No. of Printed Page : 1

**MMTE-007 (P)**

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

## Term-End Examination

## August, 2011

00785

## MMTE-007 (P) : SOFT COMPUTING AND APPLICATIONS

*Time : 1½ hours* *Maximum Marks : 40*

***Note :*** *This question paper has* ***one*** *question worth* ***30*** *marks. Remaining* ***10*** *marks are for* ***viva-voce.***

**1.** Consider a data set of six points given in the following table. Each point has two features $f_1$ and $f_2$. Assume the values of the parameters C and m as 2. Let the initial cluster centers be $V_1 = (5, 5)$ and $V_2 = (10, 10)$. **30**

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

Write a program in 'C' language to find the new cluster centers by applying FCM algorithm.

No. of Printed Pages : 5

**MMTE-007**

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

# M.Sc. (MACS)

## Term-End Examination

00659

## December, 2011

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* *Maximum Marks : 50*

***Note :*** *Attempt **any four** questions from Q. No. **1** to Q. No. **6**. Q. No. 7 is **compulsory**.*

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**1.** (a) Consider two fuzzy sets **6**

$$A = \left\{\frac{1}{2} + \frac{0.5}{3} + \frac{0.6}{4} + \frac{0.2}{5} + \frac{0.6}{6}\right\} \quad \text{and}$$

$$B = \left\{\frac{0.5}{2} + \frac{0.8}{3} + \frac{0.4}{4} + \frac{0.7}{5} + \frac{0.3}{6}\right\}$$

Find complement, union, intersection and difference of the above two fuzzy sets.

(b) Define the following giving an example of each **4**

(i) Learning Rate

(ii) Momentum

(iii) Stability

(iv) Convergence

2. (a) Consider fuzzy relation **4**

$$R = \begin{array}{c c} & \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{array}{c} x_1 \\ x_2 \end{array} & \begin{bmatrix} 0.7 & 0.6 \\ 0.8 & 0.3 \end{bmatrix} \end{array} \text{ and}$$

$$S = \begin{array}{c c} & \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{array}{c} y_1 \\ y_2 \end{array} & \begin{bmatrix} 0.8 & 0.5 & 0.4 \\ 0.1 & 0.6 & 0.7 \end{bmatrix} \end{array}$$

Find the relation T = RoS using max-min and max-product composition.

(b) Improve the solution of the following problem **6**

$f(x) = \sqrt{x}$

subject to $1 \leq x \leq 32$. Show working solution for only two iterations using genetic algorithm.



3. (a) For the given fuzzy sets **6**



$$A = \left\{\frac{1}{1.0} + \frac{0.65}{1.5} + \frac{0.4}{2.0} + \frac{0.35}{2.5} + \frac{0}{3.0}\right\}$$

$$B = \left\{\frac{0}{1.0} + \frac{0.25}{1.5} + \frac{0.6}{2.0} + \frac{0.25}{2.5} + \frac{1}{3.0}\right\}$$

$$C = \left\{\frac{0.5}{1.0} + \frac{0.25}{1.5} + \frac{0}{2.0} + \frac{0.25}{2.5} + \frac{0.5}{3.0}\right\}$$

Prove the associativity and the distributivity properties for A, B and C.

(b) Consider the following travelling sales man problem involving 9 cities. 4

Parent 1 : F I G E D C A H B

Parent 2 : C B G I H F D E A

Determine the children solution using order crossover (# 1), assuming $2^{nd}$ and $8^{th}$ sites as crossovers.

4. (a) Consider the following training data set : 6

| $I_1$ | $I_2$ | Output |
|---|---|---|
| 0.6 | 0.1 | 0.3 |

Assume two nodes at a given multilayer perceptron ,with weights between input layer and hidden layer given by

$$\begin{bmatrix} 0.2 & -0.3 \\ 0.1 & 0.5 \end{bmatrix}$$ and

weights between hidden layer and output node given by $\begin{bmatrix} -0.3 \\ 0.2 \end{bmatrix}$

Show the output at each node of MLP and updated weights after one iteration.

(b) Input to a single - input neuron is 2, its weight is 2.3 and its bias (β) is $-3$. What is the net input to the transfer function ? Also, find the output of the neuron, if it has the following transfer functions (i) hard limiting (ii) linear (iii) log-sigmoid function. 4

5. (a) Consider a data set of six points given in the following table, each of which has two features $f_1$ and $f_2$. Apply FCM algorithm to determine the new cluster center after one iteration. The initial cluster centers are given by $v_1 = (4, 5)$ and $v_2 = (11, 10)$. 6

| | $f_1$ | $f_2$ |
|---|---|---|
| $x_1$ | 2 | 12 |
| $x_2$ | 4 | 19 |
| $x_3$ | 7 | 13 |
| $x_4$ | 11 | 5 |
| $x_5$ | 12 | 7 |
| $x_6$ | 14 | 4 |

(b) Consider the ADALINE filter with two neurons in the input layer having the weights $w_{11} = 3$, $w_{12} = 2$. The input sequence is $\{---, 0, 0, 5, -4, 0, 0, ---\}$. Find the filter output from 0 to 5. 4

6. (a) Consider a Hopfield network whose weight matrix is given by 6

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

Consider two test input vectors $PT_1 = (1 \quad -1 \quad 1)$ and $PT_2 = (-1 \quad 1 \quad -1)$. Check if the output state vectors satisfy alignment conditions.

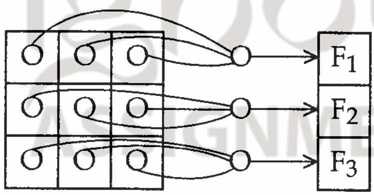
(b) Write the schema for the Gene sequence (1 0 0 0 1 1 1), and (0 0 0 1 1 0 0). **2**

(c) Write at least four chromosomes sets, which are identified by schema S = (1 0 * 0 *). **2**

**7.** Which of the following statements are true or false. Give reasons for your answers. **10**

(a) If a 3 - input neuron is trained to output a zero when the input is 110 and output one when the input is 111, then after generalization, the output will be zero when the input is 000 or 010 or 110 or 100.

(b) The following figure represents a single layer feed forward neural network.




(c) If the inputs of 4 - input neurons having weights 1, 2, 3 and 4 are 4, 10, 5 and 20 respectively, then the output will be 119 for the linear transfer function with the constant of proportionality being equal to 2.

(d) IF $\alpha_1 < \alpha_2$, then the subset relation is $A_{\alpha_1} \subseteq A_{\alpha_2}$.

(e) The length of chromosomes to determine maximum value of the set $S = \{x/0 \le x < 4096\}$ is 12.

No. of Printed Page : 2

**MMTE–007 (P)**

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

00758

## Term-End Examination

## December, 2011

## MMTE–007 (P) : (MACS)

*Time : 1½ hours* *Maximum Marks : 40*

*Note : This question paper has **one** question worth **30** marks. Remaining **10** marks are for viva–voce.*

**1.** Consider the following two - dimensional data set that consists of 15 points in $\mathbf{R}^2$. **30**

| k | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x_{k1}$ | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 5 | 6 | 6 | 6 |
| $x_{k2}$ | 0 | 2 | 4 | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 0 | 2 | 4 |

Assume that we want to determine a fuzzy pseudo partition with two clusters. Also, assume m =1.25, and the initial fuzzy pseudo

Partition is $P^{(0)} = \{A_1, A_2\}$ with

$$A_1 = \sum_{i=1}^{15} \frac{0.854}{x_i}$$

$$A_2 = \sum_{i=1}^{15} \frac{0.146}{x_i}$$

Write a program in 'C' language to obtain the final fuzzy pseudo partition and the cluster centres assuming that convergence is achieved when the difference between two values is $\leq 0.001$.

No. of Printed Pages : 7

**MMTE-007**

00831

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

## Term-End Examination

## June, 2012

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* | *Maximum Marks : 50*

***Note :*** *Attempt* ***any four*** *questions from Q. No.* **1** *to Q. No.* **6***. Q. No. 7 is* ***compulsory.***

---

**1.** Suppose a genetic algorithm uses chromosomes of the form $x = \text{a b c d e f g h}$ with a fixed length of eight genes. Each gene can be of any digit between 0 and 9. Let the fitness of individual $x$ be calculated as $f(x) = (a+b)-(c+d)+(e+f)-(g+h)$ and let the initial population consist of four individual with the following chromosomes : **10**

$$x_1 = 6\ 5\ 4\ 1\ 3\ 5\ 3\ 2$$

$$x_2 = 8\ 7\ 1\ 2\ 6\ 6\ 0\ 1$$

$$x_3 = 2\ 3\ 9\ 2\ 1\ 2\ 8\ 5$$

$$x_4 = 4\ 1\ 8\ 5\ 2\ 0\ 9\ 4$$

(a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

(b) Perform the following cross over operations :

(i) Cross the fittest two individuals using one point crossover at the middle point.

(ii) Cross the second and third fittest individuals using a two point crossover (points b and f).

(iii) Cross the first and third fittest individuals (ranked $1^{st}$ and $3^{rd}$) using a uniform crossover.

(c) Suppose the new population consists of six offspring individuals received by the crossover operations in (i) above. Evaluate the fitness of the new population. Check whether the overall fitness improved.

(d) Find the chromosomes representing the optimal solution. Find the value of this fitness.

(e) By looking at the initial population of the algorithm check whether it will be able to reach the optimal solution without the mutation operator.

2. (a) The input vectors are $I_1 = [-1\ 0]^t$, $I_2 = [0\ 1]^t$ and $I_3 = \left[\sqrt{2}\ \ 1/\sqrt{2}\right]^t$ and initial values of three weight vectors are $[0 - 1]^t$, $\left[-2/\sqrt{5}, \frac{1}{\sqrt{5}}\right]^t$, $\left[-\frac{1}{\sqrt{5}}, \frac{2}{\sqrt{5}}\right]^t$, calculate the resulting weights found after training the competitive layer with Kohonen's rule and a learning rate $\alpha$ of 0.5 on the input - series in order $I_1$, $I_2$ and $I_3$. 6

(b) What are the important operators involved in genetic algorithm ? Discuss various schemes for selecting chromosomes from a pool of chromosomes. 4

3. (a) Consider the following training data set : 5

| | Inputs | | Output |
|---|---|---|---|
| | $I_1$ | $I_2$ | |
| 1 | 0.4 | -0.7 | 0.1 |

In a given Multilayer perception with two nodes at a hidden layer and weights between input layer and hidden layer given by $\begin{bmatrix} 0.1 & 0.4 \\ -0.2 & 0.2 \end{bmatrix}$ and weights between hidden and output node given by $\begin{bmatrix} 0.2 \\ -0.4 \end{bmatrix}$.

(i) Find the output at each node of MLP.

(ii) Find the updated weights after one iteration.

(b) Using max-min composition, find relation between R and S 5

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \end{array} \quad \text{and} \quad S = \begin{array}{c} \\ y_1 \\ y_2 \\ y_3 \end{array} \begin{array}{c} \begin{array}{cc} z_1 & z_2 \end{array} \\ \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} \end{array}.$$

4. (a) Let X be the universe of commercial aircraft of interest. 6

$X = \{ a_{10}, b_{52}, b_{117}, c_5, c_{130}, f_4, f_{14}, f_{15}, f_{16}, f_{111}, kc_{130} \}$. Let A be the fuzzy set for passenger class aircraft

$$A = \left\{ \frac{0.3}{f_{16}} + \frac{0.5}{f_4} + \frac{0.4}{a_{10}} + \frac{0.6}{f_{14}} + \frac{0.7}{f_{111}} + \frac{1.0}{b_{117}} + \frac{1.0}{b_{52}} \right\}.$$

Let B be the fuzzy set of cargo

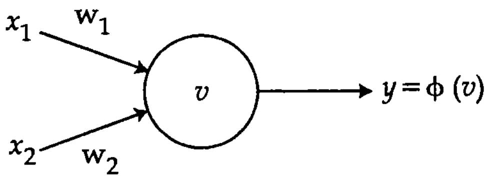
$$B = \left\{ \frac{0.4}{b_{117}} + \frac{0.4}{f_{111}} + \frac{0.6}{f_4} + \frac{0.8}{f_{15}} + \frac{0.9}{f_{14}} + \frac{1.0}{f_{16}} \right\}.$$

Find the values of the following operations.

$A \cup B$, $A \cap B$, $A^c$, $B^c$, $A - B$ and $B - A$.

(b) Draw the architecture of a multilayer perception (MLP) and explain its operations. Mention its advantages and disadvantages. 4

5. (a) The AND function can be implemented by a single unit with two nodes. 6




If the weights are $w_1 = w_2 = 1$ and the activation function is $\phi(v) = \begin{cases} 1 \; ; \text{ if } v \geq 2 \\ 0 \; ; \text{otherwise} \end{cases}$.

(i) Test, how the neural AND function works.

(ii) Suggest how to change either the weights or the threshold level of this single unit in order to implement the logical OR function. Initial weights are given by $w_1 = w_2 = 2$.

(iii) Check whether OR function can be implemented using a single unit.

(b) What is an epoch and a training set and how it is used to train neural networks ? 4

6. (a) Suppose we want to compare two sensors based upon their detection levels and gain settings. The following table of gain settings and sensor detection levels with a standard item being monitored provides typical membership values to represent the detection levels for each of the sensors. 6

| Gain setting | Sensor 1 detection levels | Sensor 2 detection levels |
|---|---|---|
| 0 | 0 | 0 |
| 20 | 0.5 | 0.35 |
| 40 | 0.65 | 0.5 |
| 60 | 0.85 | 0.75 |
| 80 | 1 | 0.90 |
| 100 | 1 | 1 |

The universe of discourse is $x = \{0, 20, 40, 60, 80, 100\}$. Find the membership function for the two sensors.

