

Program Structures & Algorithms

Fall 2021

Assignment No. 1

Task (List down the tasks performed in the Assignment)

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? Note that d is the Euclidean distance of the man from the lamp-post.

I used six different values of n (number of steps) and ran 10 times of each number of steps to prove the relationship between the number of steps (n) and Euclidean distance (d).

```

72     walk.randomWalk(m);
73     totalDistance = totalDistance + walk.distance();
74 }
75     return totalDistance / n;
76 }
77
78 public static void main(String[] args) {
79     for(int i=0; i<10; i++){
80         for(int k=0; k<10; k++){
81             args = new String[]{"10", "20", "50", "100", "200", "500", "1000", "2000", "5000", "10000"};
82             if (args.length == 0)
83                 throw new RuntimeException("Syntax: RandomWalk steps [experiments]");
84             int m = Integer.parseInt(args[i]);
85             int n = 30;
86             if (args.length > 1) n = 30; //Integer.parseInt(args[0]);
87             double meanDistance = randomWalkMulti(m, n);
88             System.out.println(m + " steps: " + meanDistance + " over " + n + " experiments");
89             //System.out.println(m);
90             //System.out.println(meanDistance);
91         }
92     }
93 }

```

Relationship Conclusion: (For ex : $z = a * b$)

$$d = \sqrt{n}$$

By observing the experimental results, it can be concluded that the Euclidean distance (d) between the initial position and final position of the movement is approximately equal to the square root of the number of steps taken, or in other words, the root mean square of distance d , which should be approximately the root of the number of steps between the two points, \sqrt{n} .

○ Evidence to support the conclusion:

1. Output (Snapshot of Code output in the terminal)

```

<terminated> RandomWalk [Java Application] C:\jdk\bin\javaw.exe (2021年9月15日 下午10:31)
0 steps: 2.7711234558060798 over 30 experiments
10 steps: 2.748458318331413 over 30 experiments
10 steps: 2.860114817831521 over 30 experiments
10 steps: 2.5017767683251355 over 30 experiments
10 steps: 2.626888401424671 over 30 experiments
10 steps: 2.7618943608849245 over 30 experiments
10 steps: 2.674028853503775 over 30 experiments
10 steps: 2.8561118024935146 over 30 experiments
10 steps: 3.314438004353322 over 30 experiments
10 steps: 2.3022627720010087 over 30 experiments
20 steps: 4.411212107100943 over 30 experiments
20 steps: 4.317459782584309 over 30 experiments
20 steps: 3.9703163758770517 over 30 experiments
20 steps: 3.2196266935092552 over 30 experiments
20 steps: 4.4789385865966125 over 30 experiments
20 steps: 4.299448836225051 over 30 experiments
20 steps: 3.8800913434724253 over 30 experiments
20 steps: 4.24728983398836 over 30 experiments
20 steps: 3.836235021399571 over 30 experiments
20 steps: 4.097130461956188 over 30 experiments
50 steps: 6.432872077920342 over 30 experiments
50 steps: 5.781185125790489 over 30 experiments
50 steps: 5.661240097569788 over 30 experiments
50 steps: 6.161590842952929 over 30 experiments
50 steps: 6.21895251903836 over 30 experiments

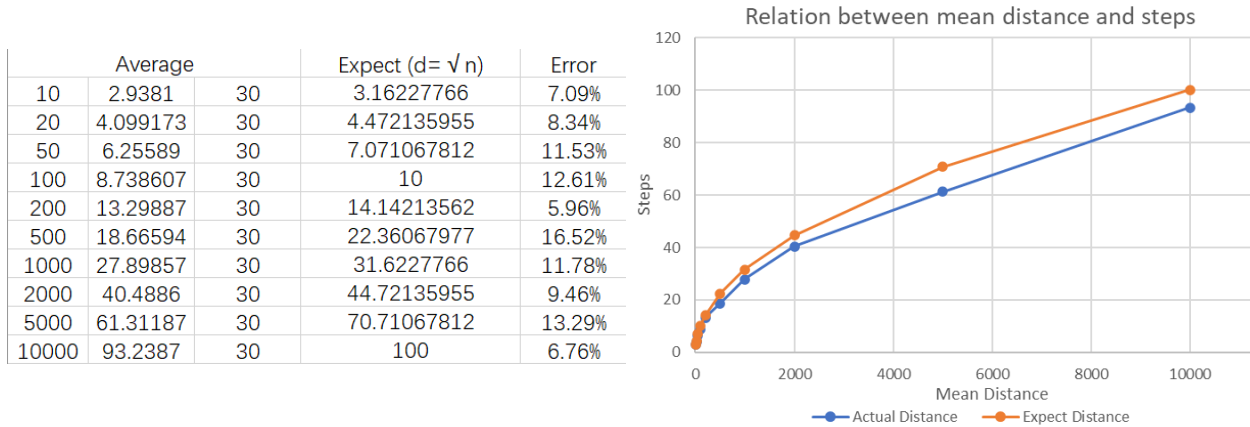
200 steps: 13.166690393336767 over 30 experiments
200 steps: 11.812342830457066 over 30 experiments
200 steps: 12.198388278843458 over 30 experiments
200 steps: 12.746871833743501 over 30 experiments
200 steps: 11.992422911973824 over 30 experiments
200 steps: 10.91073283119739 over 30 experiments
200 steps: 14.541364044650036 over 30 experiments
200 steps: 13.166525674939395 over 30 experiments
200 steps: 12.52394301246578 over 30 experiments
500 steps: 19.889285492657862 over 30 experiments
500 steps: 22.194295509327343 over 30 experiments
500 steps: 18.509651509389112 over 30 experiments
500 steps: 21.482403132395447 over 30 experiments
500 steps: 19.55653650854578 over 30 experiments
500 steps: 22.08691768091281 over 30 experiments
500 steps: 17.811372761460625 over 30 experiments
500 steps: 16.804401185211585 over 30 experiments
500 steps: 19.257917382028264 over 30 experiments
500 steps: 22.272542135542995 over 30 experiments
1000 steps: 27.39872723371851 over 30 experiments
1000 steps: 29.545034064614303 over 30 experiments
1000 steps: 30.708052673830412 over 30 experiments
1000 steps: 27.78761434422123 over 30 experiments
1000 steps: 27.811316987274342 over 30 experiments
1000 steps: 27.83577336784849 over 30 experiments

2000 steps: 42.30932724078645 over 30 experiments
2000 steps: 40.32126464697856 over 30 experiments
2000 steps: 33.681182904290665 over 30 experiments
2000 steps: 43.60996449330891 over 30 experiments
5000 steps: 61.99304199363437 over 30 experiments
5000 steps: 66.95575057075222 over 30 experiments
5000 steps: 65.64843273655879 over 30 experiments
5000 steps: 59.019756320486735 over 30 experiments
5000 steps: 58.382938215962675 over 30 experiments
5000 steps: 64.22954735530972 over 30 experiments
5000 steps: 57.82504558262108 over 30 experiments
5000 steps: 70.12034666269463 over 30 experiments
5000 steps: 62.43908747829887 over 30 experiments
5000 steps: 59.386573444944005 over 30 experiments

10000 steps: 81.92065848735112 over 30 experiments
10000 steps: 95.67607371455773 over 30 experiments
10000 steps: 78.55221172425173 over 30 experiments
10000 steps: 105.56512055010268 over 30 experiments
10000 steps: 79.85092485337243 over 30 experiments
10000 steps: 91.92833581871882 over 30 experiments
10000 steps: 95.2219697640409 over 30 experiments
10000 steps: 96.07902743449922 over 30 experiments
10000 steps: 81.61373294869904 over 30 experiments
10000 steps: 85.29911321315373 over 30 experiments
  
```

2. Graphical Representation (Observations from experiments should be tabulated and analyzed by plotting graphs(usually in excel) to arrive on the relationship conclusion)

I put all the output into the Excel, then averaged the ten distances (d) corresponding to each different step (n), and then calculated the error of expected distance (d) of each step (n), which should be $d = \sqrt{n}$, then drew a broken line diagram with actual d and expect d.



◦ Unit tests result:(Snapshot of successful unit test run)

