Overview

This laboratory involves using file input to incorporating data into Mathematica and then perform basic statistical acessments and curve fitting. Students will need to extract subsets of the input data for analysis.

Tasks

Incorporating, Analyzing, and Plotting Data from a File.

In the file located at http://pruffle.mit.edu/3.016/Laboratories/randomwalk.dat you will find data from 8000 simulations of a random walk, similar to the random walk problem in the first problem set (i.e., how many steps does it take to pass a specified boundary if each step has equal probability of going forward and backward). However, in these random walk simulations, several different step-sizes, s, were used ($s = (.5, 1.0, 1.5, 2.0)$) and several different limits, b, were used for the edges ($b = (25, 50, 75, 100)$). Each line in the file represents a single simulation: the first column is the step-size s; the second column is the boundary limit b; the third (and final) column is the number of steps required to pass the boundary for that simulation. These are the first ten lines of http://pruffle.mit.edu/3.016/Laboratories/randomwalk.dat

0.5	25	1014
0.5	50	3108
0.5	75	57012
0.5	100	16114
1.	25	347
1.	50	532
1.	75	3321
1.	100	17266
1.5	25	525
1.5	50	478

The objective is to read this data into Mathematica and plot the averages and standard deviations of the number of steps against step-size for different boundary limits.

1. Download the data from the URL (there will also be USB thumb drives available) and read it into your Mathematica session. *Hint: you may find that the function "ReadList" is useful. You will want to place the file someplace that you can easily find it from your Mathematica session*
2. Extract data for all trials of the same simulation (i.e., create a list of the number of steps for those simulations of $s = 2.0$ and $b = 75$, and likewise for all other s and b). *You may wish to name those lists for further use (i.e, NS[0.5,75] = {57012, ..., }). One way to build lists is to start with an empty list (i.e, NS[0.5,75] = {}) and then write some kind of loop that fills the list with "AppendTo"*
3. On a single graph, plot four curves of the average number of steps versus step-size, one curve for each boundary width. *Hint: ListPlot will take a list of data pairs (e.g., $\{\{x_1, y_1\}, \{x_2, y_2\}, \ldots, \{x_n, y_n\}\}$) as input to plot. The package Graphics`MultipleListPlot` is even more flexible.*
4. On a single graph, plot four curves of the standard deviation from the average number of steps versus step-size, one curve for each boundary width.

Fitting Data The function

```
displacement[numsteps_] :=
  Module[
        {position = 0},
        For[
              istep = 0,
              istep < numsteps,
              istep++,
              position += 2 Random[Integer] - 1
        ];
        Return[position]
      ]
```

returns a displacement from the origin after a random walk of *numsteps*.

We can simulate 10000 random walkers taking 100 steps by creating a table

```
walks = Table[displacement[100], {10000}];
```

We can count the number of walkers who landed at each position by counting them with

```
population[pos_] := population[pos] =  Count[walks,pos]
```

We can create a table of positions and populations with

```
randata = Table[{i,population[i]} {i,-100,100,2}]
```

Note: the range of possible positions after 100 random steps is (-100,100) and the positions must be at even numbers.

Diffusion in one dimension from a point source at the origin is given by

$$c(x,n) = \frac{c_0}{\sqrt{4\pi Dn/\Gamma}} e^{\frac{-x^2}{4Dn/\Gamma}} \tag{05-1}$$

where Γ is the number of steps per second, n is the number of steps, and D is the *diffusion* coefficient.

Find the c_0 and D/Γ that fit data from 10000 random walk simulations each taking $n = 100$ steps to Eq. 05-1.

Plot the curve with the data.

Can you predict how the diffusivity, D, depends on step-size and Γ for a one-dimensional diffusion?

Save your Work Save your work as a mathematica notebook: `3016_Lastname_Lab05.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_Lab05.nb` to 3.016@pruffle.mit.edu.