Also, find the following membership functions using standard set operations.

(i) $\mu_{S_1 \cup S_2}(x)$

(ii) $\mu_{S_1 \cap S_2}(x)$

(iii) $\mu_{S_1}C(x)$

(iv) $\mu_{S_2}C(x)$

(v) $\mu_{S_1C \cup S_2C}(x)$

(vi) $\mu_{(S_1 \cup S_2)^C}(x)$

(b) Find the length and order of the following schema. 4

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

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

7. Which of the following statements are *true* or *false* ? Justify your answer. 10

(a) A fuzzy membership can take true and false values simultaneously.

(b) Mutation defines how chromosomes of parents are mixed to obtain genetic codes of their off-springs.

(c) Every original pattern of a discrete Hopfield network with a synchronous update provides a global minimum.

(d) A non-linear separable data can be classified by a single perception.

(e) The fuzzy relation :

$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 & 0.3 \\ 0.6 & 1 & 0.4 & 0 & 0.8 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.3 & 0.8 & 0 & 0.5 & 1 \end{bmatrix}$$

is an equivalence relation.

No. of Printed Pages : **6**

**MMTE-007**

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

## Term-End Examination

## December, 2012

00601

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* | *Maximum Marks : 50*
*(Weightage : 50%)*

***Note :*** *Question No. 7 is* ***Compulsory****. Attempt* ***any four*** *questions from Q. No.* **1** *to* **6**. *Use of calculator is* ***not*** *allowed.*

**1.** (a) Select an implementation technology for a numerical processor. Computation throughout is directly related to clock speed. Assume that all implementations will be in the same family (e.g., CMOS). Considering whether the design should be implemented using medium - scale integration (MSI) with discrete parts, field - programmable array parts (FPGA), or multichip modules (MCM). Define the universe of potential clock speeds as $x = \{1, 10, 20, 40, 80, 100\}$ MHz, and define MSI, FPGA, and MCM as fuzzy sets of clock frequencies that should be implemented in each of these technologies. The following **7**

table defines the membership values for each of the three fuzzy sets. It may be noted that the assignments made in this table reflect only the operational speed capabilities, per cost ratio and do not include other factors.

| Clock frequency (MHz) | MSI (M) | FPGA (F) | MCM (c) |
|---|---|---|---|
| 1 | 1 | 0.3 | 0 |
| 10 | 0.7 | 1 | 0 |
| 20 | 0.4 | 1 | 0.5 |
| 40 | 0 | 0.5 | 0.7 |
| 80 | 0 | 0.2 | 1 |
| 100 | 0 | 0 | 1 |

Find $M \cup F$, $M \cap F$, $\overline{M}$, $\overline{F}$, $\overline{M \cup C}$, $F \cup \overline{F}$, $\overline{C} \cup \overline{F}$.

(b) Distinguish between gradient based local optimization method and stochastic hill climbing method with the help of an example. **3**

**2.** (a) Given a fuzzy set A with a triangular membership function as given in fig. 1. **7**

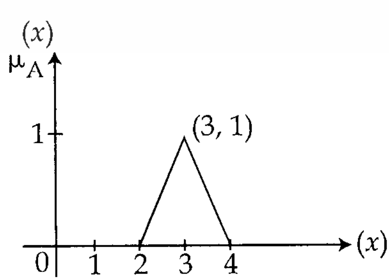


Fig. 1 : Triangular membership function

(i) Derive $\mu_A (x)$ as a mathematical equation.

(ii) Draw the graphs for $\mu_{A \cup \overline{A}}$ and $\mu_{A \cap \overline{A}}$.

(iii) Verify whether or not the following are true.

$$A \cup \overline{A} = \bigcup$$
$$A \cap \overline{A} = \phi$$

(b) Write fuzzy C - means algorithm for clustering. 3

3. (a) Differentiate between back propagation network and radial basis networks. Explain with one example of each. 4

(b) The perception may be used to perform numerous logic function. Demonstrate the implementation of the binary logic function AND, OR and COMPLEMENT. Assume that the input to AND and OR is two numbers drawn from $\{-1, 1\}$ representing false and true respectively and the input to COMPLEMENT is one number drawn from $\{-1, 1\}$. 6

4. Find the weights required to perform the following classification using perception network. The vector (1, 1, 1, 1) and (−1, 1, −1, −1) are belonging to the class (so have target value '1'), vector (1, 1, 1, −1) and (1, −1, −1, 1) are not belonging to the class (so have target value '−1'). Assume learning rate as 1 and initial weights wi = 0 for i = 0, 1, 2, 3 and 4. Also, draw the architecture of the network. **10**

5. (a) Obtain the output of the memory for the network given in fig. 2 using activation function (i) binary sigmoidal and (ii) bipolar sigmoidal. **4**

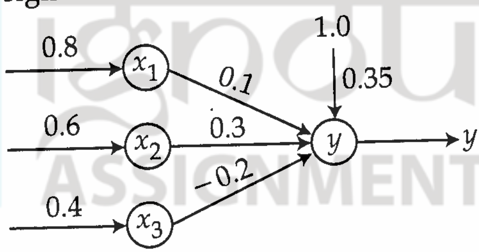



fig. 2

(b) Consider the following travelling salesman problem involving 7 cities. **6**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parent 1 | A | B | C | D | E | F | G |
| Parent 2 | D | F | E | G | A | C | B |

Determine the children solution using.

(i) Order crossover (# 1), assuming 3rd and 6th cities as crossover sites.

(ii) Order crossover (# 2), assuming 3rd, 5th and 7th cities as the key positions.

6. (a) Consider the multilayer perception given in fig. 3. Use back propagation to find the first updated values for weights $w_3$ and $w_4$ given the input and output shown in fig. 3. 7

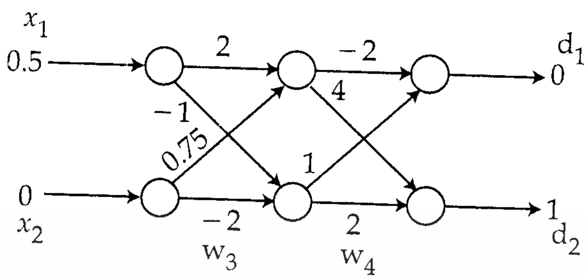



fig. 3

(b) Find the length and order of the following schema. 3

(i) (1 * * 0 0 * 0 * *)

(ii) (* 0 1 * 1 * *)

7. Which of the following statements are true or false. Give reasons for your answers. 10

(a) The length of chromosome to determine minimum of function $f(x) = x^2$ on the integer interval [ 0, 1024 ] is 10.

(b) The schema for the gene sequence { 1 0 0 0 1 1 1 } and { 0 0 0 1 1 0 0 } is (* 0 0 * 1 1 *).

(c) If $\alpha_1 < \alpha_2$ then $A_{\alpha_1} \subseteq A_{\alpha_2}$ where $\subseteq$ denotes a crisp subset relation.

(d) XOR problem can be implemented using a single perception.

(e) The number of weights in a three layer perception with four nodes, three nodes and two nodes at input layer, hidden layer and output layer respectively is 18.

No. of Printed Pages : 2

**MMTE-007 (P)**

00185

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

## M.Sc. (MACS)

## Term-End Practical Examination

## June, 2013

## MMTE-007 (P) : SOFT COMPUTING AND ITS APPLICATIONS (P)

*Time : 1½ hours* *Maximum Marks : 40*

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*Note : This question paper has* ***two*** *questions worth* **30** *marks. Remaining* **10** *marks are for* ***viva-voce****.*

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**1.** Write a program in 'C' language to implement the back propagation algorithm. Test your program to modify weights for the following inputs and outputs : **12+6=18**

| Input | | Output |
|---|---|---|
| $I_1$ | $I_2$ | 0 |
| 0.3 | – 0.5 | 0.1 |
| 0.2 | 0.5 | 0.3 |
| 0.4 | – 0.1 | 0.2 |

The initial weights are given below :

$$[W]^{\circ} = \begin{bmatrix} 0.1 \\ -0.4 \end{bmatrix} \text{ and } [V]^{\circ} = \begin{bmatrix} 0.2 & 0.4 \\ -0.1 & 0.2 \end{bmatrix}$$

2. Write a program in 'C' language to write the children solution of a genetic algorithm to solve a TSP consisting of n cities using cyclic crossover. Also, test your program for the following two parents : **8+4=12**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parent 1 : | A | B | C | D | E | F | G | H |
| Parent 2 : | C | A | D | B | F | H | E | G |

No. of Printed Pages : 6

**MMTE-007**

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

# M.Sc. (MACS)

## Term-End Examination

00322

## June, 2013

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* *Maximum Marks : 50*

*(Weightage : 50%)*

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**Note :** *Question No.* **7** *is* **Compulsory**. *Attempt* ***any four*** *questions from Q. No.* **1** *to* **6**. *Use of calculator is* ***not*** *allowed.*

---

**1.** (a) Consider a local area network of inter connected workstations that communicate using Ethernet protocols at a maximum rate of 10 M bit/s. Traffic rates on the network can be expressed as the peak value of the total bandwidth (BW) used, and the two fuzzy variables, "Quiet" and " Congested", can be used to describe the perceived loading of the LAN. If the discrete universal set X={0, 1, 2, 5, 7, 9, 10 } represents band width usage, then the membership grades of these elements in the fuzzy sets quiet Q and congested C are given in the table and Fig.1. **10**

| $x$ (BW), M bit/s | $\mu_Q(x)$ | $\mu_c(x)$ |
|---|---|---|
| 0 | 1.0 | 0.0 |
| 1 | 1.0 | 0.0 |
| 2 | 0.8 | 0.0 |
| 5 | 0.3 | 0.4 |
| 7 | 0.1 | 0.6 |
| 9 | 0.0 | 0.8 |
| 10 | 0.0 | 1.0 |


Fig. 1 : Membership functions of quiet and congested.



(b) For these two fuzzy sets find the union, intersection, complement of Q, difference Q - C, and verify any one of Demorgan's law

(i) graphically and

(ii) numerically.

2. (a) Given a fuzzy set A with the membership function given fig 2. **4**

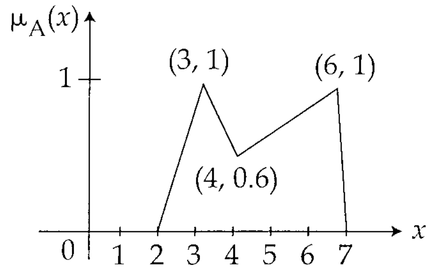


Fig. 2

Derive $\mu_A(x)$ as a mathematical function.

(b) Use a binary-coded Genetic algorithm (GA) to minimize the function **6**

$f(x_1, x_2) = x_1 + x_2 - 2x_1^2 - x_2^2 + x_1 x_2$, in the range of $0 \le x_1, x_2 \le 5$.

Use a random population of size N=6, a single point crossover with probability $P_c = 1$ and neglect mutation. Assume 3 bits for each variable and thus the GA - string will be 6 - bits long. Show only one iteration by hand calculation.



3. (a) Consider the single layer perception given in Fig 3. **6**

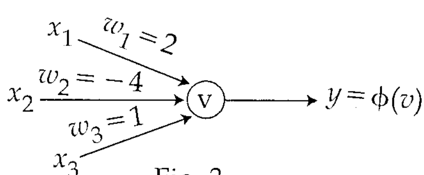


Fig. 3

7. Which of the following statements are **true** or **false**. Give reasons for your answers. **10**

(a) The support of a fuzzy set A is same as the $\alpha$ - cut of a fuzzy set A.

(b) The Manhattan distance and the Mink Owski distance are same for some condition.

(c) The input to a single input neuron is 2, its weight is 2.3 and its bias is $-3$. The neuron output for Linear transfer function is $-1$.

(d) The SOM is useful for classification.

(e) The length and order of the schema S = (0**11*0**) are 6 and 3 respectively.

The activation function is given by

$$\phi(v)=\begin{cases}1\ ;\ v \geq 0\\ 0\ ;\ v < 0\end{cases}$$

Calculate the output y of the unit for each of the following input pattern :

| Patterns | $p_1$ | $p_2$ | $p_3$ | $p_4$ |
|---|---|---|---|---|
| $x_1$ | 1 | 0 | 1 | 1 |
| $x_2$ | 0 | 1 | 0 | 1 |
| $x_3$ | 0 | 1 | 1 | 1 |

(b) Describe the Binary Hopfield network with the help of an example. 4



4\. (a) Define the following operations in Genetic algorithm with one example of each. 4

(i) Crossover



(ii) Mutation

(b) Consider the ADALINE filter with three neurons in the input layer having weights $W_{11}=3$, $W_{12}=1$ and $W_{13}=-2$ and the input sequence. 6

$\{- - - - , 0, 0, 0, -4, 5, 0, 0, 0 - - - -\}$

What is the filter output ?

5. (a) If the input vectors are $I_1 = [-1, 0]^T$, and $I_2 = [0, 1]^T$, and the initial values of two weight vectors are $[0, 1]^T$ and $[\frac{2}{\sqrt{5}}, \frac{-1}{\sqrt{5}}]$ calculate the resulting weight found after training the competitive layer with the Kohonen's rule and a learning rate $\alpha$ of 0.4 on the input series in order $I_1$, and $I_2$. 8

(b) Differentiate between bounded sum and algebric sum of two fuzzy sets. 2

6. (a) What do you mean by a feed - forward neural network ? Using diagram, show how it differs from a recurrent neural network. 4

(b) Consider the two parents which are participating in partially mapped cross over as shown below : 6

Parent 1 : C D | E A B I | H G F

Parent 2 : A B | C D E F | G H I

Using partially mapped crossover assuming 2nd and 6th as the crossover sites, find the children solution.

