MMTE–007

M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)
[M. Sc. (MACS)]
Term-End Examination
June, 2024

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 Question Nos. **1** to **6**.*

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

1. (a) Determine the following : 4

(i) $A \cup B$

(ii) $A \cap B$

(iii) Complement of set A and B

(iv) Universe of discourse of set A and B

Where, A and B are the fuzzy sets, given below :

$$A = \left\{ \frac{RAM}{0.5}, \frac{SHYAM}{0.9}, \frac{JOHN}{0.7}, \right.$$

$$\left. \frac{ARIF}{0.1}, \frac{JEET}{0.8} \right\}$$

$$B = \left\{ \frac{RAM}{0.75}, \frac{SHYAM}{0.4}, \frac{JOHN}{0.3}, \right.$$

$$\left. \frac{ARIF}{0.6}, \frac{JEET}{0.7} \right\}$$

(b) Consider the travelling salesman problem, given below :

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

where, A, B, C, D, E, F, G, H, I are ten cities under consideration.

Find the children solution using order crossover (#1), assuming 4th and 8th sites as crossover and cyclic crossover with 4th position as initial position.   4

(c) Write at least *four* chromosomes sets, which are identified by schema S = (10 * 0 *).   2

2. Write back propagation algorithm. Given the weighted structure and initial input as follows :

          10

(i) Weighted structure :

$$[W]^0 = \begin{bmatrix} -0.25 \\ -0.40 \end{bmatrix}, \text{ bias } \phi_{(0)}^{(1)} = \begin{bmatrix} -0.50 \\ -0.1 \end{bmatrix}$$

$$[V]^0 = [0.1 - 0.2], \text{ bias } \phi_{(0)}^{(2)} = [0.5]$$

(ii) Initial input = 1

Approximate the function $f(x) = 1 + \cos \pi x$ for $-1 \leq x \leq 1$, by solving 1-2-1 network, using back propagation algorithm.

3. (a) Explain Hopfield networks. Consider a Hopfield network with Weight matrix (W) as follows :

$$W = \frac{1}{3}\begin{bmatrix} 0 & -2 & 2 \\ -2 & 0 & -2 \\ 2 & -2 & 0 \end{bmatrix}$$

and two test input vectors $P_1 = [1 \ -1 \ 1]$; $P_2 = [-1 \ 1 \ -1]$ Verify that the output state vectors satisfies the alignment condition.   6

(b) List and justify, which of the genetic operator (Viz. selection, crossover and mutation) on their combination, will be required for the following :   4

   (i) To fill the population with copies of the best individual from the population.

   (ii) To cause the algorithms to converge on a good but sub-optimal solution.

4. (a) Verify whether the Genetic Algorithm (GA) improves the solution from one generation to the next generation, for the maximization of function $f(x)$ given below :

$$f(x) = \sqrt{x}; 1 \le x \le 16$$

Assume that chromosomes of length 6 are created at random and modified by Roulette-Wheel selection. 6

(b) Determine the length and order of the following schema : 4

(i) S_1 = *1*01*

(ii) S_2 = ***0****

(iii) S_3 = *00*1**

(iv) S_4 = 1**00*1**

5. Write Fuzzy C-Mean (FCM) Algorithm. Use FCM to find the new cluster center (perform only one iteration). The relevant data is given below : 10

(a) Dataset for feature f_1 and f_2 is as follows :

Point	x_1	x_2	x_3	x_4	x_5	x_6
f_1	2	4	7	11	12	14
f_2	12	9	13	5	7	4

(b) Initial cluster centers are V_1 = (6, 6) and V_2 = (11, 11).

(c) The number of clusters are two and value of parameter which influences membership grade (m) is 2.

6. (a) What are Kohonen neural networks ? Given the relevant data below, for a Kohonen network, find the output of the neurons in the network.   6

   (i) Input to Neuron-1 (I_1) = 0.5

   Input to Neuron-2 (I_2) = 0.75

   (ii) Connected weights between Neurons are :

   $I_1 \rightarrow O_1 : 0.1$

   $I_2 \rightarrow O_1 : 0.2$

   $I_1 \rightarrow O_2 : 0.3$ and

   $I_2 \rightarrow O_2 : 0.4$

(b) Determine the α-cut of the Fuzzy set (A) as given below, at 0.7 and 0.2 :   4

$$A = \left\{ \frac{0}{10}, \frac{0}{20}, \frac{0.2}{30}, \frac{0.8}{40}, \frac{1.0}{50}, \frac{1.0}{60}, \right.$$

$$\left. \frac{0.6}{70}, \frac{0.2}{80}, \frac{0}{90}, \frac{0}{100} \right\}$$

Compare the α-cut of two outcomes and give comments for the status of α-value variation.

7. State whether the following statements are True or False. Give reasons for your answers :

$$2\times5=10$$

(a) If $w(k_0) = w(k_0 + 1) = w(k_0 + 2)$, then perceptron is non-linearly separable.

(b) Only linearly separable data can be classified by multilayer perceptron.

(c) If $\alpha_1 > \alpha_2$ then subset relation is $A\alpha_1 \supseteq A\alpha_2$.

(d) The length of chromosomes to determine the maximum value of the set (S)
$S = \{x \mid 0 \leq x \leq 4096\}$ is 12.

(e) Self-organizing system is a special class of artificial neural network based on competitive learning.