# CIS6930/4930 Intro to Computational Neuroscience Spring 2006
## Home Work Assignment 6:
## Due Monday 05/1/06 before class

This project is about first constructing a random cortical network of spiking neurons and stabilizing its activity in the range 0-50 Hz. In the second part, you computationally ascertain whether the dynamics of the system is *sensitive to initial conditions*.

1. (50 pts) Begin by constructing a network of $1000$ neurons, $80\%$ of which are randomly chosen to be excitatory neurons and the remaining inhibitory neurons. Now assign $100$ synapses (each neuron *receives* inputs from $100$ neurons) to each neuron and randomly choose the pre-synaptic neurons for each such post-synaptic neuron. Next assign $50$ variables to each neuron to store the times at which the neuron spiked in the past $100$ msec (Naturally, the time bound for the horizon is $100$ msec.)

   Finally, build a spike response model for each neuron as follows. The total potential at the soma of a neuron is the sum of the excitatory and inhibitory post-synaptic potentials generated by each spike at each synapse, and the after-hyperpolarization potentials generated by the spikes emitted by the neuron itself. Randomly assign to each synapse a time in the range [0.4,0.9] msec that accounts for the time it takes for a spike to travel down the axon and reach that synapse.

   Use the following functions to model the postsynaptic potentials at the synapses

   Excitatory :

   $$\frac{Q}{\alpha\sqrt{t}} exp(-\alpha^2/t) exp(-t/\tau)$$

   set $Q$ in the range [5,10], set $\alpha$ in the range [1,2] and $\tau = 20$ msec.

   Inhibitory :

   $$\frac{-Q}{\alpha\sqrt{t}} exp(-\alpha^2/t) exp(-t/\tau)$$

   set $Q$ in the range [30,60], set $\alpha$ in the range [1,1.1] and $\tau = 20$ msec.

   AHP:

   $$-1000 * exp(-t/1.2)$$

   Start with different thresholds (5 mV for excitatory and 10 mV for inhibitory) for each neuron and play with the thresholds so as to stabilize the system to sustained recurrent activity (for at least 10 sec). The time step for your simulations should be no larger than $0.2$ msec.

   Plot the spike trains for $250$ neurons in the population, as well as the total number of spikes generated in the system over the past $100$ msec.

2. (50 pts) Now simulate the dynamics of the same system with the same exact initial configuration of spikes **except for** *one* randomly chosen spike perturbed by *one* msec. Generate a spike raster plot with the following color codes. Color spikes as red if they are generated at the same time by the two systems (original and perturbed). Otherwise color them green/blue depending on which system the spike belongs to. Based on the results of your experiment report whether the dynamics of your system is *sensitive to initial conditions*.