No. of Printed Pages : **2**

**MMTE-007 (P)**

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

## M.Sc.(MACS)

### Term-End Practical Examination

### December, 2013

## MMTE-007 (P) : SOFT COMPUTING AND ITS APPLICATIONS (P)

*Time : 1½ hours* *Maximum Marks : **40***

*Note : This question paper has **two** questions worth **30** marks. Remaining **10** marks are for viva-voce.*

1. Write a program in 'C' language to write the children solution of a genetic algorithm to solve a TSP consisting of n-cities using crossover order (# 1). **8+4=12**

   Also, test your program for the following two parents :

   Parent 1 : A B C D E F G H

   Parent 2 : A D B E C H G F

2. Write a program in 'C' language to implement the FCM algorithm. **12+6=18**

Also, test it to find the final fuzzy partition and cluster centers for the following data :

| | $f_1$ | $f_2$ |
|---|---|---|
| $x_1$ | 4 | 9 |
| $x_2$ | 7 | 13 |
| $x_3$ | 11 | 7 |
| $x_4$ | 4 | 14 |
| $x_5$ | 12 | 11 |

The initial cluster centers are :
$V_1 = (5, 5)$ and $V_2 = (10, 10)$ with $C = m = 2$.

No. of Printed Pages : 6 **MMTE-007**

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

## Term-End Examination

00040

## December, 2013

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* *Maximum Marks : 50*

*(Weightage : 50%)*

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**Note :** *(i) Question No. 7 is* **Compulsory**.

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

*(iii) Use of calculator is* **not** *allowed.*

---

**1.** (a) Two sensors based upon their detection levels and gain settings are compared. The following table of gain settings and sensor detection levels with a standard item being monitored provides typical membership values to represent the detection levels for each of the sensors. 5

| Gain Setting | Sensor 1 detection levels | Sensor 2 detection levels |
|---|---|---|
| 0 | 0 | 0 |
| 20 | 0.5 | 0.35 |
| 40 | 0.65 | 0.5 |
| 60 | 0.85 | 0.75 |
| 80 | 1 | 0.90 |
| 100 | 1 | 1 |

The universe of discourse is

$x = \{0, 20, 40, 60, 80, 100\}$. Find the membership function for the two sensors. Also, verify De-morgon's laws for these membership functions.

(b) Maximize $f(x, y) = 8x + 6y$ 5

Subject to $2x + 3y \leq 6$

$$-3x + 2y \leq 3$$
$$2x + y \leq 4$$
$$0 \leq x \leq 2.$$

Using genetic algorithm.

**2.** (a) Find max - average composition for $R(x, y)$ and $S(x, y)$ defined by the following relational matrices : 6

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{ccccc} y_1 & y_2 & y_3 & y_4 & y_5 \end{array} \\ \begin{bmatrix} 0.1 & 0.2 & 0 & 1 & 0.7 \\ 0.3 & 0.5 & 0 & 0.2 & 1 \\ 0.8 & 0 & 1 & 0.4 & 0.3 \end{bmatrix} \end{array}$$

$$S = \begin{array}{c} \\ y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{array} \begin{array}{c} \begin{array}{cccc} z_1 & z_2 & z_3 & z_4 \end{array} \\ \begin{bmatrix} 0.9 & 0 & 0.3 & 0.4 \\ 0.2 & 1 & 0.8 & 0 \\ 0.8 & 0 & 0.7 & 1 \\ 0.4 & 0.2 & 0.3 & 0 \\ 0 & 1 & 0 & 0.8 \end{bmatrix} \end{array}$$

(b) Consider the following travelling salesman problem involving 9 cities. 4

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

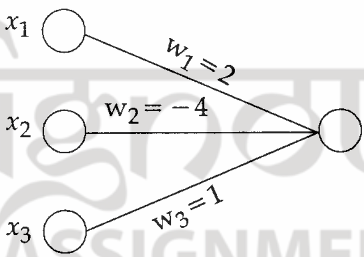
Determine the children solution using.

(i) Order crossover # 1, assuming $4^{th}$ and $7^{th}$ sites as the crossover sites.

(ii) Order crossover # 2, assuming $3^{rd}$, $5^{th}$ and $7^{th}$ as the key positions.

**3.** (a) Write a formula describing the function defined by a one - hidden - layer (already trained) MLP with a single output. Also, write the formula describing the function defined by a RBFN with a single output. How do they differ ? **4**

(b) Consider the following single layer perceptron as shown in the following figure. **6**




and the activation function of each unit is defined as $\Phi(v) = \begin{cases} 1, & \text{if } v \geq 0 \\ 0, & \text{otherwise.} \end{cases}$

Calculate the output $y$ of the unit for each of the following input patterns :

| Patterns | $P_1$ | $P_2$ | $P_3$ | $P_4$ |
|---|---|---|---|---|
| $x_1$ | 1 | 0 | 1 | 1 |
| $x_2$ | 0 | 1 | 0 | 1 |
| $x_3$ | 0 | 1 | 1 | 1 |

Also, find the modified weights after one iteration.

4. (a) Consider the problem of finding the shortest route through several cities, such that each city is visited only once and in the end traveller returns to the starting city (the travelling salesman problem). Suppose that in order to solve this problem we use a genetic algorithm, in which genes represent links between pairs of cities. For example, a link between Delhi and Mumbai is represented by a single gene 'DM : Also assume that the direction in which we travel is not important, so that DM = MD. 3

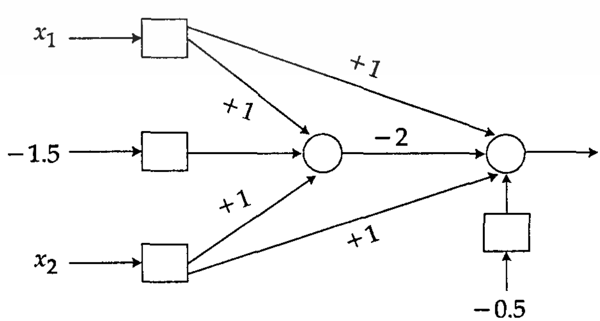
(i) How many genes will be used in a chromosome of each individual if the number of cities is 10 ?

(ii) How many genes will there be in the alphabet of the algorithm ?

(b) What is competitive learning ? How does it differ from Hebbian learning ? 3

(c) Write **any four** activation function used in neural networks. Also, draw the graph of the output of these functions. 4

5. (a) A single hidden neural network for solving the XOR problem is shown in the figure given below : 5



Show that the given network solves the XOR problem by constructing

(i) decision regions,

(ii) a truth table for the network.

(b) Write **any three** terminating conditions used in learning of a neural network. 3

(c) Consider a 4 - input neuron with weights 1, 2, 3 and 4. The transfer function is linear with the constant of proportionality being equal to 2. The inputs are 4, 10, 5 and 20, respectively. Find the output. 2

**6.** (a) Find the length and order of the following schema : 6

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

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

(iii) $S_3 = (* * * 1 * * *)$

(b) Let an activation function be defined as 4

$$\phi(v) = \frac{1}{1+e^{-av}},\ a>0$$

Show that $\frac{d\phi}{dv} = a\phi(v)\left[1-\phi(v)\right]$. What is the value of $\phi(v)$ at the origin ? Also, find the value of $\phi(v)$ as $v$ approaches $+\infty$ and $-\infty$.

**7.** Which of the following statements are true or false ? Give a short proof or a counter example in support of your answers. 10

(a) There is chance of occurrence of the premature convergence in Roulett-wheel selection scheme used in GA.

(b) Gradient based optimization methods are used when the objective function is not smooth and one needs efficient local optimization.

(c) The $\alpha -$ cut of a fuzzy set A in $\cup$ is defined as $A\alpha_0 = \{x \in \cup \mid \mu_A(x) \le \alpha_0\}$

(d) A single perceptron with preprocessing is neither an auto associative network nor a multiple layer neural network.

(e) If $W(k_0) = W(k_0 + 1) = W(k_0 + 2)$, then perceptron is non-linear separable.

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No. of Printed Pages : 1

**MMTE-007 (P)**

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

00316

## Term-End Practical Examination
## June, 2014

## MMTE-007 (P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ hours* *Maximum Marks : 40*

***Note :*** *There are **two** questions in this paper, totalling 30 marks. Answer both of them. Remaining 10 marks are for the viva-voce.*

**1.** Write a program in 'C' language to implement FCM algorithm for a data set having n points and m features. Also, test your programs to find the new cluster center for the following data :

| | Feature 1 | Feature 2 |
|---|---|---|
| $x_1$ | 2 | 12 |
| $x_2$ | 4 | 9 |
| $x_3$ | 7 | 13 |
| $x_4$ | 11 | 5 |
| $x_5$ | 12 | 7 |
| $x_6$ | 14 | 4 |

The initial two cluster centers are given by (5, 5) and (10, 10). *15*

**2.** Write a program in 'C' language to find the average correlation matrix for M input patterns with N features to design and train the Hopfield network. Also, test your program on the following input patterns : *15*

M = 3, N = 4

| | | | | |
|---|---|---|---|---|
| $IP_1$ | 1 | 1 | 1 | – 1 |
| $IP_2$ | 1 | 1 | – 1 | 1 |
| $IP_3$ | – 1 | 1 | 1 | – 1 |

No. of Printed Pages : **6** | **MMTE-007**

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

00795

## Term-End Examination

## June, 2014

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* *Maximum Marks : 50*

*(Weightage : 50%)*

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***Note :*** *(i) Question No. 7 is **Compulsory**.*

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

*(iii) Use of calculator is **not** allowed.*

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**1.** (a) In the field of computer networking there is an imprecise relationship between the level of use of a network communication band width and the latency experienced in peer-to-peer communication. Let $\underset{\sim}{X}$ be a fuzzy set of use levels (in terms of the percentage of full bandwidth used) and $\underset{\sim}{Y}$ be a fuzzy set of latencies (in milliseconds) with the following membership function : **6**

$$X = \left\{\frac{0.2}{10} + \frac{0.5}{20} + \frac{0.8}{40} + \frac{1.0}{60} + \frac{0.6}{80} + \frac{0.1}{100}\right\},$$

$$Y = \left\{\frac{0.3}{0.5} + \frac{0.6}{1} + \frac{0.9}{1.5} + \frac{1.0}{4} + \frac{0.6}{8} + \frac{0.3}{20}\right\},$$

(i) Find the Cartesian product represented by the relation $\underset{\sim}{R} = \underset{\sim}{X} \times \underset{\sim}{Y}$.

Now, suppose we have a second fuzzy set of bandwidth usage given by :

$$Z = \left\{ \frac{0.3}{10} + \frac{0.6}{20} + \frac{0.7}{40} + \frac{0.9}{60} + \frac{1}{80} + \frac{0.5}{100} \right\}.$$

(ii) Find $\underset{\sim}{S} = \underset{\sim 1 \times 6}{Z} \; o \; \underset{\sim 6 \times 6}{R}$ using Max-min composition and max-product composition.

(b) Consider the following travelling salesman problem involving 9 cities. 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parent 1 : | B | C | D | E | F | G | H | I | J |
| Parent 2 : | D | E | F | B | C | J | I | H | G |

Determine the children solution using :

(i) Order crossover #1, assuming $3^{rd}$ and $7^{th}$ as the crossover sites.

(ii) Order crossover #2, assuming $3^{rd}$, $5^{th}$ and $7^{th}$ as the crossover sites.

2. (a) Consider the following modification of the cost function defined in the following equation : 4

$$J(\mu_j) = \sum_{j=1}^{K} \sum_{i=1}^{N} W_{ij} \left\| x_i - \mu_j \right\|^2$$

In this function, the weighting factor $W_{ij}$ is defined as follows :

$$W_{ij} = \begin{cases} 1 & \text{if the data point } x_i \text{ lies inside cluster } J \\ 0 & \text{otherwise} \end{cases}$$

Show that the minimizing solution of this cost function is

$$\hat{\mu}_j = \frac{\sum_{i=1}^{N} W_{ij} x_i}{\sum_{i=1}^{N} W_{ij}}, \; j = 1, 2, \ldots K$$

How do you interpret the expressions in the numerator and denominator of this formula ?

(b) Improve the solution of the following problem : 6

Max. $f(x) = x^2$

subject to $0 \le x \le 15$, by considering the length of the string as 4. Show only one iteraction for a population of size 4.

3. (a) Two fuzzy sets $P$ and $Q$ are defined on $x$ as follows : 4

| $\mu(x_i)$ | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
|---|---|---|---|---|---|
| $P$ | 0.1 | 0.2 | 0.7 | 0.5 | 0.4 |
| $Q$ | 0.9 | 0.6 | 0.3 | 0.2 | 0.8 |

Find the following $\lambda$ cut sets

(i) $(\overline{P})_{0.2}$ and $(\overline{Q})_{0.3}$

(ii) $(Q \cup \overline{P})_{0.8}$

(iii) $(P \cap Q)_{0.4}$

(b) Compute the weight matrix for a 4-neuron Hopfield net with the single fundamental memory $\xi 1 = [1, -1, -1, 1]$ stored in it. 3

(c) Describe the relationship between the Self-Organising Map algorithm, and the Learning Vector Quantisation algorithm. 3

**4.** (a) The input to a single input neuron is 4.0, its weight is 2.3 and its bias is $-6$. 4

(i) What is the net input to the transfer function ?

