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6205 - Program Structures and Algorithms

Assignment - 1

Problem Statement:

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*) is the man from the lamp post?

Code changes:

Made changes in the move() and randomWalk() methods of RandomWalk class.

```java
/**
 * Private method to move the current position, that's to say the drunkard moves
 *
 * @param dx the distance he moves in the x direction
 * @param dy the distance he moves in the y direction
 */
private void move(int dx, int dy) {
    x += dx;
    y += dy;
}

/**
 * Perform a random walk of m steps
 *
 * @param m the number of steps the drunkard takes
 */
private void randomWalk(int m) {
    for(int i=1; i<=m; i++) {
        randomMove();
    }
}
```

Also made changes in the main() method in order to print proper result.
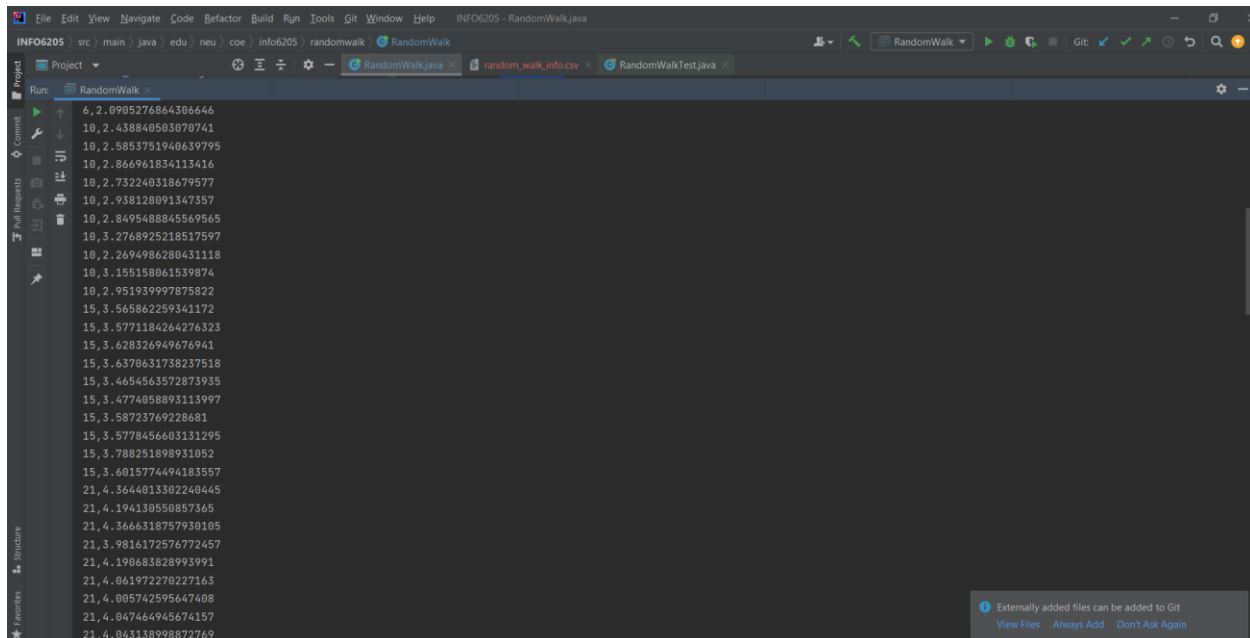
```java
75
76 ▶    public static void main(String[] args) {
77          try (FileWriter fileWriter = new FileWriter( fileName: "random_walk_info.csv")){
78              fileWriter.write( str: "Steps,Distance\n");
79              int[] stepCounter = {2,3,6,10,15,21,28,36,45,55,66,78,91,105,120};
80              for (int k : stepCounter) {
81                  for (int j = 0; j < 10; j++) {
82                      double meanDistance = randomWalkMulti(k,  n: 60);
83                      fileWriter.write( str: k + "," + meanDistance + "\n");
84                      System.out.println(k + "," + meanDistance);
85                  }
86              }
87          } catch (IOException e) {
88              e.printStackTrace();
89          }
90
91      }
```

Output:

This simulation ran for 15 different step counts ranging from 2 – 120.

Each step is re-run for 10 times. For example, program ran for 10 times for step count 2 in order to get precision of mean distance covered.

Test Case Results:

All test cases simulation ran successfully.
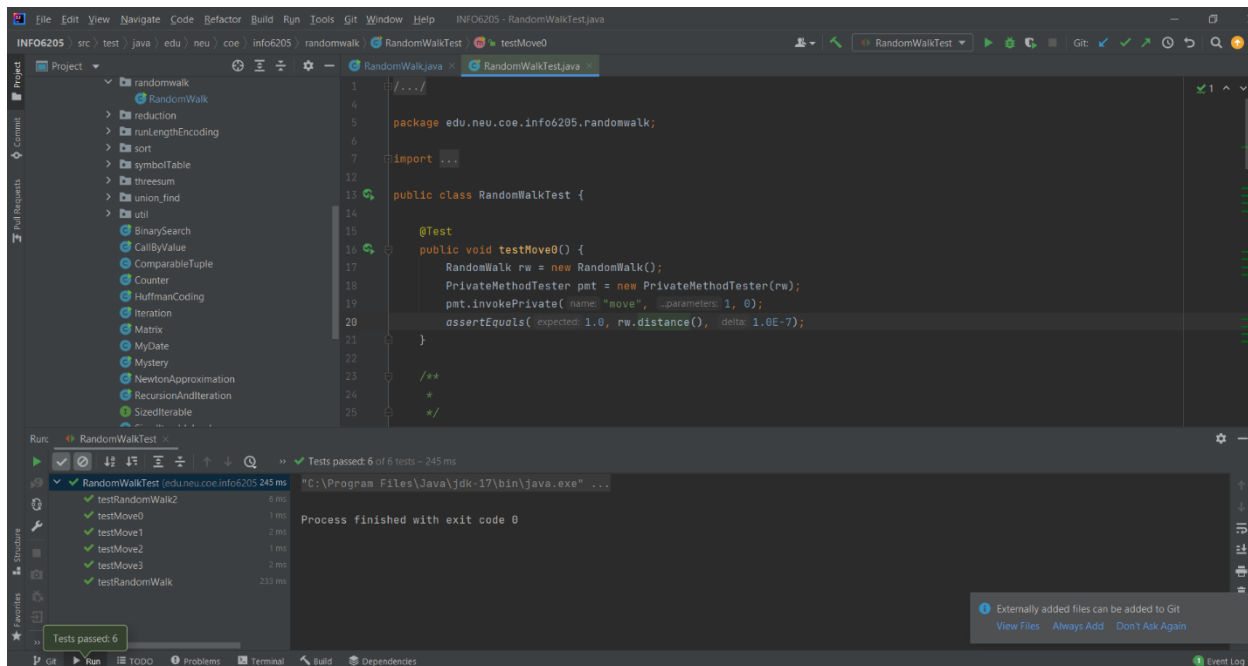
Deduction:

After reviewing the following experiment, it can be concluded that the Euclidean distance between the distance covered is square root of the number of steps the drunkard took to reach the final position.

$$d = \sqrt{n}$$

where, d = distance covered by the drunkard

n = number of steps drunkard took to reach to that position

Practical Evidence:

Following table depict the relationship with mean values. Deviation in all cases ranges from 4% to 15%.

Step Counter	Mean of Expected Distance covered	Mean of Actual Distance covered	Deviation (%)
2	1.4142135624	1.2136155194	14.18442365
3	1.7320508076	1.6557004110	4.408092201
6	2.4494897428	2.1131547214	13.73081975
10	3.1622776602	2.8064584035	11.25199286
15	3.8729833462	3.5906145757	7.290730304
21	4.5825756950	4.1766686375	8.857618171
28	5.2915026221	4.8901231690	7.585358674

36	6.0000000000	5.5574627855	7.375620242
45	6.7082039325	5.9300190461	11.60049537
55	7.4161984871	6.6416618675	10.44384965
66	8.1240384046	7.1596493785	11.87080831
78	8.8317608663	7.7169573137	12.6226646
91	9.5393920142	8.5098927887	10.79208427
105	10.2469507660	8.7162386558	14.9382206
120	10.9544511501	9.8643644863	9.951084257

Charts:

Here is the chart plotting steps taken to reach final position by the drunkard vs the actual distance that drunkard travelled from the starting position.
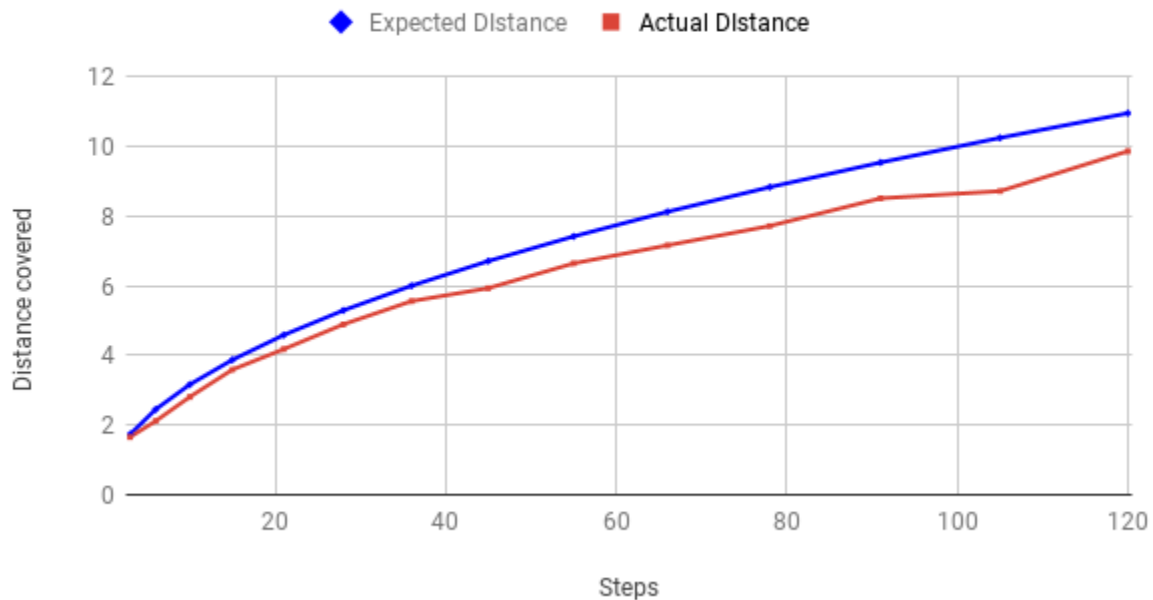
Here is the scatter plot of all the values that were encountered while running this experiment for a range of 2 steps to 120 steps.

Scatter Plot

Legend: ● Actual distance covered — Trend line for $d = \sqrt{n}$

Y-axis: Distance (0, 2, 4, 6, 8, 10, 12)

X-axis: Steps (2, 2, 3, 3, 6, 6, 10, 10, 15, 15, 21, 21, 28, 28, 36, 36, 45, 45, 55, 55, 66, 66, 78, 78, 91, 91, 105, 105, 120, 120)