Signal & Data Analysis in Neuroscience
Bar Ilan, Spring 2016 Due: April 12th April 10:00 AM.

Assignment 03

1) JPSTH (Matlab)

The file *trials.mat* contains a cell array (2000x2) that includes the simultaneous responses of 2 neurons to a stimulus that was presented during 2000 trials. Each column represents a neuron. Each row represents a trial. Each cell contains a vector of spike times (in ms, 0.5 ms resolution) of one neuron in one trial. In every trial, time 0 is the time the stimulus was presented.

Calculate and plot the following (each section on a different figure), using 2 millisecond bins:

a) The PSTH of each neuron (count).

b) The raw JPSTH (probability).*

c) The shift predictor (probability).

d) The corrected JPSTH (probability).

e) Based on b & d, what can you say about the synchronization of the two neurons?

*Co-occurrence of more than 1 spike (from any neuron) in a single time bin may be counted as 1 co-occurrence.

2) Spike triggered average (Matlab)

The file *STA.mat* contains a stimulation signal presented to a neuron and its corresponding resulted spike train. The signal is sampled at 550 Hz.

a) Plot the spike triggered average of this stimulus/spike-train pair using a 1 second window. The signal amplitude can be represented in arbitrary units ("au").

3) Optimal Kernel (Matlab)

The file *exMT3.mat* contains the results of an experiment for describing sensory neurons. The file contains two variables: *stim* – a vector (1*60000) of the white noise played (arbitrary units) and *resp* – a matrix (100*60000) of the spiking activity of a neuron during 100 exposures to the same stimulus. All variables are 60 seconds long and recorded at 1000 samples/sec:

a) Find & draw the rate function (r) of the neuron. Choose the preferred window size in the range 100-1300ms by means of trial & error. Explain (1 sentence) the choice of window size.

b) Find & draw the optimal kernel of the neuron assuming it is linear.

c) Explain (qualitatively, in 1-2 short sentences) the computation performed by the neuron.

d) Apply the kernel you found to the stimulus and show the resulting rate (over 60 seconds).

e) Apply the **naka-rushton** non-linearity (equation below) on the result from *d*, to convert the neuron's rate (that you found in **a**) to vary between 0 and 60.

$$S = R_{max} \frac{r^n}{r^n + r_{\frac{1}{2}}{}^n}$$

Where: **r** is the input firing rate, **Smax** the scaling factor determining the max resulting response, $\mathbf{r_{1/2}}$ the "threshold" input firing rate for which the function will yield the value 0.5*Smax, and **n** the exponent affecting the slope.