(ii) What is the neuron output for the following transfer functions :

(A) Hard limit,

(B) Linear

(C) Log-sigmoid ?

(b) Consider a Hopfield network whose weight matrix is given by : 6

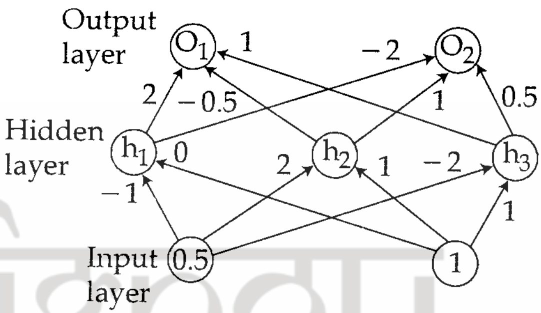
$$W = \frac{1}{3}\begin{pmatrix} 0 & -2 & 2 \\ -2 & 0 & -2 \\ 2 & -2 & 0 \end{pmatrix}$$

Run the Hopfield network for the test input vectors $pt_1 = (1 \quad 1 \quad -1)$ and $pt_2 = (-1 \quad -1 \quad 1)$.

**5.** (a) The following is a network of linear neurons, that is, neurons whose output is identical to their net input, $o_i = \text{net}_i$. 6

(i) Compute the output of the hidden-layer and the output-layer neurons for the given inputs (0.5, 1) and enter those values into the corresponding circles.

(ii) What is the output of the network for the input (1, 2), i.e. the left input neuron having the value 1 and the right one having the value 2 ? Do you have to do all the network computations once again in order to answer this question ? Explain.




(b) List all the schemas of the chromosome "101" and find their corresponding orders and lengths. **4**

6. (a) If the input vectors are $I_1 = [1 \ \ -1]^T$, $I_2 = [1 \ 1]^T$ and $I_3 = [-1 \ 1]^T$, use the Kohonen learning with $\alpha = 0.5$ and train for one pass through the input vector. Assume an initial weight matrix. **6**

$$W = \begin{pmatrix} 0 & -1 \\ \frac{-2}{\sqrt{5}} & \frac{-1}{\sqrt{5}} \\ \frac{-1}{\sqrt{5}} & \frac{2}{\sqrt{5}} \end{pmatrix}$$

(b) Show that XOR can be solved using multilayer perceptron. **4**

7. Which of the following statements are true or false ? Give reasons for your answer. **10**

(a) The Fuzzy relation

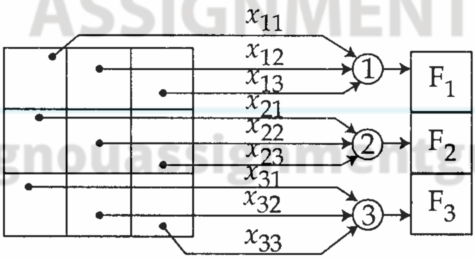
$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 & 0.3 \\ 0.6 & 1 & 0.4 & 0 & 0.8 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.3 & 0.8 & 0 & 0.5 & 1 \end{bmatrix} \text{ is}$$

always reflexive, symmetric and transitive.

(b) For a genetic algorithm to be used to evolve a binary string of length n containing only 1s, the offspring of parents with a high fitness value have a high fitness value.

(c) Hopfield networks are most often used for auto-association.

(d) The network shown in the figure below is a single layer feed-forward neural network as well as an auto - associative neural network.




where $F_1$, $F_2$ and $F_3$ are neurons of output layer.

(e) If a 3-input neuron is trained to output a zero when the input is 110 and a one when the input is 111, then after generalization, the output will be zero for the following inputs : 000, 010, 110, 100.

No. of Printed Pages : 1

**MMTE-007(P)**

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

## M.Sc. (MACS)

## Term-End Practical Examination

00006

## December, 2014

## MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ hours* *Maximum Marks : 40*

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***Note :*** *There are **two** questions in this paper totalling 30 marks. Answer **both** of them. Remaining 10 marks are for the viva-voce.*

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**1.** Write a program in 'C' language to write the children solution of a Travelling Salesman problem consisting of n cities using crossover order (#1). Also test your program for the following : *15*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parent 1 : | A | B | C | D | E | F | G | H | I |
| | * | | | * | | | * | | * |
| Parent 2 : | C | D | E | A | B | I | H | G | F |



**2.** Write a program in 'C' language to implement the backpropagation algorithm. Show step-by-step output at input, hidden and output neurons as well as errors. Also modify the weights for the training set having input $I_1 = 0{\cdot}3$, $I_2 = -0{\cdot}5$ and output $0{\cdot}1$ with initial weights *15*

$$[V]^0 = \begin{bmatrix} 0{\cdot}1 & 0{\cdot}4 \\ -0{\cdot}2 & 0{\cdot}2 \end{bmatrix} \text{ and}$$

$$[W]^0 = \begin{bmatrix} 0{\cdot}2 \\ -0{\cdot}5 \end{bmatrix}.$$

No. of Printed Pages : 1

**MMTE-007(P)**

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

**Term-End Practical Examination**

00353

**June, 2015**

**MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS**

*Time : $1\frac{1}{2}$ hours* *Maximum Marks : 40*

***Note :*** *(i) This question paper has **two** questions worth 30 marks.*
*(ii) Remaining 10 marks are for viva-voce.*

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**1.** Consider the following training data set :

| Input | | Output |
|---|---|---|
| $I_1$ | $I_2$ | |
| 0·4 | – 0·7 | 0·1 |

In a given multilayer perceptrons with two nodes at a hidden layer, the weights between input layer and hidden layer are given by $\begin{bmatrix} 0.1 & 0.4 \\ -0.2 & 0.2 \end{bmatrix}$ and weights between hidden layer and output node are given by $\begin{bmatrix} 0.2 \\ -0.4 \end{bmatrix}$.

Write a program in 'C' language to find

(i) the output at each node of MLP,

(ii) the updated weights after three iterations. *20*

**2.** Consider the following Travelling Salesman Problem involving 9 cities :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parent 1 : | F | I | G | E | D | C | A | H | B |
| Parent 2 : | C | B | G | I | H | F | D | E | A |

Write a program in 'C' language to determine the children solution using order crossover (# 1), assuming $2^{nd}$ and $8^{th}$ sites as crossovers. *10*

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No. of Printed Pages : 1

**MMTE-007(P)**

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

## Term-End Practical Examination

00283

## December, 2015

## MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ hours* | *Maximum Marks : 40*

**Note :** *(i) This question paper has **two** questions worth 30 marks. Answer **both** questions.*

*(ii) Remaining 10 marks are for viva-voce.*

**1.** Consider a data set of six points given in the following table :

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

Each point has two features $f_1$ and $f_2$. Assume the values of the parameters c = 2 and m = 2. Let the initial cluster centres be $V_1 = (5, 5)$ and $V_2 = (10, 10)$.

Write a program in 'C' language to find the new cluster centres by applying FCM algorithm. *20*

**2.** Write a program in 'C' language to write the children solution of a genetic algorithm to solve a Travelling Salesman Problem consisting of n cities using cyclic crossover. Also, test your program for the following two parents : *10*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parent 1 : | A | B | C | D | E | F | G | H |
| Parent 2 : | C | A | D | B | F | H | E | G |

00194

No. of Printed Pages : 7

**MMTE-007**

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

# M.Sc. (MACS)

## Term-End Examination

## December, 2015

## 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 calculator is **not** allowed.*



1. (a) Let two fuzzy sets be given by

$$A = \left\{\frac{0\cdot1}{0}, \frac{0\cdot2}{1}, \frac{0\cdot4}{2}, \frac{0\cdot6}{3}, \frac{1}{4}\right\} \text{ and}$$

$$B = \left\{\frac{1}{0}, \frac{0\cdot5}{1}, \frac{0\cdot7}{2}, \frac{0\cdot3}{3}, \frac{0}{4}\right\}.$$

Find : 4

(i) $A \cup \tilde{B}$

(ii) $\tilde{A}$

(iii) $A \cap \tilde{B}$

(iv) $A \cup \tilde{A}$

(b) Consider the following table for the connections between the input neurons and the hidden layer neurons :

| *Input neurons* | *Hidden layer neurons* | *Connection weights* |
|---|---|---|
| 1 | 1 | – 1 |
| 1 | 2 | – 0·1 |
| 1 | 3 | 1 |
| 2 | 1 | – 1 |
| 2 | 2 | 1 |
| 2 | 3 | 1 |
| 3 | 1 | – 0·2 |
| 3 | 2 | – 0·3 |
| 3 | 3 | – 0·6 |

The connection weights from the hidden layer neurons to the output neurons are – 0·6, – 0·3 and – 0·6 for first, second and third neurons, respectively. Corresponding threshold value for the output layer is 0·5 and for the hidden layer is 1·8, 0·05 and 0·2 for the first, second and third neurons, respectively.

(i) Draw the diagram of the network.

(ii) Write the output at each node. 6

2. (a) Find the weights required to perform the following classifications using Perceptron Network. The vectors (1, 1, –1, –1) and (1, –1, 1, –1) are belonging to the class with target value 1, vectors (–1, –1, –1, 1) and (–1, –1, 1, 1) are not belonging to the class with target value –1. Assume learning rate as 1, initial weights as [0·1, –0·2, 0·3, –0·1], and activation function to be sigmoidal (a = 1). 6

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

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

3. (a) Consider the following two-dimensional data set that consists of 10 points in $\mathbf{R}^2$ :

| R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $x_{k_1}$ | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| $x_{k_2}$ | 0 | 2 | 4 | 1 | 3 | 2 | 2 | 3 | 0 | 4 |

Assume that c = 2, m = 1·25, 11 * 11 is the Euclidean distance and the initial fuzzy pseudo-partition is $P^{(0)} = \{A_1, A_2\}$ with

$$A_1 = \left\{\frac{0{\cdot}854}{x_1} + \frac{0{\cdot}854}{x_2} + \ldots + \frac{0{\cdot}854}{x_{10}}\right\},$$

$$A_2 = \left\{\frac{0{\cdot}146}{x_1} + \frac{0{\cdot}146}{x_2} + \ldots + \frac{0{\cdot}146}{x_{10}}\right\}.$$

Starting with the initial membership values given above, obtain the final fuzzy pseudo-partition and the cluster centers assuming that convergence is achieved when the difference between the two values is $\leq 0{\cdot}01$. *6*

(b) Out of three genetic operators, viz. selection, crossover and mutation, list and justify which operator or combination thereof will be required for the following : *4*

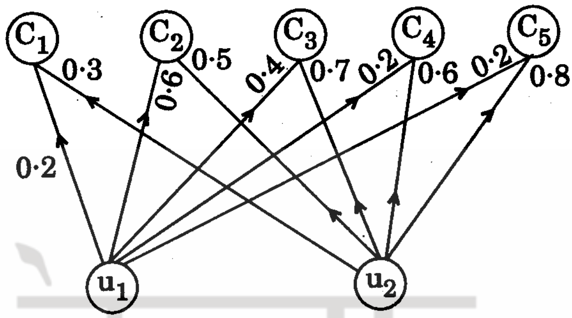
(i) To fill the population with copies of the best individual from the population.

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

**4.** (a) Maximize $f(x) = \frac{-x^2}{10} + 3x$, where $0 \leq x \leq 31$ using Genetic algorithm. *6*

(b) Solve the network to approximate the function $g(x) = 1 + \sin(\pi x/4)$ for $-2 \leq x \leq 2$, choosing the initial weights and bias as the random numbers. 4

**5.** (a)




A Kohonen self-organising map is shown with weights in the above figure. Find the cluster unit $C_j$, j = 1, 2, 3, 4, 5 that is closest to the input vector (0·3, 0·6) by using square of the Euclidean distance. 6

(b) Construct the $\alpha$-cut at $\alpha = 0{\cdot}7$ and $\alpha = 0{\cdot}5$ for the fuzzy sets defined as follows : 4

| X | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
|---|---|---|---|---|---|
| $\mu_A$ | 0·2 | 0·3 | 0·4 | 0·7 | 0·1 |

**6.** (a) A single layer neural network is to have six inputs and three outputs. The outputs are to be limited to and continuous over the range 0 to 1.

(i) How many neurons are required ?

(ii) What are the dimensions of the weight matrix ?

(iii) What kind of transfer functions could be used ?

(iv) Is a bias required ? Give reason. *4*

(b) Consider a Hopfield network whose weight matrix is given by

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

Consider two test input vectors

$PT_1 = (2 \;\; -2 \;\; 2)$ and $PT_2 = (-2 \;\; 2 \;\; -2)$.

Check if the output state vectors satisfy alignment conditions. *6*



**7.** State whether the following statements are *true* or *false*. Give reasons. *5×2=10*

(i) If a 3-input neuron is trained to output a zero when the input is 110 and output one when the input is 111, then after generalization, the output will be zero when the input is 000 or 010 or 110 or 100.

(ii) Every original pattern of a discrete Hopfield network with a synchronous update provides a global minimum.

(iii) The fuzzy relation

$$R = \begin{bmatrix} 1 & 0{\cdot}6 & 0 & 0{\cdot}2 \\ 0{\cdot}6 & 1 & 0{\cdot}4 & 0 \\ 0 & 0{\cdot}4 & 1 & 0 \\ 0{\cdot}2 & 0 & 0 & 1 \end{bmatrix}$$

is an equivalence relation.

