Due: November 2, 2017

Computational Neuroscience assignment 1:

Spike-triggered Average (STA) and Covariance (STC).

1. Consider the STC_Tutorial_main.m tutorial in the STC directory that we did in lab. Why is the Spike-triggered average for model neuron 2 (ClassModel2.m) zero, without any interesting structure? What does the spike-triggered covariance analysis reveal about the model neuron? Explain based on the plots of the eigenvalues, and the scatter plots onto the relevant eigenvectors.

2. 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 (visual system of a 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 STA lab. 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 a portion of 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, compute the autocorrelation of the spikes for the real neural spikes, and then do the same for your synthetic spikes that you generated. Compute the autocorrelation for each of these 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 of the spike sequence). 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 and compare them. Why does the real neuron have a dip at 2 millseconds?