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**MANIPAL INSTITUTE OF TECHNOLOGY**
(Constituent Institute of Manipal University)
MANIPAL-576104

SEVENTH SEMESTER B.E (CSE) DEGREE EXAMINATION
November/December 2012

**NEURAL NETWORKS AND FUZZY SYSTEMS (CSE 405.1)**

DATE: 05/12/2012

**TIME : 3 HOURS** **MAX.MARKS : 50**

**Instruction to Candidates**

- Answer **any five** full questions

**1A.** Explain the McCulloch-Pitts model of artificial neuron with a neat diagram. Show that it may be approximated by a sigmoidal neuron (i.e., neuron using a sigmoid activation function with large synaptic weights). Also explain the probabilistic behavior of a neuron using McCulloch-Pitts model. **[3]**

**1B.** Explain memory based learning using K-nearest neighbor classifier. **[3]**

**1C.** Explain Hebbian hypothesis and its limitation. How it is overcome by Covariance hypothesis. State the important observations of Covariance hypothesis. **[4]**

**2A.** Prove that for a perfect recall of pattern ***Y***, the key vectors $\boldsymbol{X}_k$ and $\boldsymbol{X}_j$ should be orthogonal. **[3]**

**2B.** Starting with the decision boundary equation, derive the weight updation rule for a single layer perceptron network. Also mention its limitation. **[3]**

**2C.** Consider a classification problem for a single layer perceptron with four classes of input vectors as follows

$$\left\{x1 = \begin{matrix}1\\1\end{matrix}\middle| d1 = \begin{matrix}0\\0\end{matrix}\right\} \left\{x2 = \begin{matrix}1\\2\end{matrix}\middle| d2 = \begin{matrix}0\\0\end{matrix}\right\} \left\{x3 = \begin{matrix}2\\-1\end{matrix}\middle| d3 = \begin{matrix}0\\1\end{matrix}\right\} \left\{x4 = \begin{matrix}2\\0\end{matrix}\middle| d4 = \begin{matrix}0\\1\end{matrix}\right\}$$

$$\left\{x5 = \begin{matrix}-1\\2\end{matrix}\middle| d5 = \begin{matrix}1\\0\end{matrix}\right\} \left\{x6 = \begin{matrix}-2\\1\end{matrix}\middle| d6 = \begin{matrix}1\\0\end{matrix}\right\} \left\{x7 = \begin{matrix}-1\\-1\end{matrix}\middle| d7 = \begin{matrix}1\\1\end{matrix}\right\} \left\{x8 = \begin{matrix}-2\\-2\end{matrix}\middle| d8 = \begin{matrix}1\\1\end{matrix}\right\}$$

Calculate the updated weights after one epoch using the perceptron learning rule. Assume learning rate, $\eta = 1$ and the following initial weights and biases.

$w(0) = \begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$ and $b(0) = \begin{bmatrix}1\\1\end{bmatrix}$. Hard limiter is $y = \left\{\begin{matrix}1 & if\ v \geq 0\\0 & otherwise\end{matrix}\right\}$ **[4]**

**3A.** Derive the equivalent time series representation of the following equation

$$\Delta w_{i,j}(n) = \alpha \Delta w_{i,j}(n-1) + \delta_j(t) y_i(t)$$

where $\alpha$ is momentum constant. **[2]**

**3B.** Explain in detail the Backpropagation algorithm with the help of mathematical equations. **[8]**

**4A.** Using proper mathematical representation, explain the following three essential processes involved in the formation of self-organizing map.

(i) Competition. (ii) Cooperation (iii) Synaptic adaptation. **[7]**

**4B.** Consider a Kohonen self-organizing network with two cluster units and five input units. The weight vectors for the cluster units are given by

$$W = \begin{bmatrix} 1.0 & 0.9 & 0.7 & 0.5 & 0.3 \\ 0.3 & 0.5 & 0.7 & 0.9 & 1.0 \end{bmatrix}$$

Use square of Euclidean distance to find the winning cluster unit for a given input pattern $x = [0.0\ \ 0.5\ \ 1.0\ \ 0.5\ \ 0.0]$. Use a learning rate $\eta$=0.25. Also calculate the updated weights for the winning unit. **[3]**

**5A.** Explain the energy function and energy minimization required to stabilize auto-associative discrete Hopfield network. **[6]**

**5B.** With a neat architectural graph of multilayer perceptron network provide a solution to XOR problem. Assume appropriate weights and biases. **[4]**

**6A.** Explain the following two methods of assigning membership values to fuzzy variables.

(i) Intuition (ii) Inference **[6]**

**6B.** We want to compare two sensors based upon their detection levels and gain settings. The following table shows sensor detection levels for different gain settings. The item being monitored provides typical membership values to represent the detection levels of each of the sensors.

| Gain Setting | Sensor S1 detection level | Sensor S2 detection level |
|---|---|---|
| 0 | 0 | 0 |
| 20 | 0.5 | 0.45 |
| 40 | 0.65 | 0.6 |
| 60 | 0.85 | 0.8 |
| 80 | 1 | 0.95 |
| 100 | 1 | 1 |

Form the two fuzzy sets for sensors S1 and S2. Find the following membership functions using standard fuzzy set operations: **[4]**

(a) $\mu_{s1\cup s2}(x)$ (b) $\mu_{s1\cap s2}(x)$ (c) $\mu_{\overline{s1\cup s2}}(x)$ (d) $\mu_{\overline{s1\cap s2}}(x)$

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