Overview

This laboratory involves writing a short program to simulate a random walk in one dimension and then plot the width of the distribution of random walkers as a function of time.

Tasks

Programming: Random Walk in One Dimension

Consider random walk on a one-dimensional lattice. At each interval, a random walker takes a unit step in the positive direction or in the negative direction with equal probability. Because the probabilities are equal, the *average* position of a random walker remains at the origin where she started. But, the expected average distance from the origin (i.e., the standard deviation of positions) will increase with the number of steps. The standard deviation of position is the same as the root-mean-squared displacement.

The goal of this lab is to discover how the width of the distribution of positions after N steps depends on N.

This can be simulated either by setting multiple independent random walkers in motion and measuring the distribution of the set; or, by setting a single random walker in motion multiple times. You will need to choose simulation parameters (how many multiples and how many steps) based on the speed of your algorithm and your computer.

Hints:

1. You could construct a list of N initial positions with `Table[0,{N}]`
2. You can make a single position move left or right randomly using `Step[n_] := n + (-1 + 2 Random[Integer])`
3. You can make a function operate over each element in a list by declaring the function to be listable: `SetAttributes[Step,Listable]`.
4. You can apply the same function n times with `Nest[Step,list,n]`. For example, `Nest[f,x,3]` is $f(f(f(x)))$.
5. The mean and standard deviation of a list can be obtained with `Mean` and `StandardDeviation`.

Plot Plot the standard deviation that you obtain in your simulation as a function of the number of steps.

Also, make a plot of the *average* displacement that you obtain for each simulation. Comment on any features that may be surprising.

Fit Fit your data to a simple function and comment, if possible, on each of the fitting parameters.

Save your Work Save your work as a Mathematica notebook: `3016_Lastname_Lab07.nb`.

Report

This homework will be graded. Your report on the work above should be ordered as it is above. Your report should include comments that would help one of your classmates understand what your work demonstrates. Send your report as a saved Mathematica notebook with name `3016_Lastname_Lab07.nb` to 3016-labreports@pruffle.mit.edu. As the subject use "3.016 Lab 07 LASTNAME".