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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.

```
/**
 * 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.

```

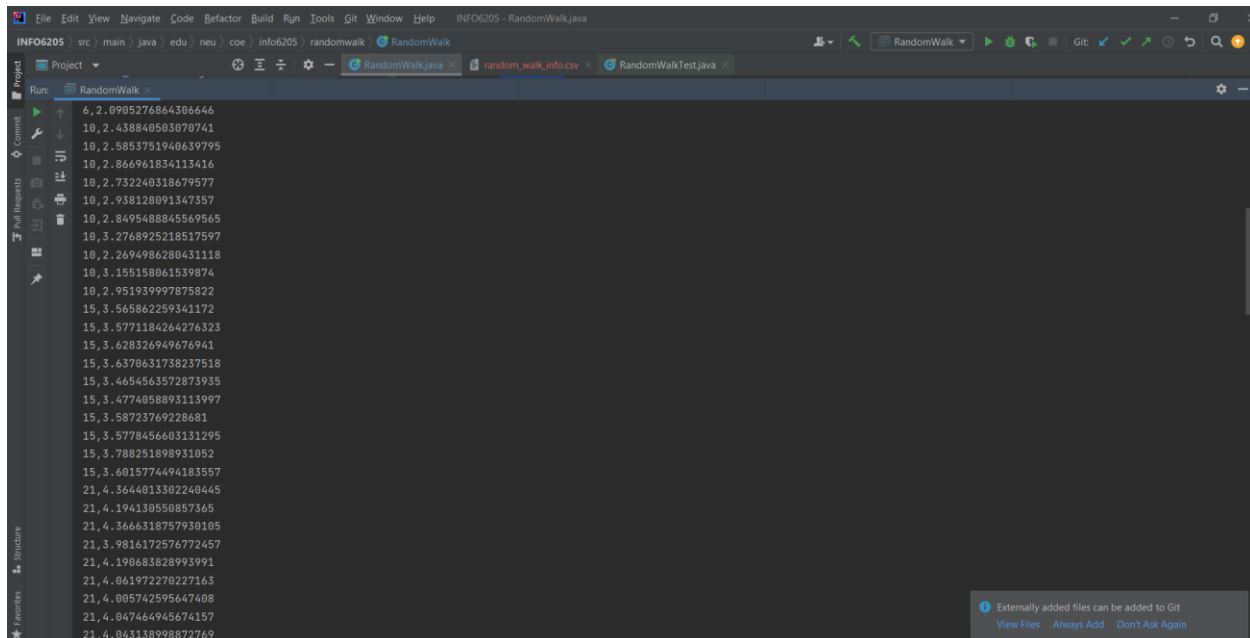
75
76 public static void main(String[] args) {
77     try (FileWriter fileWriter = new FileWriter( fileName: "random_walk_info.csv")){
78         fileWriter.write( str: "Steps,Distance\n");
79         int[] stepCounter = {2,3,6,10,15,21,28,36,45,55,66,78,91,105,120};
80         for (int k : stepCounter) {
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.



```

6, 2.0905276864306646
10, 2.438840503070741
10, 2.5853751940639795
10, 2.866961834113416
10, 2.732240318679577
10, 2.938128091347357
10, 2.8495488845569565
10, 3.2768925218517597
10, 2.2694986280431118
10, 3.155158061539874
10, 2.951939997875822
15, 3.565862259341172
15, 3.5771184264276323
15, 3.628326949676941
15, 3.6378631738237518
15, 3.4654563572873935
15, 3.4774058893113997
15, 3.58723769228681
15, 3.5778456603131295
15, 3.788251898911062
15, 3.6015774494183557
21, 4.3644013302240445
21, 4.194130550857365
21, 4.3666318757930105
21, 3.9816172576772457
21, 4.198683828993991
21, 4.061972270227163
21, 4.005742595647408
21, 4.047464945674197
21, 4.043138998872769

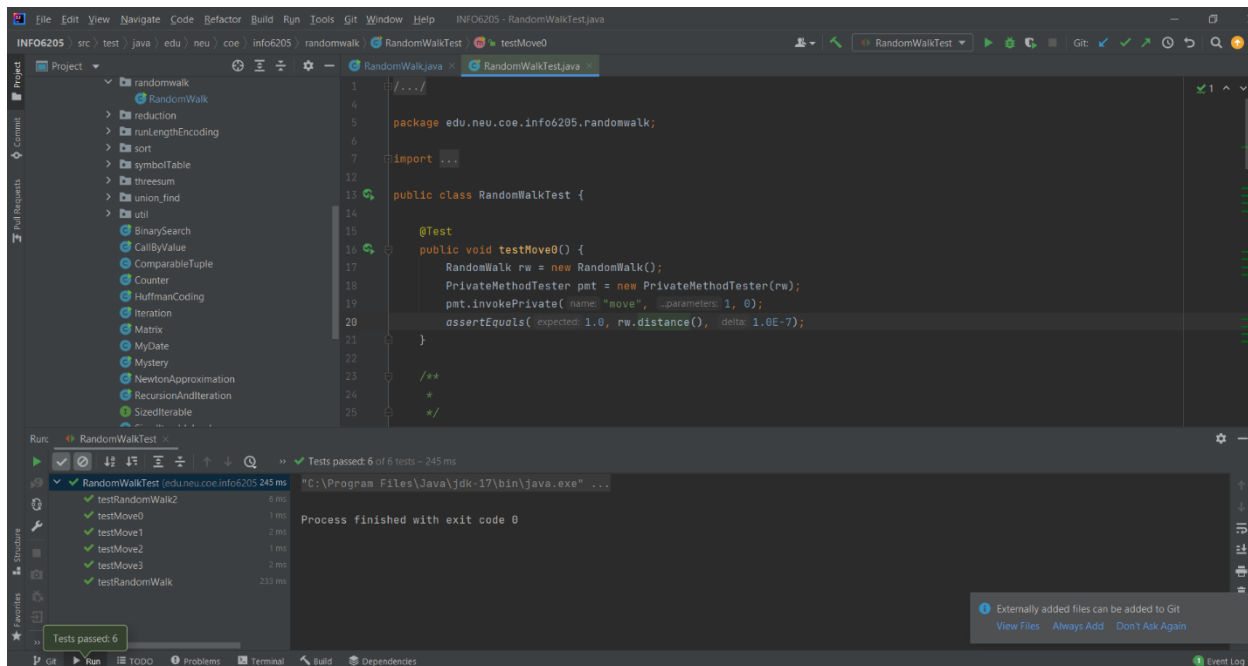
```

```
INFO6205 - RandomWalk.java
src \ main \ java \ edu \ neu \ coe \ info6205 \ randomwalk \ RandomWalk
RandomWalk
random_walk_info.csv
RandomWalkTest.java
Run: RandomWalk
C:\Program Files\Java\jdk-17\bin\java.exe" ...
2,1.2778174593052014
2,1.2737734478532134
2,1.2323520916159043
2,1.320913899932317
2,1.1444841259718683
2,1.2794925436950073
2,1.1249579113843047
2,1.1973436738927647
2,1.0714045207910312
2,1.3111507926385348
3,1.6502192602916064
3,1.537487059916603
3,1.6895639232082376
3,1.6277605243332482
3,1.72590292133322
3,1.6847086554165602
3,1.848361657291578
3,1.6326237921249256
3,1.6071593913749185
3,1.5532249250832555
6,2.1039607946043604
6,2.0574535743324764
6,2.0781801125555744
6,2.490692598279544
6,1.9231796269519612
6,2.0058560702559993
6,2.06779732658642
6,2.3473576883223
6,1.9665317296101534
```

```
INFO6205 - RandomWalk.java
src \ main \ java \ edu \ neu \ coe \ info6205 \ randomwalk \ RandomWalk
RandomWalk
random_walk_info.csv
RandomWalkTest.java
Run: RandomWalk
21,4.5109027214045305
28,5.113550011595261
28,4.627813775498642
28,5.401712429540206
28,4.8263805110515525
28,5.166219563468504
28,4.99562636395079
28,4.748579240725448
28,4.688064864530202
28,5.1132574595094455
28,4.220027470567683
36,5.186430883941486
36,5.842786695989222
36,6.435401491726419
36,5.456007227608645
36,5.803050757427046
36,5.394733093660986
36,5.372157438686354
36,5.202729832894385
36,5.355541138730034
36,5.3248812941895265
45,5.2735863499610085
45,6.449662417731793
45,5.323994097458405
45,6.146644015003066
45,6.167084100434622
45,5.713169670825304
45,6.19479275472575
45,6.180948843970546
45,5.732546869274111
```

