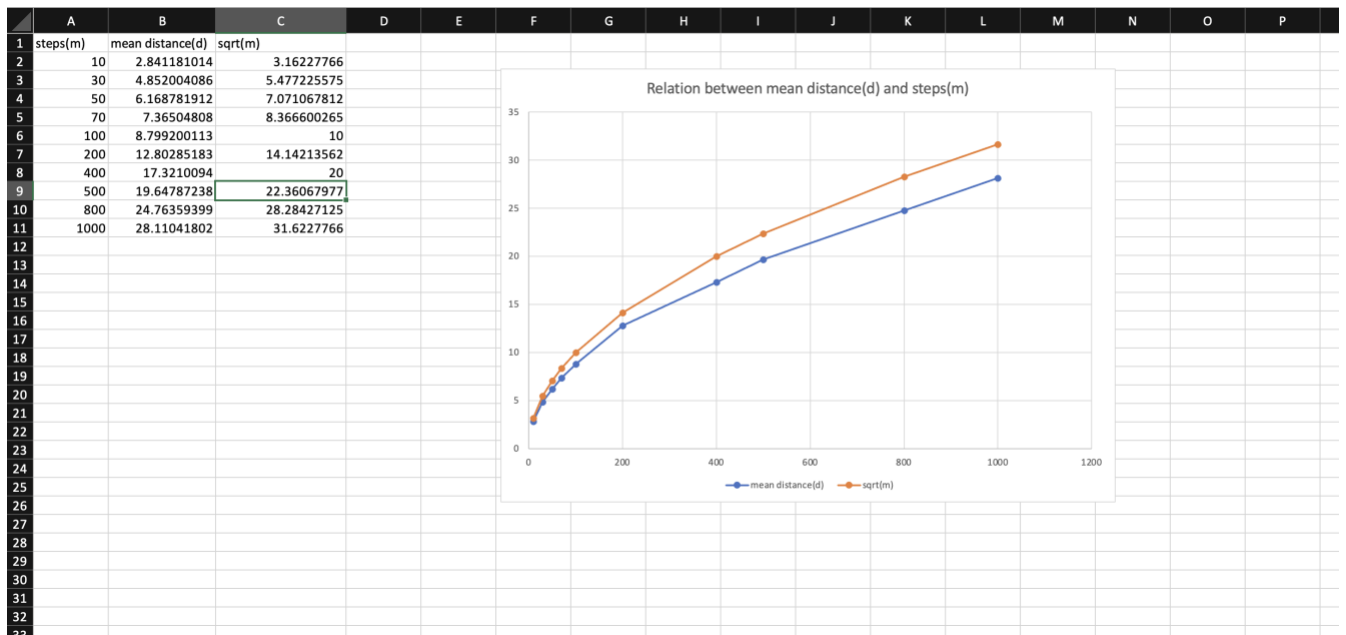
Implementing the random walk algorithm to establish a connection between the number of steps a drunken man has taken and the Euclidean distance (d) that the man covered during the process. The Euclidean distance (d) between two points (0,0) and (x,y) is calculated using the formula $\sqrt{(x-0)^2 + (y-0)^2}$.

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:
 $\langle d^2 \rangle = \langle (p_1 + p_2 + \dots + p_n)^2 \rangle = \langle p_1^2 \rangle + \langle p_2^2 \rangle + \dots + \langle p_n^2 \rangle + 2(\langle p_1 p_2 \rangle + \langle p_1 p_3 \rangle + \dots + \langle p_2 p_n \rangle)$
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

Tests passed: 6 of 6 tests - 481 ms

Process finished with exit code 0

```

* @Return the mean distance
*/
3 usages 1 xiaohuanlin
public static double randomWalkMulti(int m, int n) {
    double totalDistance = 0;
    for (int i = 0; i < n; i++) {
        RandomWalk walk = new RandomWalk();
        walk.randomWalk(m);
        totalDistance = totalDistance + walk.distance();
    }
}

```