SYDE552/BIOL487 Assignment: Linear-Nonlinear-Poisson Models

Due March 22
25 Marks Total

1. Spike Statistics
    a. Generate 50 ten-second "trials" of Poisson spikes at 25spikes/s **with a 5ms absolute refractory period**. To generate the spikes, draw samples from an appropriate inter-spike interval (ISI) distribution.
    b. Plot the spike raster (first second only) and the ISI histogram (calculated from all spike times; 10ms bins from 0 to 500ms)
    c. What is the coefficient of variation of the spike rate over all trials?
    d. What is the Fano factor for the first 100ms? Run your code a few times and comment on the consistency of the Fano factors. Run a few more times with a smaller refractory period of 1ms and comment on the difference in Fano factors.
2. LNP Models
    a. Create a linear model of the synthetic neuron given in the Neuron Responses Assignment. To so this, convolve white noise with the (appropriately scaled) white-noise spike-triggered average that you calculated in assignment 1 (Matlab: `conv`; Python: `numpy.convolve`) and scale appropriately. Make sure time is going in a sensible direction for the kernel. Plot a 1s white-noise stimulus (Δt=.001s; mean=0; SD=1) together with the corresponding rate prediction.
    b. Calculate and plot the multi-trial rate r(t) of the synthetic neuron over 250 repeated trials with the same white-noise stimulus, with 10ms bins.
    c. Scatterplot the linear rate prediction on the horizontal axis vs. the actual rate on the vertical axis. Also fit the nonlinearity with an appropriate function and plot the result. (Matlab: `lsqcurvefit`; Python: `scipy.optimize.curve_fit`).
    d. Describe how you could generate spikes with a linear-nonlinear model of the synthetic neuron using the above results.