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%.

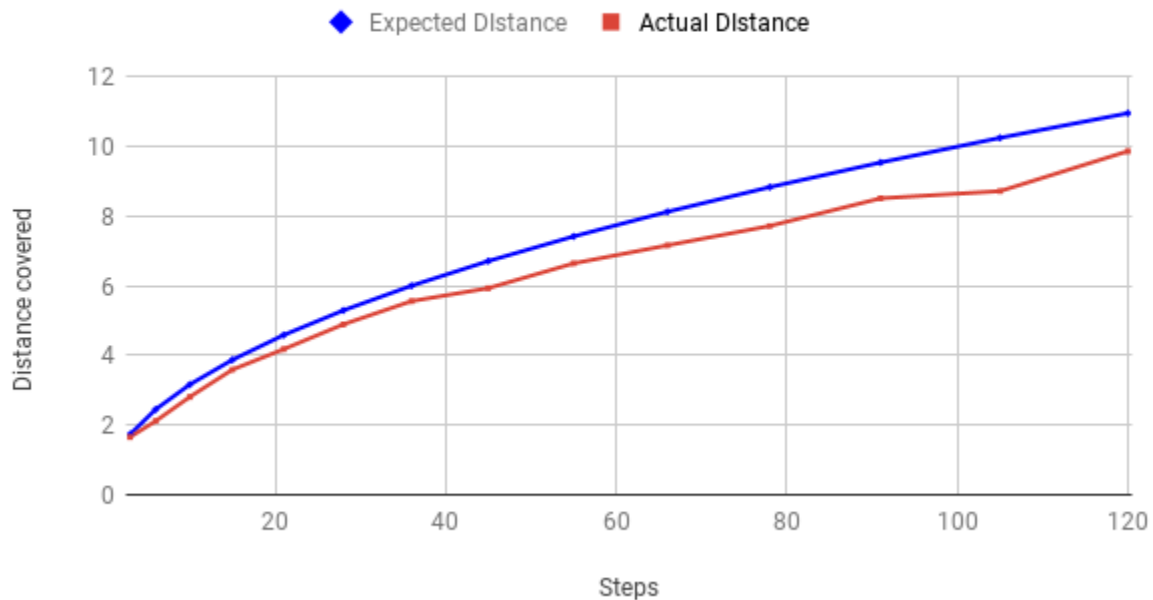
Step Counter	Mean of Expected Distance covered	Mean of Actual Distance covered	Deviation (%)
2	1.4142135624	1.2136155194	14.18442365
3	1.7320508076	1.6557004110	4.408092201
6	2.4494897428	2.1131547214	13.73081975
10	3.1622776602	2.8064584035	11.25199286
15	3.8729833462	3.5906145757	7.290730304
21	4.5825756950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

Step Vs Distance



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

