CN510 Assignment 4: Recurrent Competitive Fields

Due: November 26, 2007

The purpose of this assignment is to examine the dynamics of recurrent competitive fields. Let your network consist of ten STM cells. Use the following set of equations:

$$dx_i / dt = -Ax_i + (B - x_i)[f(x_i) + I_i] - x_i \sum_{k \neq i} f(x_k)$$

where the I_i are the inputs to the network, the x_i are the STM activities (i = 1, 2, ..., 10), and $f(\ )$ is the neuron's signal function. The constants A and B are network parameters restricted to nonnegative values; set $A = 1$ and $B = 3$ for this assignment.

(a) Initialize the values of x_i to zero and present the following stimulus pattern from $t = 0$ to $t = 1$:

$$I_i = \{ 0.2, 0.6, 0.9, 0.6, 0.2, 0.1, 0.4, 0.8, 0.4, 0.1 \}$$

Show how the network responds to this stimulus pattern for each of the following four signal functions:

$$\begin{aligned}
&(i) && f(w) = w \\
&(ii) && f(w) = w^2 \\
&(iii) && f(w) = w/(F + w) \\
&(iv) && f(w) = w^2/(F + w^2)
\end{aligned}$$

Let $F = 0.25$ and integrate the network equations from $t = 0$ to $t = 10$ (recall the input pattern is only presented from time t=0 to t=1). Be sure to use a sufficiently small integration time step to avoid "erratic" network behavior. Plot the *pattern* variables (the normalized STM activities) as a function of time and compare the final activities to the inputs. Discuss your results.

Note: This assignment requires the submission of a number of plots. Think about how you might organize these plots efficiently and effectively. One suggestion is to create eight plots for each part, consisting of, for each feedback function, a plot showing normalized neural activity vs. time (these plots will contain 10 curves) and a plot showing the final normalized activity vs. the index of the neurons (i = 1, 2, ..., 10). Also, keep in mind that it is not necessary to include plots of the network dynamics, however, these plots may prove useful for your understanding of the network.

(b) Repeat part (a) but use the following initial values:

$$x_i = \{ 0.7, 0.6, 0.8, 0.9, 0.5, 0.3, 0.5, 0.7, 0.8, 0.4 \}$$

Compare the results with those of part (a). Note that in part (b) the input pattern is the same as that of part (a); only the initial values of the neurons are changed.