CN510 Assignment 5: Recurrent Competitive Fields

Due Thursday Oct 17, 2013

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

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

where the I_i are inputs to the network, the x_i are the cell 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.

Part a

Initialize the values of x_i to zero and present this stimulus pattern from $t = 0$ to $t = 1$:

$$I_i = \{0.2, 0.7, 0.9, 0.6, 0.3, 0.5, 0.4, 0.8, 0.5, 0.1\}$$

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

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

Let $F = 0.25$ and integrate the network equations from $t = 0$ to $t = 10$ (recall that the input pattern is only presented from $t = 0$ to $t = 1$). Be sure to use a sufficiently small integration time step to avoid "erratic" network behavior.

Plot both the original activations and the the *pattern* variables (the normalized activations) as functions of time to observe the dynamics. In addition plot activations across all ten cells at time $t = 10$ and compare the final activities with the input. For linear and sigmoidal signal functions you might adjust the scale of the input pattern to better show the preservation or distortion of the pattern. For faster and slower than linear signal function plot the final pattern variables and input pattern on the same scale. Discuss your results.

Part 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).

Important: In part (b) the input pattern is **the same** as that of part (a); only the initial values of the neurons are changed.

Grading Rubric:

50 points	Each of parts (a) and (b) from which
2 points per plot	Well-formatted 12 plots with readable labels and parameter meanings listed in the caption (four functions $\times$ activations and patern variables through time + final activations across cells
4 points per function	Correctness of the solution
10 points	Discussion of the results with emphasis on what was different comparing to what you have learned from lecture