CS215 Assignment-1

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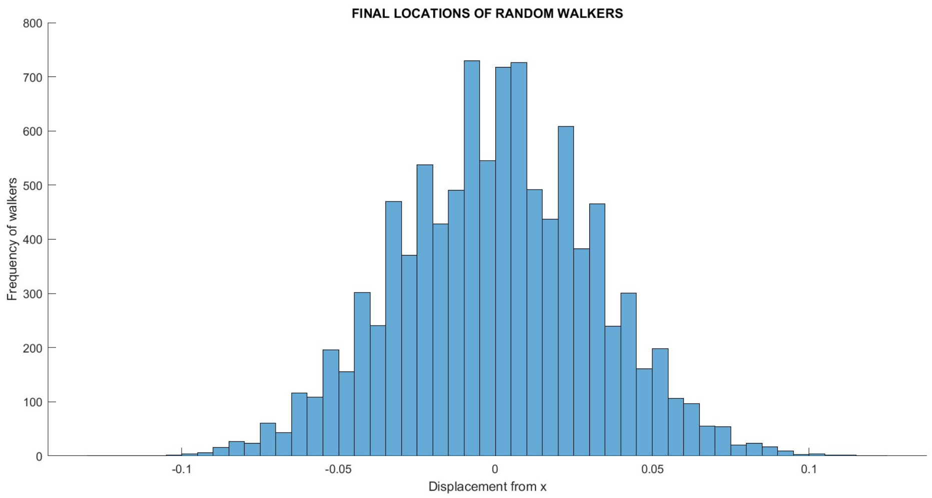
1 Part - I

1.1 Histogram Plot

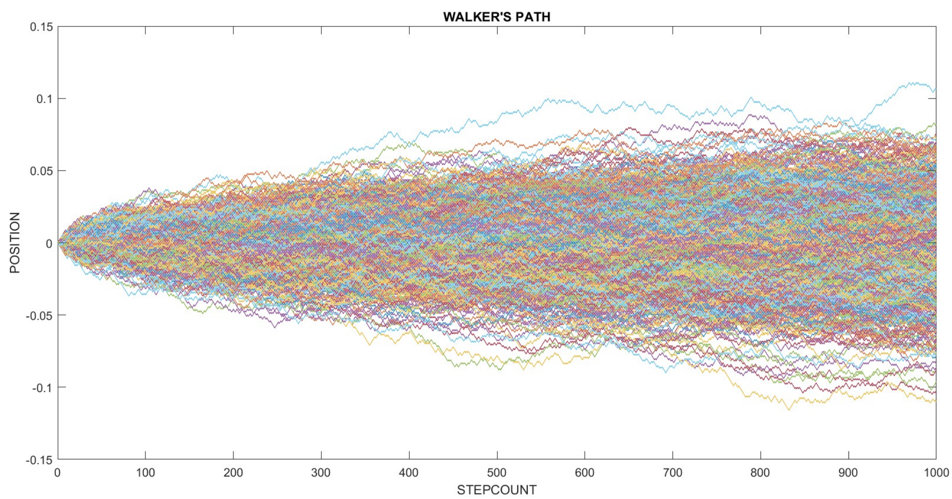
We are required to plot the histogram of all the final locations In the MATLAB WALKERSHIST.m, the function WALKERHIST is used to plot the histogram of their final locations. As walkers can have 2 options - either go towards right or towards left so We used binornd(.) function to decide increasing or decreasing at each step.



This is plot is generated on running the MATLAB code final WALKERHIST.m and graph is saved to the results directory.

1.2 Space-Time curve

Plot for the first 10^3 walkers is given below with different colors. We have randomly generated 10^4 walkers and plotted the displacement -time graph of each each walker as shown below



1.3 Sub part -3

We have Random variable X and the dataset (X1, ..., XN) from the distribution X

1.3.1 Mean

Law of large numbers(LLN) : result obtained over large number of trails should be close to the excepted value and will tend to be more closer as number of trails increases. As X1, ..., XN are from the distribution X mean of them over N → should be the mean of the distribution X from the above LLN theorem.therefore

$$\hat{M} = \frac{(X1 + ... + XN)}{N}$$

1.3.2 Variance

General variance relation is:

$$\hat{V} = \sum_{i=0}^{N} \frac{(X - \hat{M})^2}{N} = \sum_{i=0}^{N} \frac{X^2 - 2X\hat{M} + \hat{M}^2}{N}$$

$$= \sum_{i=0}^{N} \frac{X^2}{N} - \hat{M}^2 \tag{1}$$

The above is the another form of variance-mean relation, now by applying law of large numbers (LLN) on the first summation term $\sum_{i=0}^{N} \frac{X^2}{N}$,, we consider new Random variable $Y = X^2$ and apply LLN on the first summation term we replace the average of squares of X by the excepted square of X we get expected square of X from the true Var(X) for N →∞ case, as we have already proved that mean is true mean of X in N →∞ case.

$$Var(X) = (expected\ square\ of X) - \hat{M}^2 (expected\ square\ of X) = Var(X) + \hat{M}^2 \tag{2}$$

Therefore substituting the 1 in 2, we get

$$\hat{V} = (Var(X) + \hat{M}^2) - \hat{M}^2 \hat{V} = Var(X)$$

Hence that is the required result for us

1.4 Mean and Variance of final locations

Empirical mean variance their values in this case are

$$\hat{M} = -0.002000$$

$$\hat{V} = 0.000000$$

1.5 True mean and Variance

1.5.1 True mean

Consider a path which has final displacement +x, now interchange the forward with backward and viceversa (i.e if a man mkaes a particular step forward interchage with backward) for this path we get the new final location -x, therefore for every path we + and - comes in pairs which makes the mean of all final locations to be 0, however detailed proof is given below

1.5.2 True variance

Attached a Handwritten PDF - PROOF

1.6 Error

$$\hat{M} = -0.002000 - 0$$
$$\hat{M} = -0.002000$$
$$\hat{V} = 0.0000000 - 0.001000$$
$$\hat{V} = -0.001000$$

Instructions to run the code

Run the WALKERHIST.m code in the codes section on MATLAB, this gives the histogram of final locations of Walkers.

Run the WALKERTRAVERSAL.m code in the codes section on MATLAB, this gives the space-time curve of each walker.

Run the WALKERSTATISTICS.m code in the codes section on MATLAB, this gives the mean and median of the WalkTraversal graph.