

Program Structures and Algorithms

Spring 2023(SEC – 3)

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Task:

To implement the code for Random Walk and deduce the relationship between d (distance from origin) and m (number of steps).

Relationship Conclusion:

$$d = \sqrt{m}$$

Evidence to support that conclusion:

- Let's consider the starting point as the origin (0, 0) in the two-dimensional coordinate plane.
- After each step, the man can move 1 meter in one of the four directions - North, South, East or West. Let's denote the x-displacement as dx and the y-displacement as dy .
- The total x-displacement after m steps is given by the sum of the individual x-displacements:
 $dx = x_1 + x_2 + \dots + x_m$
- Similarly, the total y-displacement after m steps is given by the sum of the individual y-displacements: $dy = y_1 + y_2 + \dots + y_m$
- Since the steps are taken in random directions, the individual x-displacements and y-displacements are also random variables. However, we can say that for each step, the absolute value of dx and dy is equal to 1 with equal probability of positive and negative values.
- Therefore, the expected value of dx and dy is zero, and the expected value of dx^2 and dy^2 is 1.
- Since the steps are independent, the expected value of $(dx + dy)^2 = dx^2 + dy^2 = m$
- The distance between the starting point and the final point is given by the Euclidean distance formula, which is the square root of the sum of the squares of the x and y displacements.

$$d = \sqrt{dx^2 + dy^2} = \sqrt{m}$$

This is the final equation that describes the relationship between d and m .

Code:

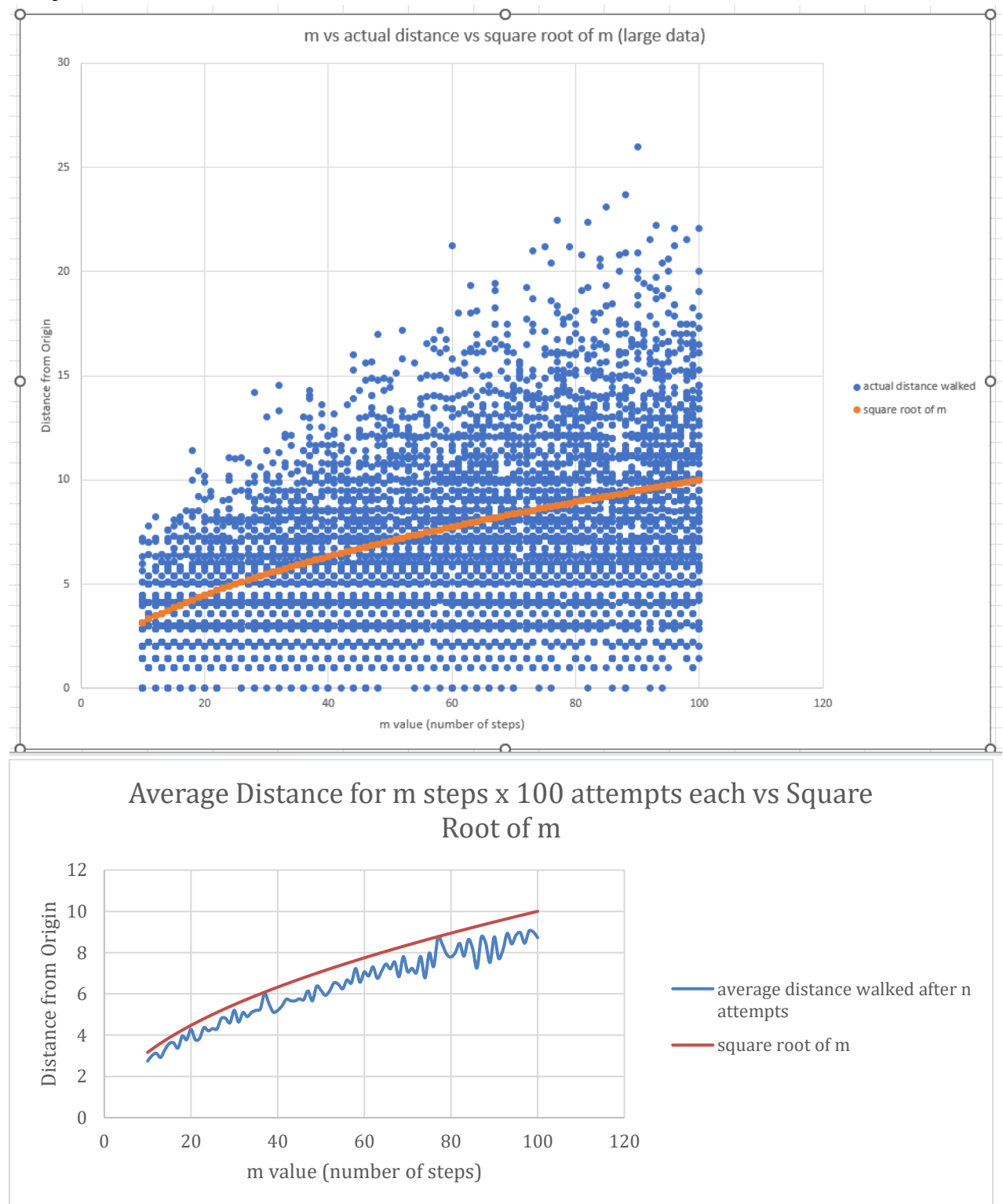
Only RandomWalk.java was changed. System.out.println was added in appropriate places to extract the data used for plotting the graph in the excel sheet. Full code can be found in the **code-assignment-1** folder. Program output for both small and large iterations can be found in **program-output-60.txt** and **program-output-10000.txt** files respectively.



RandomWalk.java

Graphical Representation:

Complete data can be found in the **Random Walk.xlsx** file.



Unit Test Screenshots:

```
Run: RandomWalkTest
Tests passed: 6 of 6 tests - 1 sec 410 ms

RandomWalkTest (eduneu.coe.info6205.random.1 sec 410 ms)
  testRandomWalk2 146 ms
  testMove0 20 ms
  testMove1 6 ms
  testMove2 4 ms
  testMove3 2 ms
  testRandomWalk 1 sec 229 ms

The drunkard is at (-1,-1) after 100 steps, distance = 1.4142135623730951
The drunkard is at (10,2) after 100 steps, distance = 10.198039027185569
The drunkard is at (7,5) after 100 steps, distance = 8.602325267042627
The drunkard is at (8,-10) after 100 steps, distance = 12.806248474805697
The drunkard is at (-11,3) after 100 steps, distance = 11.40175425099138
The drunkard is at (6,4) after 100 steps, distance = 7.211102550927978
The drunkard is at (-1,-3) after 100 steps, distance = 3.1622776601683795
The drunkard is at (5,9) after 100 steps, distance = 10.295630140987
The drunkard is at (8,0) after 100 steps, distance = 8.0
The drunkard is at (-6,-2) after 100 steps, distance = 6.324555320336759

Process finished with exit code 0
```