Question Paper

Exam Date & Time: 05-Dec-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SEVENTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV / DEC 2023

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) A) Assume that we want to compare the strength of two types of concrete. Four concrete masonry units (CMUs) from each type of concrete are stressed until they fail. The lowest stress at failure of a CMU is denoted 1, and the highest stress at failure is denoted 4, (5)

so the CMUs are rank ordered by failure stress, that is, X = {1, 2, 3, 4}. Since "failure" of CMUs is fuzzy, the membership value for a specific CMU represents the judgment that the CMU really failed. The following fuzzy sets represent the failure estimates for the two different concrete types:

$$A = \left\{\frac{0.15}{1} + \frac{0.25}{2} + \frac{0.6}{3} + \frac{0.9}{4}\right\}$$

$$B = \left\{\frac{0.2}{1} + \frac{0.3}{2} + \frac{0.5}{3} + \frac{0.8}{4}\right\}$$

For these two fuzzy sets compute

1. $\overline{A \cup B}$
2. $\bar{A} \cup \bar{B}$
3. $A|B$
4. $A \cap \bar{B}$
5. $\bar{A} \cup B$
6. $\overline{A \cap B}$

B) For a neural networks describe the three rules of knowledge representation that are common sense in nature. (3)

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

Find the following

1. Core element of the set
2. Boundary element of the set
3. Support element of set

4. Whether the given fuzzy set is normal fuzzy set?

2) In the city of Calgary, Alberta, there are a significant number of neighbourhood ponds that store overland flow from rainstorms and release the water downstream at a controlled rate to reduce or eliminate flooding in downstream areas. To illustrate a relation (5)

A)

using the Cartesian product, let us compare the level in the neighbour hood pond system based on a 1-in-100 year storm volume capacity with the closest three rain gauge stations that

measure total rainfall. Let A = pond system relative depths based on 1-in-100 year capacity (assume the capacities of four ponds are p1, p2, p3, and p4, and all combine to form one outfall to the trunk sewer). Let B= total rainfall for event based on 1-in-100 year values from three different rain gauge stations, g1, g2, and g3. Suppose we have the following specific fuzzy sets:

$$A = \left\{\frac{0.2}{p1} + \frac{0.6}{p2} + \frac{0.5}{p3} + \frac{0.9}{p4}\right\}$$

$$B = \left\{\frac{0.4}{g1} + \frac{0.7}{g2} + \frac{0.8}{g3}\right\}$$

1. Find Cartesian product of these two fuzzy sets $C = AXB$

Suppose we have a relationship between the capacity of five more ponds within a new pond system (p5, . . . , p9) and the rainfall data from the original rainfall gauges (g1, g2, and g3). This relation is given as

$$\underset{\sim}{D} = \begin{array}{c} \\ g_1 \\ g_2 \\ g_3 \end{array} \begin{array}{c} \begin{array}{ccccc} p_5 & p_6 & p_7 & p_8 & p_9 \end{array} \\ \begin{bmatrix} 0.3 & 0.6 & 0.5 & 0.2 & 0.1 \\ 0.4 & 0.7 & 0.5 & 0.3 & 0.3 \\ 0.2 & 0.6 & 0.8 & 0.9 & 0.8 \end{bmatrix} \end{array}.$$

2. Find max-min composition for the two ponding systems $E = C \circ D$

B) You are required to design a perceptron for the AND 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) State primal and dual problems in reference to SVM for non separable data (2)

3) Let A be a fuzzy set that tells about a student as shown in Figure Q. 3A and the elements with corresponding maximum membership values are also given. (5)

A)

$$A = \{(P, 0.6), (F, 0.4), (G, 0.2), (VG, 0.2), (E, 0)\}$$

Here, the linguistic variable P represents a Pass student, F stands for a Fair student, G represents a Good student, VG represents a Very Good student and E for an Excellent student.

