Question Paper

Exam Date & Time: 10-Jan-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SEVENTH SEMESTER B.TECH MAKEUP EXAMINATIONS, JAN 2024

Neural Networks and Fuzzy Logic [ICT 4052]

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Using the data given Table Q.1A, show that the first iteration of back propagation algorithm to compute the membership values for the input variables x1,x2 and x3 in the output regions R1 andR2. Use a $3\ x\ 3\ x\ 2$ neural network. Assume a random set of weights. (5)

A)

Table Q.1A.

x1	x2	x3	R1	R2
1.0	0.5	2.5	1.0	0.0

B) Consider two fuzzy sets A and B defined by the membership functions both defined on x are as follows: (3)

P(x)	x1	x2	x3	x4	X5	X6
A	0.1	0.6	0.8	0.9	0.7	0.1
B	0.9	0.7	0.5	0.2	0.1	0.0

Show that the λ-cut obey the following properties

i. $(\bar{A} \cup \overline{B})_{0.3} = A_{0.3} \cup B_{0.3}$

ii. $(\bar{A} \cap \overline{B})_{0.4} = A_{0.4} \cup B_{0.4}$

iii. $\overline{(A)}_{0.6} \neq \bar{A}_{0.6}$

C) Using the inferences approach find the membership values for each of the triangular shapes(I,R,IR, E,T) for each of following triangles: (2)

i. A=50° B=80° C =50°

ii. A=70° B=60° C =50°

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2) Let two sets P = {P1, P2, P3, P4} and D = {D1, D2, D3, D4} represent a set of variety of paddy plants and a set of plant diseases. In addition to these, also consider another set S = {S1, S2, S3, S4} to be the common symptoms of the diseases. Let, R be a relation on P x D, representing which plant is susceptible to which diseases, then R can be stated as, (5)

A)

$$\bar{R} = \begin{array}{c} \\ P_1 \\ P_2 \\ P_3 \\ P_4 \end{array} \begin{array}{c} \begin{array}{cccc} D_1 & D_2 & D_3 & D_4 \end{array} \\ \begin{bmatrix} 0.6 & 0.6 & 0.9 & 0.8 \\ 0.1 & 0.2 & 0.9 & 0.8 \\ 0.9 & 0.3 & 0.4 & 0.8 \\ 0.9 & 0.8 & 0.4 & 0.8 \end{bmatrix} \end{array}$$

Also, consider T to be another relation on D x S, which is given by

$$\bar{T} = \begin{array}{c} \\ D_1 \\ D_2 \\ D_3 \\ D_4 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 0.1 & 0.2 & 0.7 & 0.9 \\ 1.0 & 1.0 & 0.4 & 0.6 \\ 0.0 & 0.0 & 0.5 & 0.9 \\ 0.9 & 1.0 & 0.8 & 0.2 \end{bmatrix} \end{array}$$

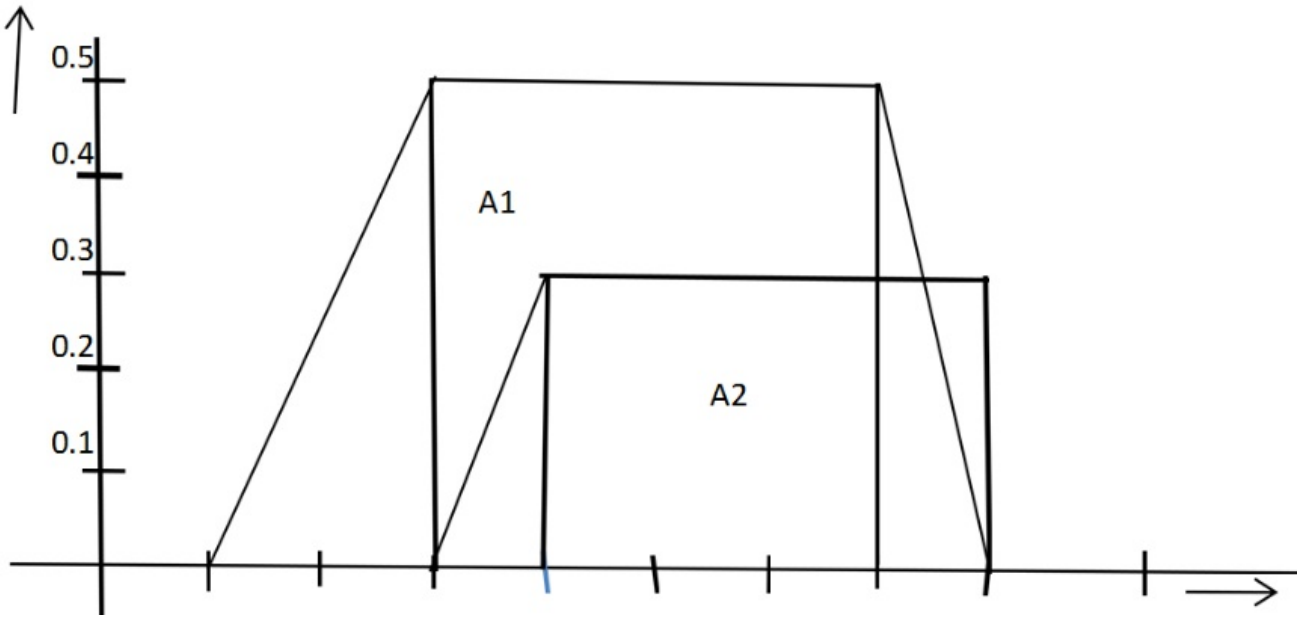
Find the association of plants with the different symptoms of the disease using max-min and max-product composition.

