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PHYC6261 Winter 2015/16

(grad) Statistical Mechanics I

assignment #1

[Due Friday Jan 22 (extensions by request).]

1. Sethna 2.5 Random Walk [3 marks] (ignore the questions they ask) Code a discrete unbiased random walk in 1d. Generate N walks and get the distribution $P(x,t)$ of net displacement x at time (number of steps). Consider $t = 1$, 10, 100 and 1000. Use at least $N = 1000$. Plot $logP$ vs x, and confirm that you have roughly a parabola. Also, compare your distribution against the solution for the diffusion equation with the expected D. Are you within error bars? (For this, plot the residual — or difference between your measurement vs the theory. So this should be zero within errors.)

How would you get error bars? If you have n hits with N samples at a given distance, i.e. probability $p = n/N$, then you expect a Poisson distribution with variance n, standard deviation $\sqrt{n}$, and error bar $\sqrt{n/N}$. Alternatively you can measure your histogram $\gtrsim 20$ times, numerically measure the variance and proceed from there. The two should agree.

How fast was your code (i.e. how long did it take to generate all of the data)?

2. Sethna 2.10 SAW [3 marks] (ignore the questions they ask) Code a self-avoiding walk in 2d. Generate each walk until it runs into itself. At any given time t (i..e number of steps) the ensemble is all walks that are at least that long. Plot R^2 vs t (on log-log) and see that you get something other than a simple random walk. There are lots of better (faster) algorithms on the web, but this is fine. Generate at least 10^3 walks of length 10^3 (and many more shorter).

3. Sethna 3.9 Gauss and Poisson [2 marks]

4. Sethna 5.4 Black Hole Entropy <u>OR</u> 5.10 Entropy with Diffusion [2 marks]