(iv) The order of schema **10** is 6.

(v) For two fuzzy sets A and B and $x \in U$, if $\mu_A(x) = 0{\cdot}3$ and $\mu_B(x) = 0{\cdot}9$, then $\mu_{\overline{A} \cup \overline{B}} = 0{\cdot}6$.

No. of Printed Pages : 2

**MMTE-007 (P)**

00130

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

## Term-End Practical Examination

## June, 2016

## MMTE-007 (P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 1½ hours* *Maximum Marks : 40*

***Note :*** *This question paper has two questions worth* ***30*** *marks. Remaining* ***10*** *marks are for the viva-voce.*

**1.** Write a program in 'C' language to write the children solution of a genetic algorithm to solve a travelling salesman problem consisting of n-cities using crossover order (#2). Also, test your program for the following two parents : **12**

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

**2.** Write a program in 'C' language to implement the back propagation algorithm. Show step by step output to hidden and output neurons. Also modify the weights w and v for the data given below : **18**

| Input $I_1$ | Input $I_2$ | Output O |
|---|---|---|
| 0.3 | – 0.2 | 0.2 |
| 0.4 | 0.6 | 0.3 |
| 0.6 | – 0.2 | 0.1 |

The initial vectors are

$$[w]^0 = \begin{bmatrix} 0.2 \\ -0.5 \end{bmatrix} \text{ and } [v]^0 = \begin{bmatrix} 0.1 & 0.4 \\ -0.2 & 0.2 \end{bmatrix}$$

No. of Printed Pages : 7

**MMTE-007**

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

## M.Sc. (MACS)

00546

## Term-End Examination

## June, 2016

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 hours* | *Maximum Marks : 50*
*(Weightage : 50%)*

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***Note :***

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

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

*(iii) Use of calculator is* ***not*** *allowed.*



---

1. (a) Let A and B be two fuzzy sets as given below :

$$A = \left\{ \frac{0{\cdot}5}{\text{Mohan}}, \frac{0{\cdot}9}{\text{Sohan}}, \frac{0{\cdot}7}{\text{John}}, \frac{0}{\text{Abdul}}, \frac{0{\cdot}2}{\text{Abraham}} \right\}$$

$$B = \left\{ \frac{0{\cdot}75}{\text{Mohan}}, \frac{0{\cdot}4}{\text{Sohan}}, \frac{0}{\text{John}}, \frac{0{\cdot}8}{\text{Abdul}}, \frac{0}{\text{Abraham}} \right\}$$

Determine the following : *3*

(i) Universe of discourse for sets A and B.

(ii) Compliment of sets A and B.

(iii) $A \cap B$

(iv) $A \cup B$

(b) Determine the $\alpha$-cut of the fuzzy set (A) as given below, at 0·7 and 0·2 :

$$A = \left\{ \frac{0}{10}, \frac{0}{20}, \frac{0 \cdot 2}{30}, \frac{0 \cdot 8}{40}, \frac{1 \cdot 0}{50}, \frac{1 \cdot 0}{60}, \frac{0 \cdot 6}{70}, \frac{0 \cdot 2}{80}, \frac{0}{90}, \frac{0}{100} \right\}$$

Compare the $\alpha$-cut of two outcomes, and give comments for status of $\alpha$-value variation. *3*

(c) Consider the following travelling salesman problem involving 10 cities :

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

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

Determine the children solution using order crossover (#1), assuming $4^{th}$ and $8^{th}$ sites as crossovers and cyclic crossover with $4^{th}$ position as initial position. *4*

2. Determine the new cluster center, using Fuzzy C-Mean (FCM) algorithm. Perform only one iteration. The relevant data is given below :

(a) Dataset for features $f_1$ and $f_2$ :

| 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) The number of clusters are 2 and the value of parameter which influence membership grade (m) is 2.

(c) The initial cluster centers are $v_1 = (6, 6)$ and $v_2 = (11, 11)$. *10*

3. Draw the multilayer architecture and determine the updated weights for the first input of the training set given below after one iteration :

| Input | | Output |
|---|---|---|
| $I_1$ | $I_2$ | O |
| 0·3 | – 0·2 | 0·2 |
| 0·4 | 0·6 | 0·3 |
| 0·6 | – 0·2 | 0·1 |

The initial vectors are $[W]^0 = \begin{bmatrix} 0\cdot3 \\ -0\cdot4 \end{bmatrix}$ and

$[V]^0 = \begin{bmatrix} 0\cdot2 & 0\cdot5 \\ -0\cdot1 & 0\cdot3 \end{bmatrix}$. Assume that the activation function is sigmoidal function, and learning rates are $\alpha = 1$ and $\eta = 0\cdot5$. *10*

4. Approximate the function $f(x) = 1 + \cos \pi x$ for $-1 \le x \le 1$, by solving 1-2-1 network, using Back propagation algorithm. The weighted structure and initial input are as follows :

(a) Weighted structure

$$[\mathbf{W}]^0 = \begin{bmatrix} -0{\cdot}25 \\ \\ -0{\cdot}40 \end{bmatrix}, \text{ bias } \phi_{(0)}^{(1)} = \begin{bmatrix} -0{\cdot}50 \\ \\ -0{\cdot}1 \end{bmatrix}$$

$$[\mathbf{V}]^0 = \begin{bmatrix} 0{\cdot}1 & -0{\cdot}2 \end{bmatrix}, \text{ bias } \phi_{(0)}^{(2)} = \begin{bmatrix} 0{\cdot}5 \end{bmatrix}$$

(b) Initial input is 1. *10*

5. (a) Compute the output for the neurons in the Kohonen networks, the related data is given below :

(i) Input to Kohonen neural network

Input Neuron-1$(I_1) = 0{\cdot}5$

Input Neuron-2$(I_2) = 0{\cdot}75$

(ii) Connected weights between the neurons are as given below :

| | |
|---|---|
| $I_1 \to O_1$ | 0·1 |
| $I_2 \to O_1$ | 0·2 |
| $I_1 \to O_2$ | 0·3 |
| $I_2 \to O_2$ | 0·4 |

*6*

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

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

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

(iii) $S_3 = * * * 0 * * * *$

(iv) $S_4 = * 1 * 0 1 *$

**6.** (a) Verify whether the Genetic Algorithm (GA) improves the solution from one generation to the next generation, for the function given below :

Maximize $f(x) = \sqrt{x}$

subject to $1 \leq x \leq 16$

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

(b) Consider a Hopfield network whose weight matrix is given by

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

Consider the two test input vectors

$\mathbf{P}_1 = [1 \quad -1 \quad 1]$ and $\mathbf{P}_2 = [-1 \quad 1 \quad -1]$.

Check whether the output state vectors satisfy alignment conditions. *4*

7. State whether the following statements are *true* or *false*. Give reasons for your answers. *5×2=10*

(a) If a 3-input neuron is trained to output a zero when the input is 110 and output one when the input is 111, then after generalization, the output will be zero when the input is 000 or 010 or 110 or 100.

(b) The length of chromosomes to determine maximum value of the set

$$S = \{x \mid 0 \leq x \leq 4096\} \text{ is } 12.$$

(c) The fuzzy relation

$$R = \begin{bmatrix} 1 & 0{\cdot}6 & 0 & 0{\cdot}2 & 0{\cdot}3 \\ 0{\cdot}6 & 1 & 0{\cdot}4 & 0 & 0{\cdot}8 \\ 0 & 0{\cdot}4 & 1 & 0 & 0 \\ 0{\cdot}2 & 0 & 0 & 1 & 0{\cdot}5 \\ 0{\cdot}3 & 0{\cdot}8 & 0 & 0{\cdot}5 & 1 \end{bmatrix}$$

is an equivalence relation.

(d) The backpropagation algorithm is used for both classification and clustering.

(e) In a single layer neural network, if $\sum_{i=0}^{n} x_i w_i > 0$, then the output is $-1$, otherwise 1.

*You may like to use the following table, wherever required :*

| $x$ | $e^x$ |
|---|---|
| $-0.09$ | $0.91$ |
| $-0.08$ | $0.92$ |
| $-0.75$ | $0.47$ |
| $-0.7$ | $0.50$ |
| $-0.5$ | $0.61$ |
| $-0.1$ | $0.90$ |
| $0.1$ | $1.11$ |
| $0.2$ | $1.22$ |
| $0.115$ | $1.27$ |
| $0.08$ | $1.08$ |

No. of Printed Pages : 6

**MMTE-007**

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

## M.Sc. (MACS)

## Term-End Examination

00484

## December, 2016

## 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 calculator is* ***not*** *allowed.*

**1.** (a) Let R and S be two fuzzy relations as given below :

R = "X considerably larger than Y" =

$$\begin{bmatrix} 0{\cdot}3 & 0{\cdot}8 & 0{\cdot}4 \\ 0{\cdot}6 & 0{\cdot}9 & 0{\cdot}1 \\ 0{\cdot}2 & 0{\cdot}5 & 0{\cdot}6 \end{bmatrix}$$

S = "X is very close to Y" =

$$\begin{bmatrix} 0{\cdot}2 & 0{\cdot}8 & 0{\cdot}4 \\ 0{\cdot}7 & 0{\cdot}9 & 0{\cdot}1 \\ 0{\cdot}8 & 0{\cdot}3 & 0{\cdot}5 \end{bmatrix}$$

Define the following fuzzy relations :

(i) X is considerably larger or very close to Y.

(ii) X is considerably larger and very close to Y. *3*

(b) Let X be a linguistic variable that measures a company's intellectual assets, which takes values from the Universe of discourse U = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}. Suppose the term set of X includes Excellent, Good, Fair and Bad. Express these fuzzy sets through enumeration. Construct the $\alpha$-cut at $\alpha$ = 0·4 for these fuzzy sets. *4*

(c) Design a neural network for XOR problem. *3*

**2.** (a) Consider a single input neuron, whose input is 2·0, weight is 2·3 and bias is –3. Find

(i) Net input to the transfer function,

(ii) Neuron output for transfer functions : Hard Limit, Linear, and Sigmoid (use a = 1). *5*

(b) Show that backpropagation reduces to the LMS algorithm for a single layer linear network (ADALINE). 5

3. (a) Consider a Hopfield network, whose weight matrix is given by

$$W = \frac{1}{4}\begin{bmatrix} 0 & -2 & 2 & 2 \\ -2 & 0 & -2 & 2 \\ 2 & -2 & 0 & -2 \\ 2 & 2 & -2 & 0 \end{bmatrix}.$$

Consider the two test input vectors $\mathbf{pt}_1 = (1\ -1\ 1\ 1)$ and $\mathbf{pt}_2 = (-1\ 1\ 1\ -1)$. Check whether the output state vectors satisfy the alignment condition. 5



(b) Consider two normally distributed probability distributions given by

$$P(x\,|\,\omega_i) = \frac{1}{\sqrt{2\pi}\,\sigma}\exp\left[-\frac{1}{2}\left(\frac{x-\mu_i}{\sigma}\right)^2\right], i = 1, 2$$

with equal deviations $\sigma = 1$ and priori probabilities $P(\omega_1) = P(\omega_2)$. Determine a classifier with a minimum classification error. 5

4. Calculate the modified weights found after training the competitive layer with Kohonen's rule, with learning rate ($\alpha$) 0·5 on the input-series in order $I_1$, $I_2$ and $I_3$.

where, $\mathbf{I_1} = [-1 \quad 0]^T$; $\mathbf{I_2} = [0 \quad 1]^T$ and $\mathbf{I_3} = \begin{bmatrix} \sqrt{2} & \dfrac{1}{\sqrt{2}} \end{bmatrix}^T$ and the initial values of three weight vectors are : $[0 \quad -1]^T$; $\begin{bmatrix} \dfrac{-2}{\sqrt{5}} & \dfrac{1}{\sqrt{5}} \end{bmatrix}^T$; $\begin{bmatrix} \dfrac{-1}{\sqrt{5}} & \dfrac{2}{\sqrt{5}} \end{bmatrix}^T$. *10*

5. (a) Minimize the fitness function $f(x) = x^2$, subject to $0 \leq x \leq 16$, using genetic algorithm approach. *6*

(b) Consider the following travelling salesman problem involving 9 cities :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parent 1 : | A | B | C | D | E | F | G | H | I |
| Parent 2 : | C | D | E | A | B | I | H | G | F |

Determine the children solution using

(i) Order crossover #1, where two crossover sites are at positions $3^{rd}$ and $7^{th}$.

(ii) Order crossover #2, for selected position 2, 4, 7, 8 as key positions. *4*

6. (a) State Schema theorem and perform the following : 5

(i) Write the schema for the gene sequence {0 1 1 1 0 0 0} and {1 1 1 0 0 1 1}.

(ii) Write at least 4 chromosome sets, which are directly identified by schema S = (0 1 * 1 *) .

(b) Derive the updation rule for weights in backpropagation algorithm, when the activation function is tanh x. 5

7. Which of the following statements are *True*, and which are *False* ? Give reasons. 10

(a) In a multilayer neural network, if the number of nodes at input, hidden and output layers are 6, 4 and 2 respectively, then the number of edges involved in the network is 32.

(b) If A and B are two fuzzy sets with $\mu_A(x) = 0{\cdot}4$ and $\mu_B(x) = 0{\cdot}8$, then $\mu_{A \cap B}(x) = 0{\cdot}4$.

(c) The order of the schema * * 0 1 * * is 2.

(d) In genetic algorithm, minimization problems can be transformed into maximization problems.

(e) In a single-layer neural network, the output corresponding to the input vector $[1 \quad 1]^t$ with weight vector $[1 \quad 1]$ and bias $-1\cdot5$ is 0.

