Probability

1. Suppose you have three neurons, A, B and C. A and B fire independently, but both are connected to C. The probability that A fires in a second is 0.1. The probability that B fires in a second is 0.4. If A fires the probability that C will fire is 0.5. If B fires the probability the C fires is 0.2. C only fires when it receives a spike from A or B, and if C gets a spike from both A and B the probability of C firing is 1.

   a. If you observe a spike from C, what is the probability that A fired?
   b. If you observe a spike from C, what is the probability that B fired?
   c. If you observe a spike from C, what is the probability that both A and B fired?
   d. If you observe a spike from C, what is the probability that A fired but B did not fire?
   e. If you observe a spike from C, what is the probability that B fired but A did not fire?

2. Using Matlab, code up a simulation of the network from problem 1 and run the simulation 10000 times, keeping track of which neurons fire during each run.

   a. Verify your answers to problem 1 with the simulation. The easiest way to do this is to use the rand(1) function to return a random number between 0 and 1 and use a sequence of calls to rand(1) to determine whether neurons A, B and C are active in each run. This can be done in vectorized form rather than in a for loop, but a for loop is fine. This can also be done with a single call to the rand() function.
   b. Determine how the similarity in answers between 1a. and the simulation for 1a depends on the number of simulation runs. To do so, run the simulation 1, 10, 100, 1000, 10000 and 100000 times and plot the error (the difference between the simulated and calculated values) for each set of runs.

3. Load Probability_Data1.mat into Matlab. Responses containing the spike counts one neuron across 200 trials of presentation of one of two stimuli. Stimulus A was presented on odd number trials and Stimulus B was presented on even number trials.

   a. Plot a histogram (Matlab: hist function) of the number of spikes for s1 on each trail for each stimulus (use a single plot with two bar graphs, one for stimulus a in red and one for stimulus b in blue). Put a bin center every count up to 100 (e.g. use the vector [0:1:100] to specify the locations of the bin centers.)
      Hint: to get a sense for the shape of both histograms, plot the second one with a slight offset on the x axis by adding 0.1 to the x coordinate:
      Histogram 1:
      bar(bincenters, s1acounts, ‘r’)
      Histogram 2:

bar(binceneters+0.1, s1bcounts, ‘b’)

b. Make another set of histograms with bins every 5 counts [0:5:100].

c. Plot the pdf and the cdf for stimulus A and for stimulus B (four plots total). How are the pdfs related to the histograms from a.?

d. Suppose you were told that neuron 1 fired 44 spikes in a particular trial. Use Bayes’ rule to determine the probability that stimulus A was on for that trial using a scheme based on the 1 count bin size (histograms from a)

e. Repeat with a scheme based on the 5 count bin size (histograms from b). Which of these two estimates is likely to be closer to the true value and why?