Assignment – 1

Random Walk

Conclusion: Assume the drunk man has completed his random walk, which consists of ‘n’ steps, and is now at position (x, y) in the space, which is at a distance ‘d’ from the lamp post. Since ‘d’ is the Euclidean Distance, the formula to calculate that distance from the origin (0, 0) is:

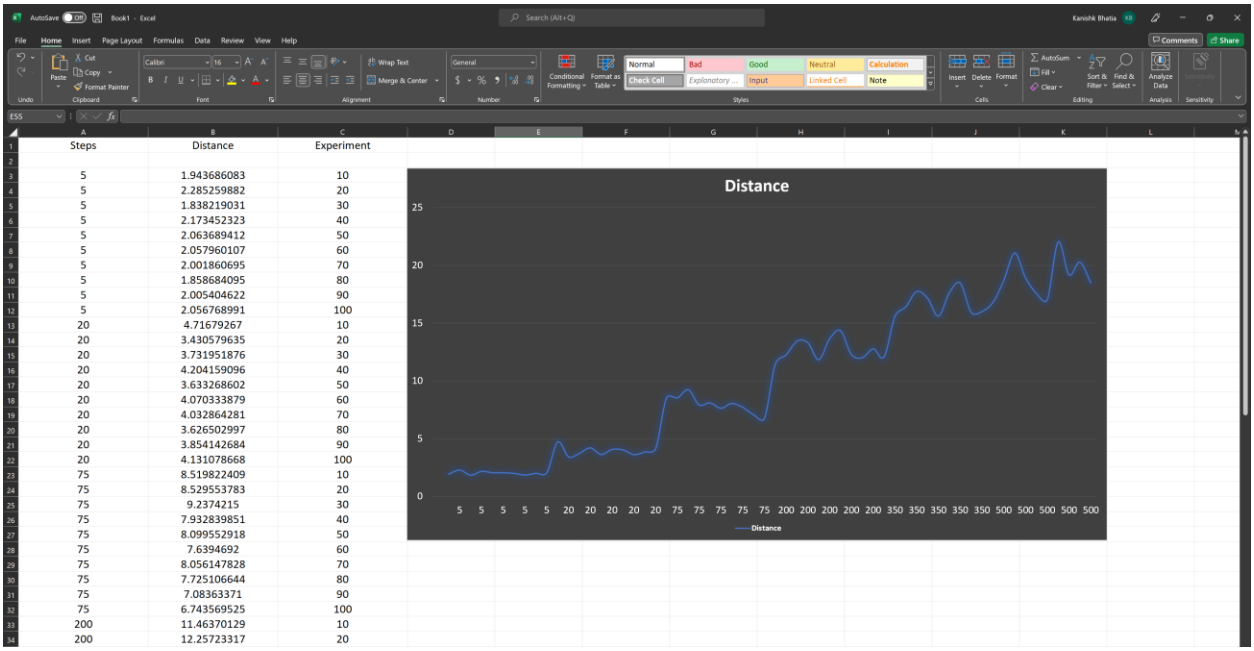
Euclidean Distance = $\sqrt{(x^2 + y^2)}$

From the experiment, we observe that the relationship between the number of steps ‘n’ and the distance ‘d’ is directly proportional to each other **($n \propto d$)**. As observed on the graph, the distance increases as the value of steps increases. The concluded approximate relation between ‘n’ and ‘d’ is:

$d \approx \sqrt{n}$

Evidence

- **Graph between Steps (n) and distance (d)**



Steps	Distance	Experiment
5	1.943686083	10
5	2.285259882	20
5	1.838219031	30
5	2.173452323	40
5	2.063689412	50
5	2.057960107	60
5	2.001860695	70
5	1.858684095	80
5	2.005404622	90
5	2.056768991	100
20	4.71679267	10
20	3.430579635	20
20	3.731951876	30
20	4.204159096	40
20	3.633268602	50
20	4.070333879	60
20	4.032864281	70
20	3.626502997	80
20	3.854142684	90
20	4.131078668	100
75	8.519822409	10
75	8.529553783	20
75	9.2374215	30
75	7.932839851	40
75	8.099552918	50
75	7.6394692	60
75	8.056147828	70
75	7.725106644	80
75	7.08363371	90
75	6.743569525	100
200	11.46370129	10
200	12.25723317	20

