Feb 11, 2020 (due March 10, 2020)

Computational Neuroscience assignment: Choose **only one** of the following two questions, **either (i) or (ii)**:

(i) If you prefer to focus on the in-class tutorials: Explain the main steps of going through the spike-triggered average tutorial in class (neuralBox2_main.m) and answer the questions at the end of the tutorial. Also, in the tutorial, we assume Poisson spiking of neurons. In what ways is this different from biological neurons?

(ii) If you want to work with real data and utilize the tools we learned: This mat file c1p8.mat and assignment are from the Dayan and Abbott book. The mat file is available here:

http://www.gatsby.ucl.ac.uk/~dayan/book/exercises/c1/data/c1p8.mat

These are data from an H1 neuron in the fly, with **rho** the spike counts and **stim** the stimulus sequences. Compute the Spike-triggered average, with a temporal kernelSize of 150 (corresponding to 300 milliseconds; each time step is two milliseconds). You can look at how we computed the Spike-triggered average for a temporal vector in the second lab (note: please do ***not*** use the model neurons such as neuralBox that we had in the lab since they were made up simulations, but rather use the approach and associated code for finding the average of stimuli leading to a spike ***in the spike data***. The idea is that here we have an actual neuron recorded from a fly and we want to find the Spike-triggered average filter from that data). Plot the Spike-triggered average.

Generate synthetic Poisson spike trains using the Spike-triggered average linear filter that you found above. Do this by first computing the linear responses for this filter (this is similar to what we did in the Spike-triggered average lab). Then generate the Poisson spikes as in our tutorial for Spike-triggered average, and try to make the number of spikes approximately equal to the number of spikes in the real neuron (see how we multiplied the random draws xr in our tutorial by a fixed number to get the spikeCounts; modify this fixed number appropriately). Plot the spike sequences from the real neuron, and the spike sequences from your synthetically generated spikes (you can use Matlab's stem function). How do these spike sequences differ?

Next, compare the autocorrelation of the spikes for the real neural spikes versus your synthetic spikes that you generated for 0 to 100 milliseconds (or 0 to 50 time steps). This can be done using Matlab's corr function. For instance, the autocorrelation for 10 milliseconds (5 time frames apart) is given by taking the correlation between the spike sequence from the 1st time point to the end minus 5th time point, with the spike sequence from the 6th time point to the end (which amounts to a temporally shifted version). This correlation for a time shift of 6 should give you a single number. Do this at all time shifts from 0 to 50. Plot the resulting autocorrelation function for the real neuron and your synthetic spikes. Why does the real neuron have a dip at 2 milliseconds?