B.E. Instrumentation Engineering (Model Curriculum) Semester-VII

IN703M - Artificial Intelligence in Instrumentation

P. Pages : 3 **GUG/W/23/14258**

Time : Three Hours * 7 8 2 5 * Max. Marks : 80

Notes : 1. Same answer book must be used for each section.
2. All questions carry marks as indicated.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Define fuzzy logic. Discuss the potential advantages of fuzzy logic based systems over classical approach. **8**

b) Define the following term: **8**
1) Equality of fuzzy sets
2) Containment of a fuzzy set.

OR

2. a) Define Membership function. Discuss following MFs in detail. **8**
1) Trapezoidal MF
2) Gaussian MF
3) Generalized bell-shaped MF
4) Sigmoidal MF

b) Fuzzy sets A = {0.7/1+0.5/2+0.1/3+0.6/4} and B = {0.4/1+0.9/2+0.3/3+0.7/4} **8**
Calculate the following Set Theoretic Operations of Fuzzy Sets

a) $\bar{A} \cup B$ b) $A \cap \bar{B}$

c) $A \mid \bar{B}$ d) $B \mid \bar{A}$

3. a) Find Sugeno's class of complement of fuzzy set A given below for the values of **8**
$\lambda = \{-0.8, 0, 1, 2\}$
A = 0.8/1+0.4/2+0.3/3+0.6/4

b) Two fuzzy relations $R_1(x, y)$ and $R_2(y, z)$ are defined on the space X * Y and Y * Z **8**
respectively defined as below:

$$R_1(x, y) = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{cccc} y_1 & y_2 & y_3 & y_4 \end{array} \\ \begin{bmatrix} 0.7 & 0.6 & 0.3 & 0.4 \\ 0.9 & 0.4 & 0.2 & 0.7 \\ 0.1 & 0.9 & 0.5 & 0.6 \end{bmatrix} \end{array}$$

Find the Max-product composition of R_1 and R_2

OR

4. a) Find the intersection of fuzzy sets A and B for the universe of discourse X = {1, 2, 3, 4} using T – norm operators. **8**

A = 0.7/1+0.5/2+0.1/3+0.6/4

B = 0.8/2+0.3/3

b) Two fuzzy sets A and B with universe of discourse X' and Y, respectively defined as **8**

$A = 0.2 / x_1 + 0.4 / x_2 + 0.5 / x_3$

$B = 0.5 / y_1 + 0.1 / y_2 + 0.7 / y_3$

Find the following:

i) Fuzzy relation R between A & B

ii) Projection of fuzzy relation R on A

iii) Projection of fuzzy relation R on B

iv) Cylindrical extension of R_B in the direction of fuzzy set A i.e. $C(R_B)$

5. a) Draw and discuss the following models of neurons: **8**

1) Hard-limiting neuron 2) Soft-limiting neuron

b) Draw and discuss the architecture of feed forward neural network. **8**

OR

6. a) Define activation function. Discuss different types of activation functions. **6**

b) Compute the new updated weights for the network shown in Figure 1 using Hebbian learning rule with the initial weight vector. **10**

$W^1 = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$. The network needs to be trained using the set of three input vectors as below:

$x_1 = \begin{bmatrix} 1 \\ -2 \\ 1.5 \\ 0 \end{bmatrix}, x_2 = \begin{bmatrix} 1 \\ -0.5 \\ -2 \\ -1.5 \end{bmatrix}, x_3 = \begin{bmatrix} 0 \\ 1 \\ -1 \\ 1.5 \end{bmatrix}$, with learning constant c = 1.

Assume that bipolar binary neurons are used and thus f(net) = sgn(net).

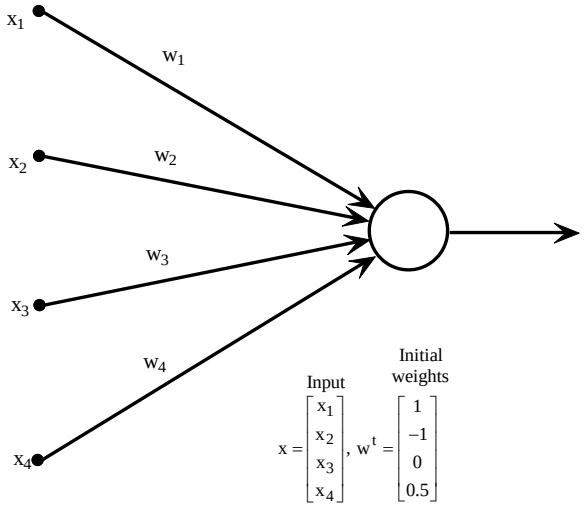

Figure 1

7. a) Design and demonstrate a perceptron for performing "AND" function. Also state the limitations single layer perceptron. **10**

b) If $f(\text{net}) = \frac{2}{1+\exp(-\text{net})} - 1$ with $\lambda = 1$ **6**

Then prove the following identity

$$f'(\text{net}) = \frac{1}{2}\left(1 - o^2\right)$$

OR

8. Discuss the feed forward neural network with two continuous perceptron layers with respect to following points: **16**

i) Architecture of two layer feed forward neural network

ii) Illustrate error back propagation training algorithm using flowchart.

9. a) Discuss with an example the principle of supervised learning with respect to machine learning. **8**

b) Discuss the concepts of Machine learning with suitable example. **8**

OR

10. a) Discuss with an example the principle of reinforcement learning with respect to machine learning. **8**

b) Discuss the types of machine learning with suitable example. **8**

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