Assignment 8, PHYS 490
Computers in Physics
Due 3/25/10 at start of class

I realize that you still haven't turned in your previous assignment (assignment 7, due 3/11/10). However, I wanted to get this into your hands as soon as possible so you can get ahead of the game before spring break if you are so inclined. (Alternatively, if you get far enough ahead with your assignments, you are likely to have more time to work on your class project).

1. We worked a bit in the past on plotting. Let's see if you can handle a bunch of these commands from the command line instead of using the mouse for everything. I want you to generate a function called `hyperbolic.m` that has n and xmax as inputs. The output is just a single figure with 12 subplots. For each of the subplots, the x-axis will be a vector running from -xmax to +xmax. The spacing between elements on this vector will be governed by n equal subdivisions of the domain. For example, if n is set equal to 5, you will have 5 points:

   -xmax, -xmax/2, 0, xmax/2, and xmax.

   The subplots will graph the following functions as a function of the generated vector:

   Row 1: $\sinh(x)$, $\cosh(x)$, $\tanh(x)$
   Row 2: $\sinh^{-1}(x)$, $\cosh^{-1}(x)$, $\tanh^{-1}(x)$
   Row 3: $\mathrm{csch}(x)$, $\mathrm{sech}(x)$, $\coth(x)$
   Row 4: $\mathrm{csch}^{-1}(x)$, $\mathrm{sech}^{-1}(x)$, $\coth^{-1}(x)$

   In all cases, just plot the real component of the resulting function. Make all of the lines black. Put the appropriate function name along the y-axis of each figure. (Note that this has to be done within the body of the function, not using the mouse after-the-fact). Also, put on the $\mathrm{sech}^{-1}(x)$ subplot the x-axis label of "distance". [Hint – to do this part of this question, you may want to look into the xlabel and ylabel commands.]

2. We've talked about Poisson statistics a few times this semester. Now we'll do a little numerical experiment to explore it a little more. First, all of this will be done in an m-file called `poisson.m`. Start out by generating 100000 random numbers between 0 and 1 (use rand(1e5,1)). Then, generate a figure that has 1 column and 3 rows of subfigures. Put the following in each of the subfigures:

   - Subfigure 1 – use the `hist` command to identify how many of your random numbers are in bins of size 0.02, spanning the entire interval between 0 and 1. (If done correctly, this should be a bar chart with 50 bars, each with approximately a height around 2000.) Write "frequency" on the y-axis and "spatial region" on the x-axis.
   - Subfigure 2 – use the `sort` command followed by the `diff` command to get an ordered list of the distances between points when sorted sequentially. The second subfigure should use `hist` on the vector received after doing the `diff` on the `sort`. Use a bin-width of approximately 1×10^{-6} and go up to a largest bin size of around $1 \times 10-4$. (100 bins). If you've done this correctly, you should get a bar graph that looks very close to an exponential decay curve. Label the y-axis "frequency" and the x-axis "distances between points".
   - Subfigure 3 – use the `hist` command on the original data one more time. However, instead of doing this 50 times like you did in the first subfigure, use 5000 bins. Then, histogram the histogram. Put "frequency" on the y-axis and "number per bin" on the x-axis.
   - Extra Credit – the theoretical curve for a perfectly random set for these figures would be a horizontal straight line for subfigure 1, a negative exponential curve for subfigure 2, and the Poisson pdf for subfigure 3. Use any resources available to try and obtain a pencil-and-paper solution to what these three curves should theoretically look like. Use the `hold` function to keep the results of the numerical simulation and simultaneously plot the theoretical results in red. (Use lines on top of the histogram charts).

You should turn in your homework files (`hyperbolic.m` and `poisson.m`) to me via email at LarsenML@unk.edu by the start of class on 3/25/10.