*You may like to use the following table wherever required :*

| x | exp(x) |
|---|---|
| 1·6 | 4·95 |
| – 1·6 | 0·20 |
| 1·5 | 4·48 |
| – 1·5 | 0·22 |
| 2 | 7·39 |

No. of Printed Pages : 1

**MMTE-007(P)**

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

00173

### Term-End Practical Examination

### December, 2016

### MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ Hours* *Maximum Marks : 40*

**Note :** (i) *This question paper has two questions worth 30 marks. Answer* **both** *questions.*

(ii) *Remaining 10 marks are for viva-voce.*

**1.** Write a program in 'C' language to implement the FCM algorithm. Also, test it to find the final fuzzy partition and cluster centers for the following data :

| | $f_1$ | $f_2$ |
|---|---|---|
| $x_1$ | 11 | 6 |
| $x_2$ | 14 | 9 |
| $x_3$ | 7 | 9 |
| $x_4$ | 13 | 6 |
| $x_5$ | 9 | 10 |

The initial cluster centers are : $v_1 = (5, 5)$, $v_2 = (10, 10)$ with $c = m = 2$. *15*

**2.** Write a program in 'C' language to write the Children Solution of a Travelling Salesman Problem consisting of n cities using

(a) Cyclic crossover, and

(b) Position-based crossover.

Test your program for *15*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parent 1 : | A | B | C | D | E | F | G | H |
| Parent 2 : | C | B | A | F | E | D | H | G |

No. of Printed Pages : 1

**MMTE-007(P)**

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

**Term-End Practical Examination**

00362

**June, 2017**

**MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS**

*Time : $1\frac{1}{2}$ Hours* *Maximum Marks : 40*

***Note :*** *(i) There are two questions in this paper, totalling 30 marks. Answer **both** of them.*

*(ii) Remaining 10 marks are for viva-voce.*

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**1.** Write a program in 'C' language to find the modified weights for Kohonen Networks. Also test your program on the input patterns as given below :

$I_1 = [-1 \quad 0]^t$, $I_2 = [0 \quad 1]^t$ and $I_3 = \left[\sqrt{2} \quad \frac{1}{\sqrt{2}}\right]^t$

Given that the initial values of three weight vectors are $[0 \quad -1]^t$, $\left[-\frac{2}{\sqrt{5}} \quad \frac{1}{\sqrt{5}}\right]^t$ and $\left[-\frac{1}{\sqrt{5}} \quad \frac{2}{\sqrt{5}}\right]^t$ and learning rate $\alpha = 0{\cdot}5$. *15*



**2.** Write a program in 'C' language to maximize $f(x) = \sqrt{x}$, subject to $1 \le x \le 625$ by considering the string length 10 using Genetic Algorithm. *15*

No. of Printed Pages : 5

**MMTE-007**

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

## M.Sc. (MACS)

## Term-End Examination

00122

## June, 2017

## 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 scientific and non-programmable calculator is allowed.*

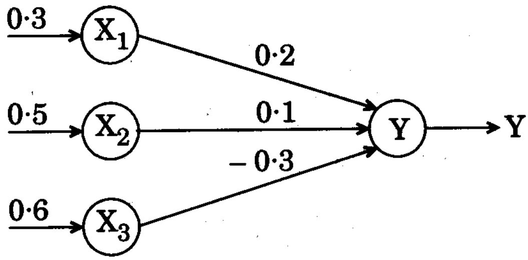


1. (a) Perform Union, Intersection, Difference and Complement operations over fuzzy sets A and B given below : 4

$$\mathbf{A} = \left\{\frac{1}{2}, \frac{0{\cdot}3}{4}, \frac{0{\cdot}5}{6}, \frac{0{\cdot}2}{8}\right\};$$

$$\mathbf{B} = \left\{\frac{0{\cdot}5}{2}, \frac{0{\cdot}4}{4}, \frac{0{\cdot}1}{6}, \frac{1}{8}\right\}$$

(b) Calculate the net input to the output neuron, for the network shown below : 2




(c) A single-layer neural network has six inputs and two outputs. The outputs are to be limited to and continuous over [0, 1]. Answer the following : 4

(i) How many neurons are required ?

(ii) What are the dimensions of the weight matrix ?

(iii) Which transfer function can be used ?

(iv) Is a bias required ? If yes, why ?

**2.** (a) Consider a Kohonen self-organizing net (given below) with two cluster units and five input units. The weight vectors for the cluster units are given by

$$w_1 = \{1 \cdot 0, 0 \cdot 9, 0 \cdot 7, 0 \cdot 5, 0 \cdot 3\}$$

$$w_2 = \{0 \cdot 3, 0 \cdot 5, 0 \cdot 7, 0 \cdot 9, 1 \cdot 0\}$$

Use the square of the Euclidean distance to find the winning cluster unit for the input pattern (x)

$$x = [0 \cdot 0 \quad 0 \cdot 5 \quad 1 \cdot 0 \quad 0 \cdot 5 \quad 0 \cdot 0].$$

Using learning rate of 0·25, find the new weights for the winning unit. 7

(b) Differentiate between the effects of operator crossover and mutation in the genetic algorithm with suitable example. 3

3. (a) State the Schema theorem. 2

(b) Improve the solution of the following problem using the genetic algorithm :

Maximize $f(x) = \sqrt{x}$, subject to $1 \leq x \leq 25$ by considering the length of the string 4. Show only one iteration, 5

(c) Give an example of Radial Basis Function Network and draw its network diagram. 3

4. (a) Design a Hopfield Network for 4-bit bipolar patterns. The training patterns are

$$S_1 = [1 \ \ 1 \ \ -1 \ \ -1]$$

$$S_2 = [-1 \ \ 1 \ \ -1 \ \ 1]$$

$$S_3 = [-1 \ \ -1 \ \ -1 \ \ 1]$$

Find the weight matrix and energy for the three input samples. Determine the pattern to which the sample $S = [-1 \ \ 1 \ \ -1 \ \ -1]$ associates. 7

(b) Using max-min composition, find the relation between R and S : 3

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \end{array} \text{ and } S = \begin{array}{c} \\ y_1 \\ y_2 \\ y_3 \end{array} \begin{array}{c} \begin{array}{cc} z_1 & z_2 \end{array} \\ \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} \end{array}$$

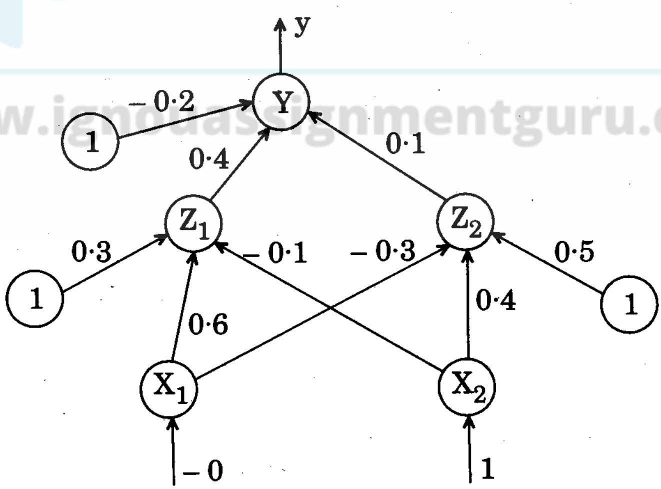
**5.** (a) Differentiate between supervised and unsupervised pattern recognition. Also give an example of each. *4*

(b) Apply both Order crossover and Position crossover on the two strings given below to generate offsprings : *4*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A → | 1 | 2 | 4 | 9 | 8 | 6 | 7 | 3 | 5 |
| B → | 2 | 3 | 6 | 8 | 5 | 1 | 4 | 7 | 9 |

(c) Write 4 chromosome sets which are identified by the schema S = (0 1 * 1 *). *2*

**6.** Using Back propagation network, find the new weights for the net shown below. It is presented with the input pattern [0, 1] and the target output is 1. Use learning rate of 0·25 and binary sigmoidal activation function. *10*



7. State whether the following statements are *True* or *False* ? Give reasons for your answers. 10

(a) The length and order of the schema $S = (* * * 0 * * *)$ are 0 and 1 respectively.

(b) If $\alpha_1 < \alpha_2$, then the subset relation is $A_{\alpha_1} \supseteq A_{\alpha_2}$.

(c) If $w(k_0) = w(k_0 + 1) = w(k_0 + 2)$, then the perceptron is non-linear separable.

(d) In a single-layer neural network, if $\sum_{i=0}^{n} x_i w_i < 0$, then the output is 1, otherwise it is $-1$.

(e) Hopfield network is a multi-layer network.

No. of Printed Pages : 1

**MMTE-007(P)**

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

### Term-End Practical Examination

### December, 2017

00363

### MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ Hours* *Maximum Marks : 40*

***Note :*** *(i) There are two questions in this paper, totalling 30 marks. Answer **both** of them.*

*(ii) Remaining 10 marks are for the viva-voce.*

---

**1.** Write a program in 'C' language to write the children solution of the Travelling Salesman Problem consisting of n cities using crossover order (#1). Test your program to find the children solution of the following two parents : *15*

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

**2.** Write a program in 'C' language to implement the back propagation algorithm. Show step-by-step output to input, hidden and output neurons as well as errors. How are the weights **W** and **V** modified ?

Test your program for the following values :

The weights $w_{11}$, $w_{12}$, $w_{21}$ and $w_{22}$ on connection from the input neurons to hidden layer neurons are $w_{11} = 0{\cdot}15$, $w_{12} = 0{\cdot}3$, $w_{21} = 0{\cdot}15$, $w_{22} = 0{\cdot}3$. The weights on the connections from hidden layer neurons to output layer neurons are $v_1 = -0{\cdot}3$ and $v_2 = 0{\cdot}3$. *15*

No. of Printed Pages : 5 **MMTE-007**

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

# M.Sc. (MACS)

00801

## Term-End Examination

## December, 2017

## 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.*

**1.** (a) How do classical sets differ from fuzzy sets ? Consider the two given fuzzy sets A and B.

$$A = \left\{\frac{1}{2} + \frac{0 \cdot 3}{4} + \frac{0 \cdot 5}{6} + \frac{0 \cdot 2}{8}\right\} \text{ and}$$

$$B = \left\{\frac{0 \cdot 5}{2} + \frac{0 \cdot 4}{4} + \frac{0 \cdot 1}{6} + \frac{1}{8}\right\}$$

Perform Union, Intersection, Complement and Difference operations over fuzzy sets A and B. *6*

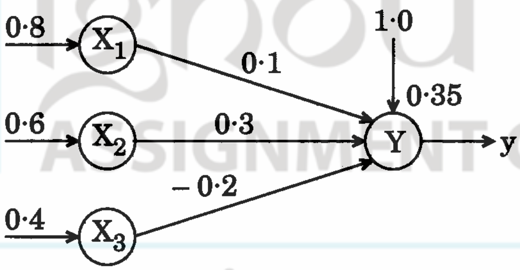
(b) Compare and contrast the following with suitable examples : *4*

(i) Crisp K-NN classification technique and Fuzzy K-NN classification technique

(ii) Supervised pattern recognition and Unsupervised pattern recognition

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

(b) Obtain the output of the neuron Y for the network given below using activation function as (i) binary sigmoidal, and (ii) bipolar sigmoidal : *5*






**3.** (a) Find the weights required to perform the following classification using perceptron network :

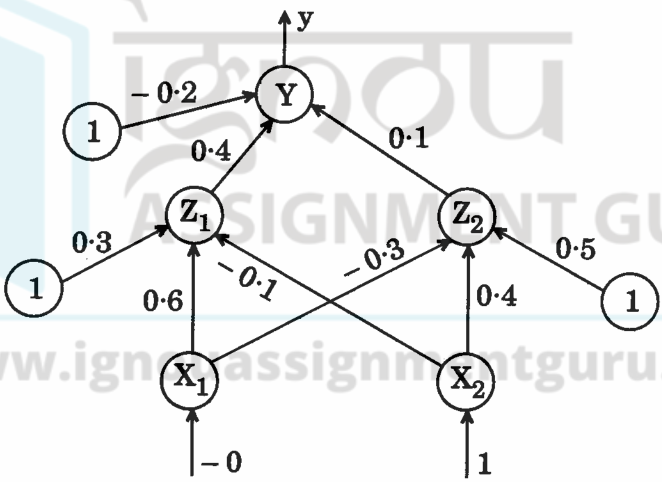
The vectors (1, 1, 1, 1) and (– 1, 1, – 1, – 1) are belonging to the class (so have target value 1), vectors (1, 1, 1, – 1) and (1, – 1, – 1, 1) are not belonging to the class (so have target value – 1).
Assume learning rate as 1 and initial weights as 0. *6*

(b) Two fuzzy relations are given by

$$R = \begin{array}{c|cc} & y_1 & y_2 \\ \hline x_1 & 0{\cdot}6 & 0{\cdot}3 \\ x_2 & 0{\cdot}2 & 0{\cdot}9 \end{array} \quad \text{and } S = \begin{array}{c|ccc} & z_1 & z_2 & z_3 \\ \hline y_1 & 1 & 0{\cdot}5 & 0{\cdot}3 \\ y_2 & 0{\cdot}8 & 0{\cdot}4 & 0{\cdot}7 \end{array}.$$

Obtain fuzzy relation $T$ as a composition between these fuzzy relations. *4*

4. Using back-propagation algorithm, find the new weights for the following network [perform one iteration] :






Given that :

(a) Input pattern is [0, 1].

