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CS 6673 spring 2009

Assignment 1, Due February 10, 2009
Please submit a hardcopy at the beginning of class

We are interested in feedforward neural networks with the following two different training sets:

(Case A:)

$$\mathbf{s}^{(1)} = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(1)} = 1$$

$$\mathbf{s}^{(2)} = \begin{bmatrix} 1 & 1 & -1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(2)} = 1$$

$$\mathbf{s}^{(3)} = \begin{bmatrix} -1 & 1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(1)} = 1$$

$$\mathbf{s}^{(4)} = \begin{bmatrix} -1 & -1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(2)} = 1$$

$$\mathbf{s}^{(5)} = \begin{bmatrix} 1 & -1 & -1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(3)} = -1$$

$$\mathbf{s}^{(6)} = \begin{bmatrix} 1 & -1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(4)} = -1$$

(Case B:)

$$\mathbf{s}^{(1)} = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(1)} = 1$$

$$\mathbf{s}^{(2)} = \begin{bmatrix} 1 & 1 & -1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(2)} = 1$$

$$\mathbf{s}^{(3)} = \begin{bmatrix} 1 & -1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(1)} = 1$$

$$\mathbf{s}^{(4)} = \begin{bmatrix} -1 & -1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(2)} = 1$$

$$\mathbf{s}^{(5)} = \begin{bmatrix} 1 & -1 & -1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(3)} = -1$$

$$\mathbf{s}^{(6)} = \begin{bmatrix} -1 & 1 & 1 \end{bmatrix}, \quad \text{with} \quad \mathbf{t}^{(4)} = -1$$

(a) For each of the two cases, is the classification problem linearly separable? Give arguments to support your claim.

(b) Specify the neural network architecture that you will attempt to use to solve the classification problem. Give the number of layers, the number and type (*i.e.* binary or bipolar) of neurons in each layer, and the transfer functions used.

(c) Assuming zero initial weights and bias, find the weights and bias using the Hebb learning rule. Do not write a program. You should do the problem by hand and show me all the steps.

(d) Check to see if your neural network can solve the intended classification given by the training set.

(e) For each of the two cases, how does the neural network classify this new pattern that is not in the original training set:

$$\mathbf{x} = \begin{bmatrix} 1 & 0 & -1 \end{bmatrix}$$

Note that the components of a bipolar vector that have not been measured are commonly assigned a value of zero.