Problem Set 0

Biological Physics

Due Thursday, January 28, 2015

Intro to Matlab and Histograms

This problem set will go over the fundamentals of histograms and normalization, along with the basics of using Matlab.

Comparing Histograms

Make three arrays of random numbers from an exponential distribution: one with 1000 points and a mean of 1, one with 1000 points and a mean of 3, and one with 2000 points and a mean of 3. Use `histogram` to plot all 3 of these. Try using different normalizations like `'count'`, `'probability'`, `'countdensity'`, and `'pdf'` (see the Matlab documentation for all the possibilities). If these three data sets were from 3 different runs of the same experiment, which would be the appropriate normalization in order to compare them? Remember that $\int P(x)\, dx = 1$.

[Output] For this problem, output a plot with all three histograms, normalized appropriately, and state which normalization you used.

Calculating a Histogram

In class, we used the Matlab `histogram` function, which calculated the number of points in each bin, and plotted bars for each bin. In this exercise, we are going to recreate most of that function in order to understand what it does.

1. Make 1000 points randomly taken from an exponential distribution of mean 1, and call that `rand_nums`.
2. Make an array called `bins`, with 21 numbers from 0 to 5 (inclusive).
3. Use the `histcounts` function to calculate how many numbers from `rand_nums` are in each of the bins, and call that result `rand_counts`.
4. **[Output]** Use `histogram` to plot bars, like before, normalizing with `histogram(..., 'normalization', 'pdf')`.

5. Calculate `bin_centers`, the centers of your bins. Note that `bins` is an array of the *edges* of your bins. In mathematical terms, if e_i and e_{i+1} are the bin edges, then $b_i = \frac{e_i+e_{i+1}}{2}$ is the bin center. *Hint*: you will need to use indexing for this.

6. **[Output]** Use the command `plot(bin_centers, exp(-bin_centers))` to show the "theoretical" distribution that our random numbers are approximating.

7. **[Output]** Now use the `plot` command to plot your `rand_counts` on top of your histogram. You will need to divide `rand_counts` by (number of points $\times$ bin width) in order to get the appropriate normalization, and you can use `bin_centers` as the x-values for your plot.

Functions you may need `linspace`, `exprnd`, `histcounts`, `plot`, `diff`

Submission

To submit your problem set, please save all the code, figures, and output to the same folder, compress the folder into a zip file (or `.tar` / `.tgz` if you wish), name the file *`LASTNAME-FIRSTNAME-PS0.zip`*, and upload the compressed file to the `Assignments` section on the classesv2 server. Here are the steps:

1. First, gather all your code in one place. If you already have it in a `.m` file, that's great; if not, open the Matlab Editor, copy and paste *all* the necessary commands into the editor (without the `>>`), and save it as a `.m` file. To test that it works, you can type `clear` into the main window, close all your figures, and then go to the editor and press `F5`. Your code will all run in the main window, and you should see the same output as before.

2. Next, put all your text output in a `.ps`, `.pdf`, or `.txt` file. You can do this however you would like, but the simplest way is to close Matlab, reopen it, run your code, and then go to `File` $\rightarrow$ `Print` and check the box `Print to File`, and then hit `Print`. You can also use the `diary` command, or Cut and Paste into a `.txt` file. **Please do not turn in a .doc**; if you want to use Word, export it as a PDF.

3. You should also save any figure you have created to this same folder.

4. Finally, you should put all of this in a single compressed file. There are instructions for Windows here and for Macs here. You can also use the `Current Folder` pane to the left of Matlab, select all the files you want to compress using `Ctl`-Click, and then right-click and select `Create Zip File`. You can also use the `zip` or `tar` functions; see the Matlab documentation. *Name your file `LASTNAME-FIRSTNAME-PS0.zip` before you upload it.* Make sure to get the extension right if you made a `tar` file. **Please do not turn in a rar file.**

5. Upload to the classesv2 **Assignments** section.