G63.2855/G80.3400 – Fall 2005
Computational Modeling of Neuronal Systems

Homework 1

Due: 19 Oct 2005

Your results should be in the form of a MATLAB file (typically, the filename should have an extension of `.m`). Email your solutions to `eero.simoncelli@nyu.edu`.

1. Write a matlab function `simLNP` to simulate a particular LNP model neuron. The function should take a Tx16 stimulus matrix (with T the temporal duration), and return a binary column vector indicating which time bins contained a spike.

   For the linear kernel, use a vector of size 16 containing a spatial Gabor function:

   $$k(x) = exp[-(x^2)/16] \sin[2\pi(x)/(6\sqrt{2})]$$

   where x is the position relative to the center of the kernel. Normalize the kernel so that $\sum_x k^2(x) = 1$.

   For the nonlinearity, use a hyperbolic tangent:

   $$f(r) = [tanh(4r - 1) + 1]/8$$

2. Run your function on an input containing univariate Gaussian white noise (generated using matlab's `randn`). Compute the spike-triggered average (STA), normalize it, and compare it to the true kernel. Do this for stimuli of different temporal duration, and plot the mean squared error of the estimate as a function of the number of spikes, N. Show that the mean squared error falls approximately as $\sqrt{N}$.

3. Starting with one of the estimated STA kernels from the previous part, estimate the nonlinear function, and plot your estimate along with the true nonlinearity.

4. Examine the STA for "sparse noise" stimuli. Specifically, generate a space-time stimulus in which the spatial vector at each time step contains fifteen values of $-1/15$ and a single value of 1, at a randomly chosen position. Normalize the stimulus to have unit variance (to make it comparable to the Gaussian white noise case). Does it appear noticably different? Plot the mean squared error as a function of stimulus duration, and describe the result.