M.Sc. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)

M.Sc. (MACS)

Term-End Examination

June, 2021

MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

Time : 2 hours *Maximum Marks : 50*

(Weightage : 50%)

Note :

*(i) Question no. **7** is **compulsory**.*

*(ii) Attempt any **four** questions from questions no. 1 to 6.*

(iii) Use of non-programmable scientific calculator is allowed.

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1. (a) Determine $A \cup \bar{B}$; $\bar{A}$; $A \cap \bar{B}$ and $A \cup \bar{A}$,

for the fuzzy sets A and B given below : *4*

$$A = \left\{ \frac{0 \cdot 1}{0}, \frac{0 \cdot 2}{1}, \frac{0 \cdot 4}{2}, \frac{0 \cdot 6}{3}, \frac{1}{4} \right\} \text{ and}$$

$$B = \left\{ \frac{1}{0}, \frac{0 \cdot 5}{1}, \frac{0 \cdot 7}{2}, \frac{0 \cdot 3}{3}, \frac{0}{4} \right\}$$

(b) A 3-input, 2-output neural network has the weight values $w_{11} = 0.6$, $w_{12} = 1.1$, $w_{21} = 0.7$, $w_{22} = 0.5$, $w_{31} = 0.8$ and $w_{32} = 0.2$. The input is $[0.3 \ 0.7 \ 1.6]^T$. What is the output of the neural network, if the step function is used ? You may assume a threshold of 1.5. *4*

(c) Find the length and order of the following schema : *2*

   (i) $S_1 = 1 * * 0 \ 0 * 1 * *$

   (ii) $S_2 = * 0 \ 0 * 1 * *$

2. (a) Consider the fuzzy sets A and B defined on the interval [0, 4] of real numbers by the following membership function :

$$\mu_A(x) = \frac{x}{x + 2}, \ \mu_B(x) = 3^{-x}$$

Determine the mathematical expression for the membership functions of $\bar{A}$ and $\bar{B}$. Also draw their graphs. *4*

(b) Consider a 2-input neuron with threshold 1.5. The weight matrix is [2, 3] and the input is [6, – 5]. Calculate the neuron output for the following transfer functions : *6*

   (i) A linear transfer function

   (ii) Tan sigmoid transfer function

   (iii) Hard limit transfer function

3. (a) Consider the following travelling salesman problem involving 10 cities :

Parent 1	A	B	C	D	E	F	G	H	I	J
Parent 2	C	D	E	A	B	I	J	H	G	F

Determine the children solution using

(i) Order crossover #1, where two crossover sites are at 4th and 7th positions.

(ii) Order crossover #2, for key positions 2nd, 4th, 6th and 8th. *4*

(b) Determine the new cluster centre using Fuzzy C-mean algorithm for the following data :

Points	X_1	X_2	X_3	X_4	X_5
Feature f_1	3	5	7	9	1
Feature f_2	2	3	4	5	6

You may use the initial cluster centres as $V_1 = (5, 5)$ and $V_2 = (2, 2)$, respectively. The number of clusters is 2 and the value of the parameters for membership grade is 2. Perform only one iteration. *6*

4. (a) What are Radial Basis Functions (RBF) ? Write mathematical expressions for the following RBFs : *5*

   (i) Thin plate spline function

   (ii) Gaussian function

   (iii) Multi-Quadratic function

   (iv) Inverse-Multi-Quadratic function

   (b) Implement AND function using McCulloch-Pitts neuron. *5*

5. (a) A Hopfield network has the following standard binary pattern :

   $S = [1\ 1\ 1;\ 1\ 0\ 1;\ 1\ 0\ 0]$

   Find the weight matrix. *5*

   (b) Write the schema for the Gene Sequence (1000111) and (0001100). *2*

   (c) Discuss the XOR problem, with suitable example. *3*

6. (a) Consider the following population of binary strings for a maximization problem :

String	01101	11000	10110	00111	10101	00010
Fitness	5	2	1	10	3	100

   Find the expected number of copies of the best string using (i) Roulette wheel selection, and (ii) Tournament selection. *6*

(b) Derive the back propagation algorithm for the neurons in the hidden layer and output layer using linear function. *4*

7. State whether the following statements are *True* or *False*. Give a short proof or a counter example to justify your answer. *5×2=10*

(a) The membership function of a fuzzy set belongs to the interval [0, 1].

(b) ADALINE makes use of unsupervised learning.

(c) K-Nearest Neighbour is a clustering technique.

(d) Hopfield networks are recurrent neural network models that possess auto-associative property.

(e) Length and Order of Schema S = ∗ 1 ∗ 0 1 ∗ are 3 and 3, respectively.

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