Compute $X^* = \dfrac{\sum \mu(x).x}{\sum \mu(x)}$

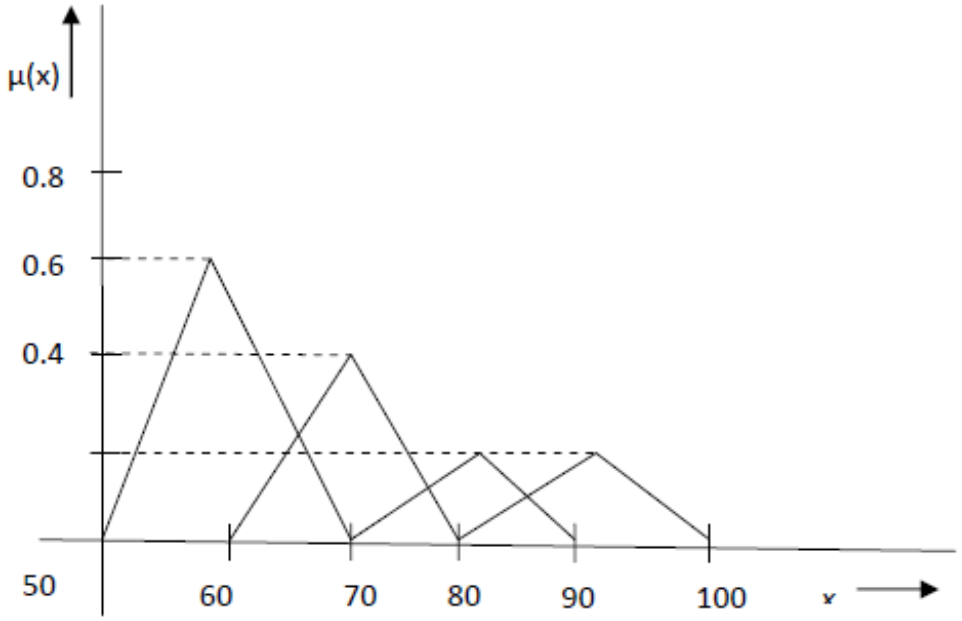

Figure Q.3A.

B) Using the inferences approach find the membership values for each of the triangular shapes(I,R,IR, E,T) for each of following triangles: (3)

1. A=60° B=70° C =50°
2. A=80° B=60° C =40°

C) State Cover's theorem and discuss its applicability with respect to neural networks. (2)

4) Consider the neural network shown in Figure Q.4A. Perform one pass of Back propagation algorithm and redraw the network with updated weights. Consider sigmoid function as the activation function. (5)

A)

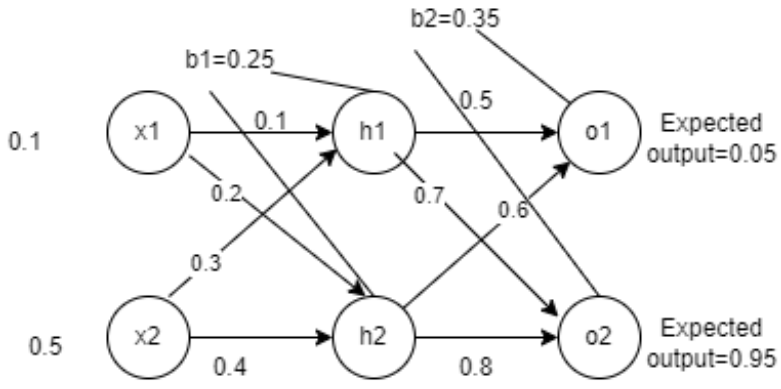

Figure Q.4A

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
A	0.2	0.8	1.0
B	0.4	0.6	0.9

Express following λ-cut set using Zadeh's notation

1. $\overline{(B \cap B)}_{0.4}$
2. $A_{0.7}$
3. $\overline{(B)}_{0.3}$
4. $(A \cap \overline{B})_{0.3}$
5. $\overline{(A \cup B)}_{0.2}$
6. $\overline{(B \cup A)}_{0.5}$

C) List the characteristics of a Hebbian synapse. Apply Hebb's learning and comment on the behaviour of synaptic weight updation for the datapoints (x,y)=(7,4) with mean $\bar{x} = 3$ and $\bar{y} = 5$ respectively. (2)

5) the susceptibility of the columns to buckling under axial loads. The normalized ratios are on the universe, X = {0, 1, 2, 3}. These ratios are characterized as "small" (5)

A) to "large":

$$small = \left\{\frac{1}{0} + \frac{0.9}{1} + \frac{0.8}{2} + \frac{0.4}{4} + \frac{0.7}{3}\right\}$$

$$large = \left\{\frac{0}{0} + \frac{0.1}{1} + \frac{0.2}{2} + \frac{0.3}{3}\right\}$$

Calculate the membership functions for the following phrases:

1. very small
2. fairly small = ([small]$^{2/3}$)
3. very, very large
4. not fairly large and very, very small.

B) Show that Radial Basis Function solves the XOR problem without increasing the dimension of feature space. (3)

C) List the characteristics of competitive learning mechanism. (2)

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