Assignment 02

1) Stochastic Point Process

The file 'ex2Question1.mat' contains spike times of a stochastic point process. Spike times are in seconds.

a) Calculate the Fano Factor (FF) and the Coefficient of variation of the interspike intervals (Cv) using 1 second window.

b) Calculate FF & Cv using 25 msec window.

Explain the differences.

c) Would you suspect the given spike train is an outcome of a Poisson stochastic process? Explain.

2) Properties of a single Poisson process with refractory period

Generate a spike train for 90 seconds using a Poisson process with a refractory period, in 1 millisecond bins.

The baseline firing rate rate (r_0) should be 55 spikes/second.

The refractory period should be simulated as followed: after each spike, set an absolute refractory period for 4 ms (i.e. r(t+1)= r(t+2)= r(t+3)= r(t+4)=0, where t (in ms) is the time of the spike), and a recovery period of 7 ms, in which the firing rate (r_{ref}) increases linearly from 0 back to r_0 (i.e. r(t+5)=(r_0 *1/7) , r(t+6)=(r_0 *2/7), r(t+7)=(r_0 *3/7), etc.)

Using Matlab, calculate and plot the following:

a) TIH -Time interval histogram.

b) Survivor function.
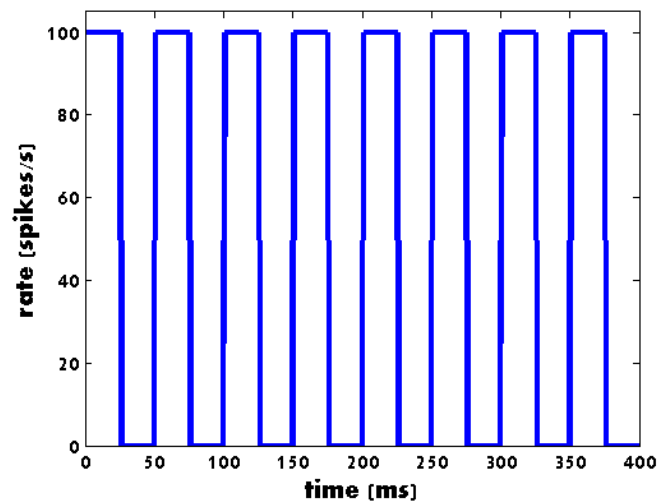
c) Hazard function.

d) Autocorrelation (maximal offset ±100 ms) – normalized to rate.

Explain the graphs based on the discharge properties if the neuron. Also explain the normalization of each plot.

3) Autocorrelation

The rate function of a non-homogeneous Poisson-process neuron is:

$$r(t) = \begin{cases} 100 \ spikes/s, & mod(t, 50) < 25 \\ 0 \ spikes/s, & Otherwise \end{cases}$$

The neuron is sampled at 1000Hz [samples/sec] and recorded for 20 seconds.

a) Draw the spike count autocorrelation function of the neuron.

b) Draw the rate-normalized autocorrelation function.

-Remember titles, X and Y labels, units and key values at points of interest (max / min points, etc.)

-Solve analytically, no Matlab in your solution please. (It may be useful to validate your results/answer using Matlab.)

4) Extracting the autocorrelation from the Hazard function

Given the following hazard function:
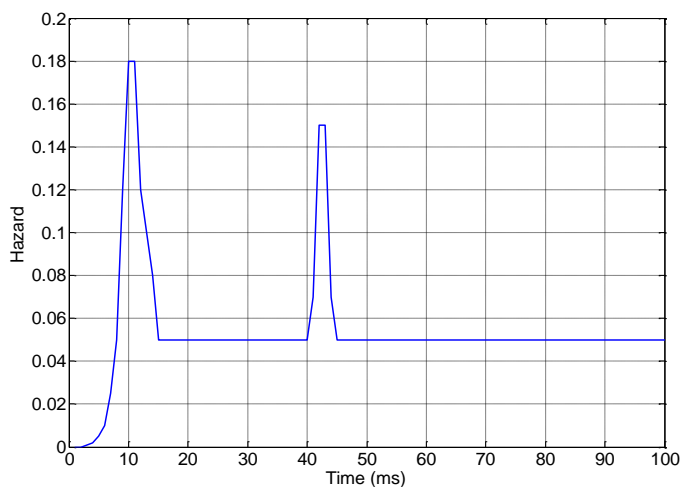
a) Sketch the autocorrelation function ±1 second.

b) Is the neuron Poisson, Regular, Bursty? Explain your answer

Notes:

- Solution of questions 3 and 4 should not include Matlab code. You can use Matlab in order to validate your answers and acquire intuition.

- "Draw" means draw by hand an exact solution and indicate exact values for points of special interest (e.g. min/max). Specify accurate calculation results.

- "Sketch" means draw by hand a coarse solution when you should provide values for points of special interest (min/max). Values can be either accurate calculation results is possible and easy to extract. Otherwise, provide rough estimation.