CSE 5526 - Autumn 2014

Introduction to Neural Networks

Homework #4

Due Tuesday, Nov. 25

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Problem 1. For a winner-take-all network with 5 neurons, the function of each neuron is defined as

$$y_i(t+1) = \varphi\left((S-1)y_i(t) - \sum_{j \neq i} y_j(t)\right)$$

where S is the number of output neurons, and the activation function is defined as

$$\varphi(x) = \begin{cases} 0 & if\ x < 0 \\ x & if\ 0 \le x \le 1 \\ 1 & if\ x > 1 \end{cases}$$

The above network receives the input vector at time step 0, $\mathbf{x}^T$ = (0.2, 0.2, 0.3, 0.4, 0.3). Find the network output at time step 1 and 2.

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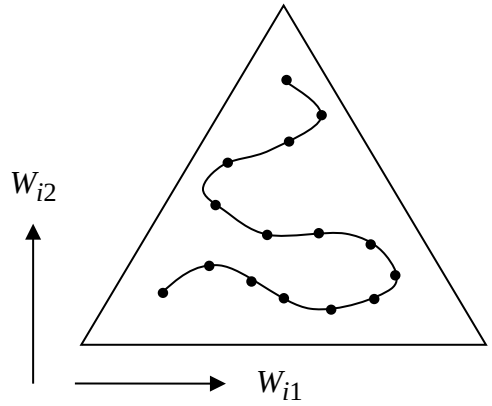
Problem 2. The following figure shows the final weight vectors of a self-organizing map that has been trained on two-dimensional input vectors which were drawn from a uniform distribution over the triangular area. Lines between units (represented by dots) connect topological neighbors. Draw the diagram of the network that has undergone such self-organization. Specify the elements of the network and their connections (no detailed values are needed).



Problem 3. Consider a Hopfield network made up of five neurons, which is required to store the following three fundamental memories:

$$\xi_1 = [+1, +1, +1, +1, +1]^T$$
$$\xi_2 = [+1, -1, -1, +1, -1]^T$$
$$\xi_3 = [-1, +1, -1, +1, +1]^T$$

(a) Evaluate the 5-by-5 synaptic-weight matrix of the network.
(b) Use asynchronous updating to demonstrate that all three fundamental memories, ξ_1, ξ_2, ξ_3 satisfy the alignment condition
(c) Investigate the retrieval performance of the network when it is presented with a noisy version of ξ_1 in which the second element is reversed in polarity
(d) Write down the energy function in terms of x_is.