CN510 Assignment 5: Recurrent Competitive Fields

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 $t = 1$:

= { 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:

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

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; or even better to use surface plots by using mesh and surf in MATLAB) and a plot showing the final normalized activity vs. the index of the neurons (i = 1, 2, ..., 10). Also, keep in mind that plots of the network dynamics (as you did in the last assignment), may prove useful for your understanding of the network behavior.

(b) Repeat part (a) but use the following initial values (of 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) with particular attention to the signal functions and the spatial distribution of activities.