Xiaodan Hu (001063529)

Program Structures & Algorithms
Summer 2021
Assignment No. 1

- **Task**

  Suppose there is a drunken man who, starting at (0,0) of a coordinator space, takes a series of steps of the same length: 1 unit. The direction of these steps is randomly chosen from North(0,1), South(0,-1), East(1, 0) or West(-1, 0). After n steps, how far (*d*) the Euclidean distance of the man is from the start point.

  The task is to deduce the relationship between the Euclidean distance(d) and steps in the above scenario.

- **Output**

  The data generated during the process is listed below.

- **Relationship Conclusion:**

  Euclidean distance(d) ≈ √steps(n)

  By analyzing the generated data and graph, it can be seen that there is a positive correlation between steps the drunken man has taken and the distances he is from the starting point. The more steps he takes, the far he is from the starting point. By running plenty of trails each with different steps, we can see there is approximately math relationship that:

  step(n) ^ 2 ≈ Euclidean distance(d)

  Euclidean distance(d) ≈ √steps(n)

- **Evidence to support the conclusion:**

  The graph generated by all the data can support the conclusion. Also, I try to modify the main method to see how approximate √steps(n) is to the mean Euclidean distance. Below is the result. From the screen shot, we can see the two numbers are relatively close.

After 1 steps the Mathematically predicted distance is 1.0 and the actually distance is 1.0

After 2 steps the Mathematically predicted distance is 1.4142135623730951 and the actually distance is 1.1861362184380753

After 3 steps the Mathematically predicted distance is 1.7320508075688772 and the actually distance is 1.6041779674049133

After 4 steps the Mathematically predicted distance is 2.0 and the actually distance is 1.7675055335672794

After 5 steps the Mathematically predicted distance is 2.23606797749979 and the actually distance is 2.015543454601737

After 6 steps the Mathematically predicted distance is 2.449489742783178 and the actually distance is 2.116081187473811

After 10 steps the Mathematically predicted distance is 3.1622776601683795 and the actually distance is 2.8350792088479477

After 20 steps the Mathematically predicted distance is 4.47213595499958 and the actually distance is 4.064071714578188

After 30 steps the Mathematically predicted distance is 5.477225575051661 and the actually distance is 4.8113050998061055

After 40 steps the Mathematically predicted distance is 6.324555320336759 and the actually distance is 5.706342175440947

After 50 steps the Mathematically predicted distance is 7.0710678118654755 and the actually distance is 6.270712772409325

After 60 steps the Mathematically predicted distance is 7.745966692414834 and the actually distance is 6.88838270221658

After 70 steps the Mathematically predicted distance is 8.366600265340756 and the actually distance is 7.559010212783154

After 80 steps the Mathematically predicted distance is 8.94427190999916 and the actually distance is 8.0217610603017

After 90 steps the Mathematically predicted distance is 9.486832980505138 and the actually distance is 8.557334868771308

After 100 steps the Mathematically predicted distance is 10.0 and the actually distance is 9.07165861988529

After 110 steps the Mathematically predicted distance is 10.488088481701515 and the actually distance is 9.272708668860435

After 120 steps the Mathematically predicted distance is 10.954451150103322 and the actually distance is 9.649080784267536

After 130 steps the Mathematically predicted distance is 11.40175425099138 and the actually distance is 10.022954093531428

After 140 steps the Mathematically predicted distance is 11.832159566199232 and the actually distance is 10.323472605344712

After 150 steps the Mathematically predicted distance is 12.24744871391589 and the actually distance is 10.89971832964015

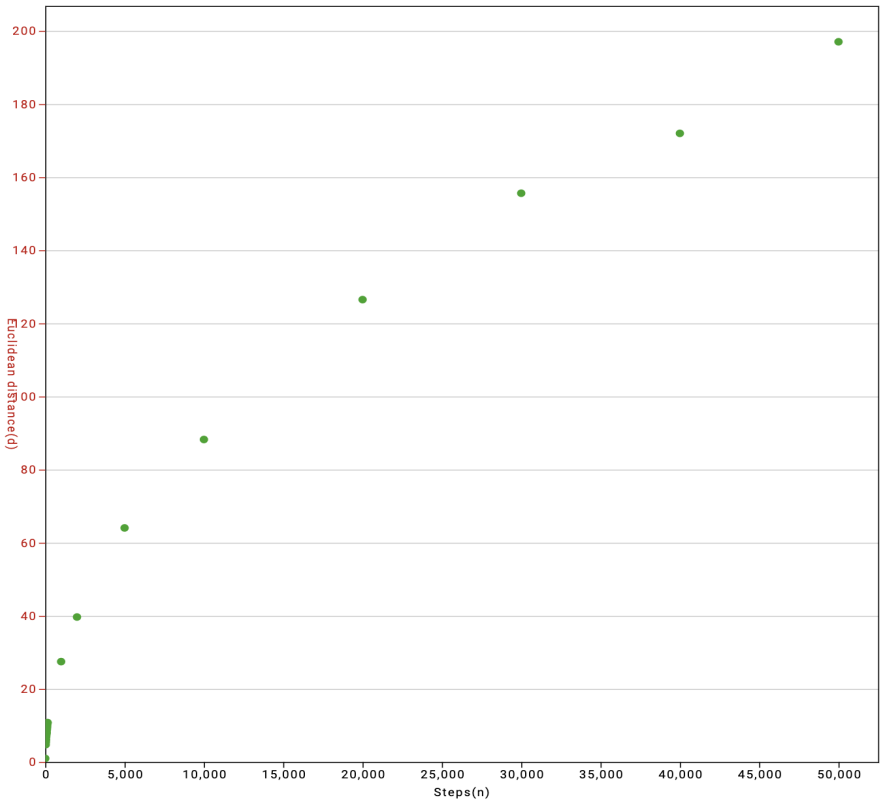
After 1000 steps the Mathematically predicted distance is 31.622776601683793 and the actually distance is 28.208414443549383

After 2000 steps the Mathematically predicted distance is 44.721359549995796 and the actually distance is 39.984625730706824

After 5000 steps the Mathematically predicted distance is 70.71067811865476 and the actually distance is 61.80102376829357

After 50000 steps the Mathematically predicted distance is 223.60679774997897 and the actually distance is 198.18321112259204

- **Graphical representation:**



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- **Unit tests result:**