(b) Target output is 1.

(c) Learning rate $\alpha = 0{\cdot}25$.

(d) Activation function is binary sigmoidal. *10*

**5.** (a) Generate the population in the next iteration using Roulette-Wheel criterion. *6*

| k | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $F_k$ | 3·5 | 4·6 | 5 | 2·8 | 1·8 |

(b) Write a formula describing the function defined by one-hidden-layer (already trained) MLP with a single output. Also, write a formula describing the function by a RBFN with a single output. How do they differ ? *4*

**6.** (a) Use a binary-coded Genetic Algorithm (GA) to minimize the function

$$f(x_1, x_2) = x_1 + x_2 - 2x_1^2 - x_2^2 + x_1 x_2$$
$$0 \le x_1, x_2 \le 5.$$

Use a random population of size N = 6, a single point crossover with probability $P_c = 1$ and neglect mutation. Assume 3 bits for each variable. Perform one iteration. *6*

(b) Take any two fuzzy sets and verify any one of De Morgan's laws graphically and numerically. *4*

7. State, giving reasons, whether the following statements are *True* or *False* : *5×2=10*

(a) A multilayer network with linear transfer function is equivalent to a single-layer network.

(b) If a Genetic Algorithm is to be used to evolve a binary string of length n containing only 1's, and the initial population is a randomly generated set of binary strings of length n, then the suitable fitness function would be the sum of 1's in the string.

(c) In the Hopfield network, the neurons belonging to the same layer receive inputs from the neurons of the previous layer and send their values only to neurons of the next layer.

(d) Radial Basis Function (RBF) network is a local network.

(e) The length of chromosomes to determine the maximum value of the set

$$S = \{x \mid 0 \le x \le 4096\} \text{ is } 12.$$

No. of Printed Pages : 1

**MMTE-007(P)**

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

## Term-End Practical Examination

00090

**June, 2018**

## MMTE-007(P) : SOFT COMPUTING AND ITS APPLICATIONS

*Time : $1\frac{1}{2}$ Hours* *Maximum Marks : 40*

**Note :** *(i) This question paper has two questions worth 30 marks.*

*(ii) Remaining 10 marks are for viva-voce.*

**1.** Write a program in 'C' language to write the children solution of a Travelling Salesman Problem (TSP) consisting of n cities using position-based crossover in genetic algorithm.

Also, test your program to find the children solution of the following parent problem :

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parent 1 : | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Parent 2 : | 2 | 1 | 4 | 3 | 6 | 5 | 8 | 7 | 10 | 9 |

15



**2.** Write a program in 'C' language to implement the back propagation algorithm. Test your program to modify weights by taking any suitable initial vectors. Also show step-by-step output to input, hidden and output neurons as well as errors. 15

No. of Printed Pages : 6

**MMTE-007**

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

## M.Sc. (MACS)

## Term-End Examination

00575

## June, 2018

## 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.*



**1.** (a) Given the two fuzzy sets

$$A = \left\{\frac{1}{1\cdot0}, \frac{0\cdot75}{1\cdot5}, \frac{0\cdot3}{2\cdot0}, \frac{0\cdot15}{2\cdot5}, \frac{0}{3\cdot0}\right\}$$

$$B = \left\{\frac{1}{1\cdot0}, \frac{0\cdot6}{1\cdot5}, \frac{0\cdot2}{2\cdot0}, \frac{0\cdot1}{2\cdot5}, \frac{0}{3\cdot0}\right\}$$

Find the following : *3*

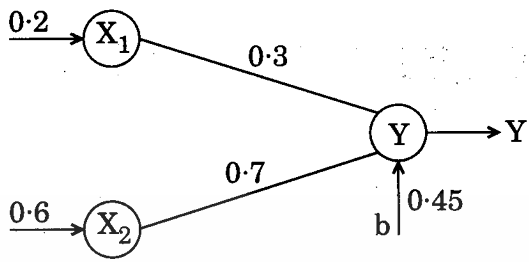
(i) $A \cup B$

(ii) $A \cap B$

(iii) $A \cap \overline{B}$

(iv) $A \cap \overline{A}$

(b) Calculate the net input to the output neuron for the network shown below. Here b is the bias included in the network. 2




(c) Implement AND NOT function using McCulloch-Pitts neuron. 5

**2.** (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 4

(i) Order crossover # 1, where two crossover sites are at positions $4^{th}$ and $8^{th}$.

(ii) Order crossover # 2, for selected positions 3, 5, 7, 9 as key positions.

(b) Determine the new cluster centre, using Fuzzy C-Mean (FCM) algorithm. Perform only one iteration. The relevant data is given below : *6*

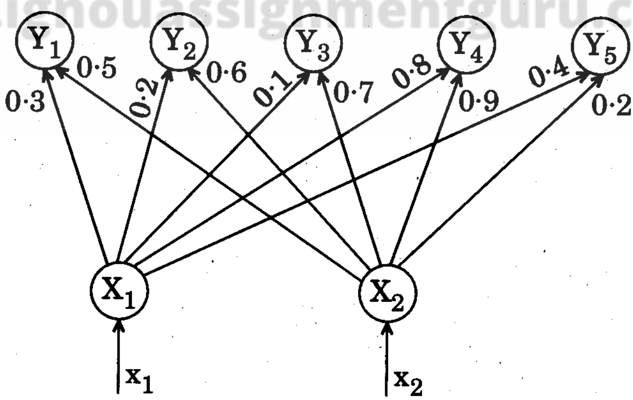
(i) Data set for features $f_1$ and $f_2$ :

| Point | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ |
|---|---|---|---|---|---|
| $f_1$ | 1 | 3 | 5 | 7 | 9 |
| $f_2$ | 11 | 8 | 12 | 4 | 6 |

(ii) The number of clusters are 2 and the value of parameters which influence membership grade (m) is 2.

(iii) The initial cluster centres are $v_1 = (6, 6)$ and $v_2 = (11, 11)$.

**3.** (a) Perform the following for the Kohonen self-organizing feature map with weights, given below.
Find the cluster unit $Y_j$ closest to the input vector (0·2, 0·4). Also find the new weights for unit $Y_j$.
Use learning rate of 0·2 and square of the Euclidean distance to find the cluster unit. *7*

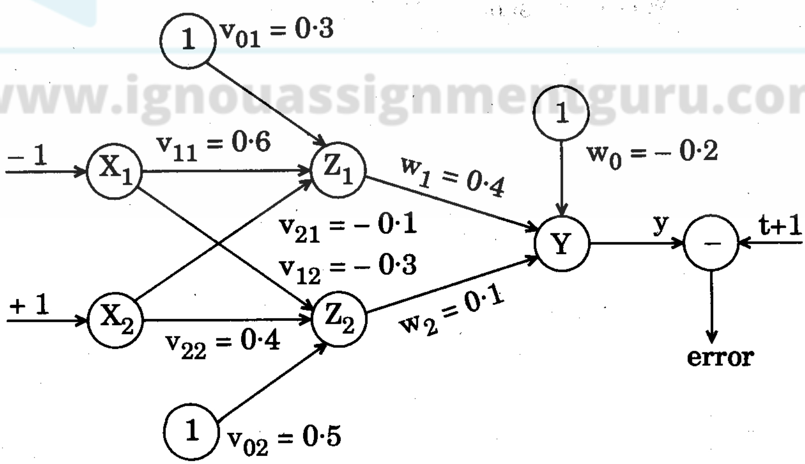



(b) Discuss the XOR problem. *3*

**4.** (a) Find the alpha ($\alpha$) cut relation for $\alpha = 0{\cdot}2, 0{\cdot}4, 0{\cdot}7$ and $0{\cdot}9$ on the fuzzy relation R given as 2

$$R = \begin{bmatrix} 0{\cdot}2 & 0{\cdot}5 & 0{\cdot}7 & 1 & 0{\cdot}9 \\ 0{\cdot}3 & 0{\cdot}5 & 0{\cdot}7 & 1 & 0{\cdot}8 \\ 0{\cdot}4 & 0{\cdot}6 & 0{\cdot}8 & 0{\cdot}9 & 0{\cdot}4 \\ 0{\cdot}9 & 1 & 0{\cdot}8 & 0{\cdot}6 & 0{\cdot}4 \end{bmatrix}$$

(b) Find the new weights, using Back-Propagation network, for the network shown below. The network is presented with the input pattern [– 1, 1] and target output is + 1. Use learning rate of 0·25 and bipolar sigmoidal activation function. 8



5. (a) Differentiate between Classical and Fuzzy clustering with example. 3

(b) Generate the population in the next iteration using Roulette-Wheel Criterion. 5

| Variable No. K | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Fitness Value $F_k$ | 3·5 | 4·6 | 5 | 2·8 | 1·8 |

(c) Apply single point crossover on the following binary strings and generate two offsprings

$A \rightarrow 0\,1\,1\,0\,1\,0\,0\,1\,0\,1$

$B \rightarrow 0\,1\,0\,0\,1\,1\,0\,0\,1\,0$

Consider $4^{th}$ bit as the crossover site. 2

6. (a) Show that a multi-layer network with linear transfer function is equivalent to a single layer linear network. 3

(b) Write the schema for the gene sequence {0 1 1 1 0 0 0} and {1 1 1 0 0 1 1}.

Find the length and order of the schema. 3

(c) The input to a single-input neuron is 2·0, its weight is 2·3 and its bias is – 3. 4

(i) What is the net input to the transfer function ?

(ii) What is the neuron output for the following transfer function :

(a) Hard Limit

(b) Linear

(c) Log-Sigmoid

**7.** State, giving reasons, whether the following statements are *True* or *False* : *5×2=10*

(a) The cardinality of fuzzy sets on any universe is finite.

(b) Laws of excluded middle are not valid for fuzzy sets.

(c) The Self Organizing Map (SOM) is unsupervised learning technique.

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

(e) The length of chromosomes to determine maximum value of the set

$$S = \{x \mid 0 \leq x \leq 4096\} \text{ is } 10.$$

192141

No. of Printed Pages : 3

**MMTE-007(P)**

# M. Sc. (Mathematics with Applications in Computer Science) M. Sc. (MACS)

## Term-End Examination

## December, 2018

## SOFT COMPUTING AND ITS APPLICATIONS (PRACTICAL)

*Time : $1\frac{1}{2}$ Hours* *Maximum Marks : 40*

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***Note :*** (i) This question paper has *two* questions worth 30 marks.

(ii) Remaining 10 marks are for viva-voce.

---

1. Write a program in 'C' language to write the children solution of a Travelling Salesman problem consisting of n cities using cyclic crossover in genetic algorithm. Also, test your program to find the children solution of the following two parents : 15

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

2. Implement the Fuzzy C-means (FCM) algorithm using 'C' language. Also, test the program to find the cluster centers for the following two-dimensional data sets :

| $k$ | $x_{k_1}$ | $x_{k_2}$ |
|---|---|---|
| 1 | 0.9 | 0 |
| 2 | 1.1 | 0 |
| 3 | 1.9 | 0 |
| 4 | 0.8 | 0 |
| 5 | 0.6 | 0 |
| 6 | 0 | 0.1 |
| 7 | 0 | 1.7 |
| 8 | 0 | 1.8 |
| 9 | 0 | 1 |
| 10 | 0 | 0.2 |

Assume that convergence is achieved when the difference between the two values is less than or equal to 0.05. Starting with different initial membership matrices check whether the final membership functions are always same ? 15

No. of Printed Pages : 6

**MMTE-007**

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

## M.Sc. (MACS)

## Term-End Examination

00292

## December, 2018

## 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 scientific and non-programmable calculator is allowed.*

**1.** (a) What are fuzzy relations ? Compute the Cartesian product of two fuzzy sets A and B given below : *4*

$$A = \left\{\frac{0{\cdot}3}{x_1} + \frac{0{\cdot}7}{x_2} + \frac{1}{x_3}\right\} \text{ and } B = \left\{\frac{0{\cdot}4}{y_1} + \frac{0{\cdot}9}{y_2}\right\}$$

(b) Implement NAND function using McCulloch-Pitts neuron, for binary data representation given below : *6*

| | | | | | |
|---|---|---|---|---|---|
| Input | $x_1$ | 0 | 0 | 1 | 1 |
| | $x_2$ | 0 | 1 | 0 | 1 |

2. (a) Write short notes on the following with examples : 6

(i) Perceptron Learning Rule

(ii) Widrow-Hoff (LMS) Learning Rule

(b) Determine the following :

(i) Net input to the transfer function

(ii) Output of neuron for the following transfer functions :

I. Hard limit

II. Linear

III. Log-sigmoid

for a Neutral network, where input to a single-input neuron is 2·0, weight is 2·3 and bias is –3. 4



3. (a) Consider three-layer perceptron with three inputs, three hidden and one output units. Given the initial weight matrix for hidden and output nodes as,

$$W_H = \begin{bmatrix} 3 & 2 & 1 \\ 2 & 3 & 3 \\ 1 & 4 & 2 \end{bmatrix} \text{ and } W_0 = \begin{bmatrix} 0 \\ 2 \\ 3 \end{bmatrix}$$

If input vector is $I = [4 \quad 5 \quad 1]$, calculate the output using hard limiting function as activation function. 6

(b) Consider a 5-bit chromosome '10011'. List all the schemas. Find the length and order of each of the schemas. *4*

4. (a) Improve the solution of the following problem :

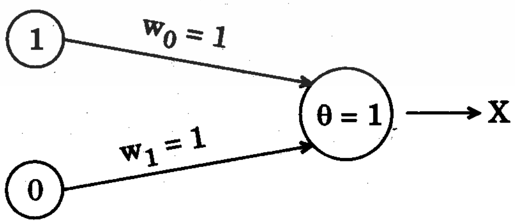
Maximize $f(x) = \sqrt{x}$, subject to

$1 \leq x \leq 15$ by considering the length of the string as 4. Show only one iteration. *5*

(b) A small perceptron with two inputs and one output unit is trained using the following training set :

| Pattern No. | Input | Output |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 0 | 0 |

At some instant, current weights of connections and inputs to the network are as shown below :




(i) What training pattern has been used at that instant ?