- **Spreadsheet**

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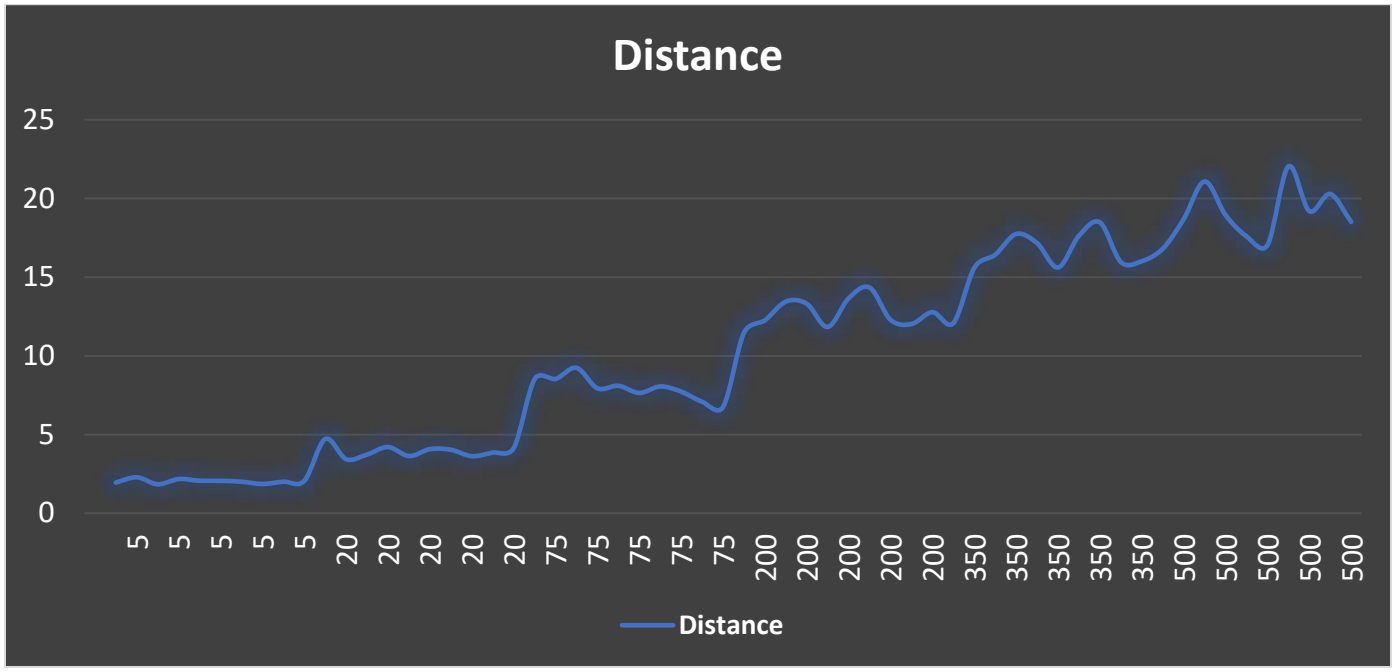
75	6.743569525	100
200	11.46370129	10
200	12.25723317	20
200	13.44497098	30
200	13.30337543	40
200	11.83403073	50
200	13.65338885	60
200	14.33786955	70
200	12.28538628	80
200	12.01956453	90
200	12.76992977	100
350	12.07959514	10
350	15.58818925	20
350	16.42343665	30
350	17.73988465	40
350	17.15376806	50
350	15.61144898	60
350	17.62627925	70
350	18.47587511	80
350	15.95545479	90
350	16.00945272	100
500	16.80087889	10
500	18.68241876	20
500	21.07339852	30
500	18.93513186	40
500	17.58538011	50
500	17.02965829	60
500	22.02836835	70
500	19.19357028	80
500	20.27895523	90
500	18.50565349	100

- **Graph**



Code:

```
/*
 * Copyright (c) 2017. Phasmid Software
 */
package edu.neu.coe.info6205.randomwalk;
import java.util.Random;
public class RandomWalk {
    private int x = 0;
    private int y = 0;
    private final Random random = new Random();
    /**
     * 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) {
        // TO BE IMPLEMENTED
//        System.out.println("dx: " +dx+", dy: "+dy);
        this.x += dx;
        this.y += + dy;
    }
    /**
     * Perform a random walk of m steps
     *
     * @param m the number of steps the drunkard takes
     */
    private void randomWalk(int m) {
        // TO BE IMPLEMENTED
        for (int i = 0; i < m; i++) {
            this.randomMove();
        }
    }
    /**
     * Private method to generate a random move according to the rules of the
     * situation. That's to say, moves can be (+-1, 0) or (0, +-1).
     */
    private void randomMove() {
        boolean ns = random.nextBoolean();
        int step = random.nextBoolean() ? 1 : -1;
        move(ns ? step : 0, ns ? 0 : step);
```

```
    }
    /**
     * Method to compute the distance from the origin (the lamp-post where the
     * drunkard starts) to his current position.
     *
     * @return the (Euclidean) distance from the origin to the current position.
     */
    public double distance() {
        // TO BE IMPLEMENTED
//        System.out.println(" x: "+x+" y: "+y);
        return Math.sqrt((x * x) + (y * y));
    }
    /**
     * Perform multiple random walk experiments, returning the mean distance.
     *
     * @param m the number of steps for each experiment
     * @param n the number of experiments to run
     * @return the mean distance
     */
    public static double randomWalkMulti(int m, int n) {
        double totalDistance = 0;
        for (int i = 0; i < n; i++) {
            RandomWalk walk = new RandomWalk();
            walk.randomWalk(m);
            totalDistance = totalDistance + walk.distance();
        }
        return totalDistance / n;
```

```
    }

    public static void main(String[] args) {
        //if (args.length == 0)
          //  throw new RuntimeException("Syntax: RandomWalk steps [experiments]");
        int m = 500; //Integer.parseInt(args[0]);
        //int n = 100;
        //if (args.length > 1) n = Integer.parseInt(args[1]);
        int[] arr = new int[]{10, 20, 30, 40, 50, 60, 70, 80, 90, 100};
        for (int n = 0; n < 10; n++) {
        double meanDistance = randomWalkMulti(m, arr[n]);
            System.out.println(m + "\t" + meanDistance+"\t"+arr[n]);
        }
//        System.out.println(m + " steps: " + meanDistance + " over " + n + " experiments");
    }
}
```

Test Cases: