

CSE5301 Neuro-Fuzzy Computing

Neural Networks

1. A neural network generates its output according to the following equation

$$y = \sigma \left(U \cdot \begin{bmatrix} h \\ 1 \end{bmatrix} \right), \quad h = \sigma \left(W^h \cdot \begin{bmatrix} x \\ 1 \end{bmatrix} \right)$$

where σ is a suitable step function (a hard limiter),

$$W = \begin{bmatrix} -2 & 4 & 1 \\ 6 & -4 & 1 \end{bmatrix}, \quad U = \begin{bmatrix} 3 & 4 & -1 \end{bmatrix}.$$

- (a) Sketch a dendritic diagram of the network. 5 marks
 (b) calculate the network output y for the following input vectors:

$$X = \begin{bmatrix} 0.5 & 0 & 0 & 1 & 1 \\ 0.25 & 0 & 1 & 0 & 1 \end{bmatrix}$$

- 5 marks
- (c) Plot the decision plane/line for every neuron in the network 5 marks
 (d) If the step functions are removed from the network, what function the network performs. 5 marks

2. In Adaline, the performance index is given in the following form:

$$J(w_1, w_2) = 4w_1^2 + 6w_1w_2 + 5w_2^2 + 2w_1 - 3w_2 + 2$$

- (a) Determine the cross-correlation and input correlation matrices. 3 marks
 (b) Assuming that the current weight vector $w = [1 \ -1]$ calculate the gradient of the performance index. 4 marks
 (c) In the steepest descent learning law, what would be the next value of the weight matrix? 3 marks

3. In Generalised Hebbian learning

- (a) the current values of the input vector and the weight matrix are as follows:

$$\mathbf{x} = \begin{bmatrix} -2 \\ -1 \\ 1 \end{bmatrix}, \quad W = \begin{bmatrix} 1 & 0 & 2 \\ -1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

Calculate the weight update ΔW . Assume $\eta = 1$.

8 marks

- (b) At the conclusion of the learning process, what do the weight matrix,
- W
- , and the output vector,
- y
- , represent?

2 marks

4. Consider a Kohonen Self-Organizing Map where dimensionality of the input and feature spaces are 2 and 1, respectively. The number of neurons is 8.

- (a) Sketch a structure of the network.

3 marks

- (b) Assuming the contents of the weight and neuronal position matrices is as follows:

W		V
4	3	5
1	3	1
5	4.5	7
2	1	3
1.5	2	2
4.5	5	6
3	2.5	4
5.5	3	8

Sketch the resulting feature map.

7 marks