B) Consider the data set $\{(x_i, d_i) \mid i = 1, \ldots, N\}$ where $x \in \mathbb{R}^m$. You are required to design a RBFN. The hidden space dimensionality of the required RBFN could be any value higher than m. How will you find the optimal value of the hidden space dimension? (3)

C) Describe the Error correction learning and memory based learning. (2)

3) Let A be a fuzzy set that tells about a student as shown in Figure Q. 3A. Compute the following: (5)

A) $x^* = \frac{\sum_{i=1}^{n} x_i . \mu(x)_i}{\sum_{i=1}^{n} \mu(x)_i}$



B) A Bayes classifier for Gaussian distributed data has following relation $log\Lambda(x) = (\mu_1 - \mu_2)^T C^{-1} x + \frac{1}{2}(\mu_2^T C^{-1}\mu_2 - \mu_1^T C^{-1}\mu_1)$ (3)

where $log\Lambda(x)$ is the log likelihood ratio of conditional density function. Now consider two one-dimensional Gaussian-distributed classes C1 and C2 that have a common variance equal to 1. Their mean values are μ_1 =-10 and μ_2 = 10 respectively. These two classes are essentially linearly separable. Design a classifier that separates these two classes.

C) Consider a Fuzzy set $B = \left\{\frac{0.1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{0.3}{5} + \frac{0.4}{6} + \frac{0.5}{7}\right\}$. (2)

Find the following

i. Core element of the set

ii. Boundary element of the set

iii. Support element of set

Whether the given fuzzy set is normal fuzzy set?

4) Consider the neural network shown in Figure Q. 4A. Perform one pass back propagation algorithm and redraw the network with updated weights. Assume tanh function as the activation function defined as follows: (5)

A)

$$f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

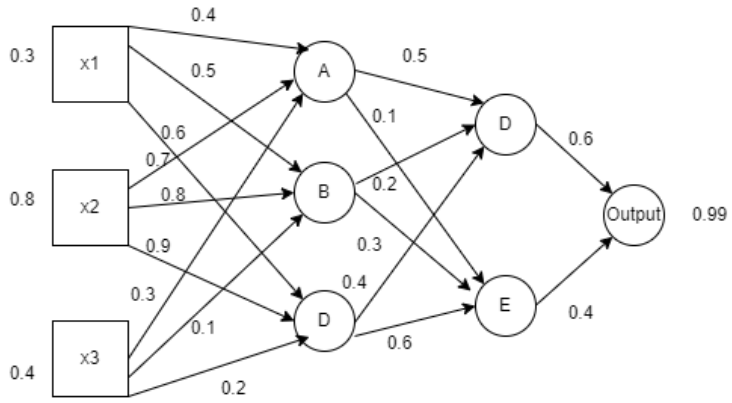


Figure Q.4A

Figure Q. 4A

B) Figure Q.4B shows the signal flow graph of 2-2-2-2--1 feedforward network. (3)
The function $\varphi(.)$ denotes a logistic function.

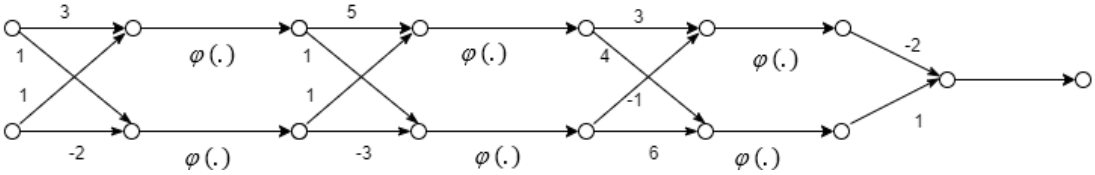


Figure Q. 4B.

i. Write the input output mapping defined by this network

ii. Suppose that the output neuron in the given signal-flow graph operates in its linear region. Write the input output mapping defined by this network.

C) Derive the expression for weight updates as per the least mean square algorithm. (2)

5) Consider the following two discrete fuzzy sets, which are defined on universe X = {–5, 5}: (5)

A) $$A = "zero" = \left\{\frac{0}{-2} + \frac{0.5}{-1} + \frac{1.0}{0} + \frac{0.5}{1} + \frac{0}{2}\right\}$$

$$B = "positive\ medium" = \left\{\frac{0}{0} + \frac{0.5}{1} + \frac{1.0}{2} + \frac{0.5}{3} + \frac{0}{4}\right\}$$

i. Construct the relation for the rule IF A, THEN B (i.e., IF *x* is "zero" THEN *y* is "positive medium") using the Mamdani implication,

ii. If we introduce a new antecedent,

$$A' = "positive\ small" = \left\{\frac{0}{-1} + \frac{0.5}{0} + \frac{1.0}{1} + \frac{0.5}{2} + \frac{0}{3}\right\}$$

Find the new consequent B' using max-min composition,

For the relation obtained in (i).

B) You are required to design a perceptron for the OR function, which takes binary inputs and gives bipolar outputs. Assume that the perceptron has a bias b=1. Obtain the synaptic weights of the perceptron after one epoch. (3)

C) With respect to SVM, briefly explain the slack variable. (2)

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