Signal & Data Analysis in Neuroscience
Bar Ilan, Spring 2017 Due: 8th May 8:00 AM.

Assignment 04

1) Spike triggered average (Matlab)

The file *STA.mat* contains spike times in seconds, and the continuous stimulus sampled at 6009Hz, that generated the spike train.

a) Plot the spike triggered average of this stimulus/spike-train pair using +/-300 ms window. The signal amplitude can be represented in arbitrary units ("au").

b) What would be the optimal sine frequency to activate this neuron?

2) Optimal Kernel (Matlab)

The file ***kernel.mat*** contains the results of an experiment for describing sensory neurons in the Magical Toad. The file contains two variables: stim – a vector (1*60000) of the white noise magical stimulus played to the toad (measured in MU) and resp – a matrix (100*60000) of the spiking activity of a neuron during 100 exposures to the 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.

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

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

d) Translate the neuron's response to a fight/flight decision by Implementing a **sigmoid** non-linearity (a soft threshold – see equation below), that converts the neuron's rate function (that you found in **a**) to vary between 0 and 1.

I. Explain your choice of the sigmoid parameters ($\mathbf{r_{1/2}}$, $\boldsymbol{\beta}$).

II. Plot the response of the function to input firing rates ranging from 0 to 100 spikes*s^{-1}

III. Plot the resulting (0->1) decision sequence.

IV. Assuming the Toad "learned" to respond (fight or flight) more accurately and with greater confidence – how would you implement this in the formula? (i.e. which parameter would you change and how)

$$S = \frac{1}{1 + e^{\beta(r_{\frac{1}{2}} - r)}}$$

Where: **r** is the input firing rate, $\mathbf{r_{1/2}}$ the "threshold" input firing rate, for which the function will yield the value 0.5 (the middle between a definitive 0 decision and a definitive 1 decision)

3) ROC (analytic solution, don't use Matlab)

Given the following probabilities of evoked potential amplitudes:

P314 (μV)	0	1	2	3	4
Disorder	0.1	0.2	0.2	0.3	0.2
Control	0.3	0.3	0.2	0.1	0.1

N271 (μV)	0	1	2	3	4
Disorder	0.2	0.2	0.2	0.2	0.2
Control	0.2	0.3	0.5	0	0

a) Plot the ROC curves of both statistics.

b) Which statistic is better for identifying the disorder? Why?

c) What is p[success] for the two statistics?