(ii) What output will the network produce ?

(iii) If the network learning rate is 0·25, then find the change in weights $w_0$ and $w_1$. 5

5. (a) How does ADALINE differ from MADALINE ? Discuss the MADALINE architecture with a suitable diagram. 4

(b) Consider a data set of five points given in the following table, each of which has two features $f_1$ and $f_2$. Apply FCM algorithm to determine the new cluster centre after one iteration. The initial cluster centres are given by $v_1 = (4, 5)$ and $v_2 = (11, 10)$.

| | $f_1$ | $f_2$ |
|---|---|---|
| $x_1$ | 7 | 12 |
| $x_2$ | 12 | 3 |
| $x_3$ | 13 | 8 |
| $x_4$ | 4 | 4 |
| $x_5$ | 5 | 5 |

Assume the constants $c = m = 2$. 6

6. (a) State the Travelling Salesman Problem (TSP) and give an example. Consider the following TSP involving 9-cities :

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

Determine the children solution using

(i) Order Crossover #1, assuming $4^{th}$ and $7^{th}$ sites as the Crossover sites.

(ii) Order Crossover #2, assuming $3^{rd}$, $5^{th}$ and $7^{th}$ as the key positions. *6*

(b) Determine the connectivity matrix for the pattern P (four patterns) given below : *4*

$$P = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

**7.** State whether the following statements are *True* or *False*. Justify your answer. *5×2=10*

(a) Back propagation reduces to the LMS algorithm for a Single Layer Linear Network (ADALINE).

(b) The offsprings of parents with a high fitness value, have a high fitness value, for any fitness function.

(c) In Radial Basis Function (RBF) network, the neurons belonging to the same layer send their output to the neurons of the next and previous layers.

(d) Hopfield network is a particular case of Kohonen network.

(e) For any two fuzzy sets A and B and $x \in U$, if $\mu_A(x) = 0{\cdot}4$ and $\mu_B(x) = 0{\cdot}8$, then the value of $\mu_{\overline{A} \cup \overline{B}} = 0{\cdot}4$.

No. of Printed Pages : 5

**MMTE-007**

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

## M.Sc. (MACS)

00621

## Term-End Examination

## June, 2019

## 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 and non-scientific calculator is allowed.*

*(iv) All symbols have their usual meanings.*

**1.** (a) In a neural network, if input, weight and bias to a single-input neuron are 2·0, 2·3 and – 3 respectively, then,

(i) Determine the net input to the transfer function.

(ii) Determine the neuron output for the following transfer functions : *4*

I. Hard Limit

II. Linear

III. Log-sigmoid

(b) What is Sigma-Pi Network ? How is it different from Multilayer Perceptron (MLP) ? What are the limitations of Sigma-Pi Network ? 6

2. (a) What are two major limitations of Hopfield networks ? Under what conditions, a Hopfield model of 'N' nodes can achieve 100% correct retrieval on 'P' patterns ? 5

(b) Maximize $f(x) = \frac{-x^2}{10} + 3x$, where $0 \leq x \leq 31$ using genetic algorithm. 5



3. (a) Let P and Q be the fuzzy sets with their membership functions $\mu_P(x) = 0{\cdot}8$ and $\mu_Q(x) = 0{\cdot}65$, respectively. Write the membership function of $\overline{P}$, $P \cap Q$, $P \cup Q$ and $\overline{P} \cup Q$. 4

(b) Consider a single layer perceptron having 2 inputs and 1 output. Let threshold be 0·5, learning rate be 0·6, bias be – 2 and weight values $w_1 = 0{\cdot}3$ and $w_2 = 0{\cdot}7$. If the input patterns are given in the following table, then find the value of output and training using perceptron learning rule for one epoch. *6*

Input Pattern

| $x_1$ | $x_2$ | D |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | – 1 |
| 0 | 0 | 1 |

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

$$S = [111; 101; 100]$$

Find the weight matrix. *8*

(b) Write the expression for triangular membership function. *2*



5. (a) Consider the following travelling salesman problem involving 9 cities :

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

Determine the children solution using

(i) order crossover #1, and

(ii) order crossover #2. *4*

(b) Find max – average composition for R(x, y) and S(x, y) defined by the following relational matrices : 6

$$R = \begin{bmatrix} 0.1 & 0.2 & 0 & 1 & 0.7 \\ 0.3 & 0.5 & 0 & 0.2 & 1 \\ 0.8 & 0 & 1 & 0.4 & 0.3 \end{bmatrix},$$

$$S = \begin{bmatrix} 0.9 & 0 & 0.3 & 0.4 \\ 0.2 & 1 & 0.8 & 0 \\ 0.8 & 0 & 0.7 & 1 \\ 0.4 & 0.2 & 0.3 & 0 \\ 0 & 1 & 0 & 0.8 \end{bmatrix}$$

**6.** (a) Write the schema for the gene sequence (1000111) and (0001100). Also, write six chromosome sets identified by the schemas written by you. 4



(b) Consider the data :

| | $x_1$ | $x_2$ | $x_3$ | $x_4$ |
|---|---|---|---|---|
| $f_1$ | 1 | 2 | 3 | 4 |
| $f_2$ | 10 | 8 | 6 | 5 |

Apply fuzzy c-mean algorithm to find the new cluster centre after one iteration. 6

[Use c = m = 1 and $v_1 = (4, 4)$, $v_2 = (8, 8)$].

7. State whether the following statements are *True* or *False*. Give reasons for your answers. *10*

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

(b) The length of chromosomes to determine the maximum value of the set (S)

$$S = \{X \mid 0 \leq x \leq 4096\} \text{ is } 12.$$

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

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

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

No. of Printed Pages : 4

**MMTE-007**

M00745

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

## Term-End Examination,

## December 2019

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 Hours]* *[Maximum Marks : 50*
*(Weightage : 50%)*

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*Note :* (i) *Question No. 7 is* ***compulsory.***

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

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

(iv) *All the symbols have their usual meaning.*

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1. a) What is $\alpha$-cut of a Fuzzy set? Establish the relation between the set generated by $\alpha$-cutting and the value of $\alpha$. Why do we need to determine the $\alpha$- cut of a fuzzy set? 5

   b) Differentiate between the following: 5

      i) Clustering and classification techniques

      ii) Mays Learning Rule and Widrow-Hoff (LMS) Learning rule.

2. a) Write Fuzzy C-Means algorithm? How it is related to K-means algorithm? What is the practical application of Fuzzy C-mean algorithm? Discuss with suitable example. 6

b) Find the Length and Order of the following schemas: 4

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

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

iii) $S_3 = * * * 0 * * * *$

iv) $S_4 = * 1 * 0 1 *$

3. a) Define the McCulloch-Pitts model. What are the rules for evaluating the input to a McCulloch-Pitts unit? Implement AND function using McCulloch-Pitts neuron (Take binary data) 7

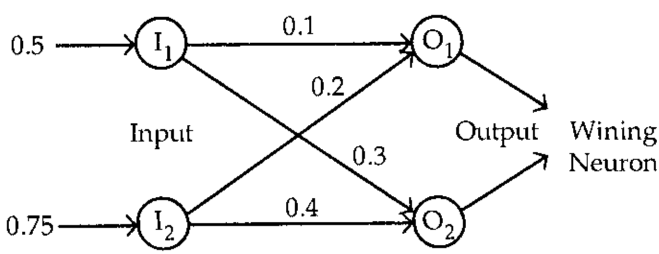
b) Check whether the Fuzzy relation

$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 \\ 0.6 & 1 & 0.4 & 0 \\ 0 & 0.4 & 1 & 0 \\ 0.2 & 0 & 0 & 1 \end{bmatrix}$$ is an equivalence relation.

3



4. a) Write the algorithm for training a Kohonen network. Calculate the output of each neuron, for the Kohonen network shown below. 4



b) Illustrate the steps involved in genetic algorithm to minimize $f(x) = x \sin x + 1$, such that $x$ takes the values between $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ for one generation. The value of crossover probability and mutation probability are 0.4 and 0.2 respectively, and the population size is 6. 6

5. a) Show that single layer linear network is equivalent to multilayer network with Linear transfer function. 5

b) What are Radial Basis Function Networks (RBFN)? How RBFN is used for polynomial fitting? Give suitable example. 5



6. a) Find the children solution of the following travelling salesman problem using order crossover #2 and position crossover: 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parent 1: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Parent 2: | 2 | 3 | 6 | 8 | 5 | 1 | 4 | 7 | 9 |

b) Consider the Fuzzy sets A and B defined on the interval $X = [0, 5]$ by the membership grade functions

$$\mu_A(x) = \frac{x}{x+1} \text{ and } \mu_B(x) = 2^{-x}$$

Determine the mathematical formulae and graphs of the membership function of each of the following sets: $A^C$, $B^C$, $A \cup B$, $A \cap B$, $(A \cup B)^C$. 6

7. State whether following statements are True or False. Give reasons for your answers. 10

i) Kohonen network is trained in an unsupervised mode.

ii) Hop field network is a form of Artificial Neural Network that serves as content, addressable memory system with binary threshold units.

iii) The K-Nearest Neighbour algorithm is used for both classification and clustering.

iv) The length and order of the schema

S = (* * * 0 1 * * 1) are 0 and 1 respectively.

v) If two Fuzzy sets A and B are $\left\{\frac{0.2}{x_1}, \frac{0.8}{x_2}\right\}$ and $\left\{\frac{0.6}{x_1}, \frac{0.8}{x_2}\right\}$ respectively, then A ≠ B.



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No. of Printed Pages : 10 **MMTE-007**

# M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)

## M. Sc. (MACS)

## Term-End Examination

## June, 2020

## MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 Hours* *Maximum Marks : 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 $\alpha$-cut of the Fuzzy set (A) are given below, at 0.7 and 0.2. 3

$$A = \left\{\frac{0}{10}, \frac{0}{20}, \frac{0.2}{30}, \frac{0.8}{40}, \frac{1.0}{50}, \frac{1.0}{60}, \frac{0.6}{70}, \frac{0.2}{80}, \frac{0}{90}, \frac{0}{100}\right\}$$

Also, compare the $\alpha$-cut of the two outcomes, and give comments for status of $\alpha$-value variation.

(b) Consider the following table for the connections between input neurons and the hidden layer neurons :

| Input Neurons | Hidden Layer Neurons | Connection Weight |
|---|---|---|
| 1 | 1 | – 1 |
| 1 | 2 | – 0.1 |
| 1 | 3 | 1 |
| 2 | 1 | – 1 |
| 2 | 2 | 1 |
| 2 | 3 | 1 |
| 3 | 1 | – 0.2 |
| 3 | 2 | – 0.3 |
| 3 | 3 | – 0.6 |

The connection weights from the hidden layer neurons to the output neurons are – 0.6, – 0.3 and – 0.6, for the first, second and third neurons, respectively. Corresponding threshold value for the output layer is 0.5 and for the hidden layer is 1.8, 0.05 and 0.2 for the first, second and third neurons, respectively. 5

(i) Draw the diagram of the network.

(ii) Write the output at each node.

(c) Using diagram, show the difference between feed-forward neural network and recurrent neural network. 2



2. (a) Let A and B be two Fuzzy sets as given below : 4

$$A = \left\{ \frac{0.5}{\text{Mohan}}, \frac{0.9}{\text{Sohan}}, \frac{0.7}{\text{John}}, \frac{0}{\text{Abdul}}, \frac{0.2}{\text{Abraham}} \right\}$$

$$B = \left\{ \frac{0.75}{\text{Mohan}}, \frac{0.4}{\text{Sohan}}, \frac{0}{\text{John}}, \frac{0.8}{\text{Abdul}}, \frac{0}{\text{Abrahm}} \right\}$$

Determine the following :

(i) Universe of discourse for Set A and Set B

(ii) Complements of Set A and Set B

(iii) $A \cap B$

(iv) $A \cup B$

(b) Write schema for the Gene Sequence (1000111) and (0001100). Also, write two different gene sequences from the schema. 2

(c) Consider the following travelling salesman problem involving 10 cities : 4

| Parent 1 | Parent 2 |
|---|---|
| A<br>B | E<br>G |

| | |
|---|---|
| C | I |
| D | D |
| E | C |
| F | B |
| G | J |
| H | H |
| I | A |
| J | F |

Determine the children solution using order cross-over (#1), assuming 4th and 8th sites as cross-overs and cyclic cross-over with 4th position as initial position.

3. (a) Implement AND function using McCulloch-Pitts neuron. 5

(b) Maximize :

$$f(x) = \frac{-x^2}{10} + 3x$$

where $0 \le x \le 31$, using Genetic Algorithm. 5

4. 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. The weighted structure and initial input are as follows :

Weighted structures are :

$$[W]^{\circ} = \begin{bmatrix} -0.25 \\ -0.40 \end{bmatrix} \text{ and bias } \phi^{(1)}_{(0)} = \begin{bmatrix} -0.50 \\ -0.1 \end{bmatrix}$$

$$[V]^{\circ} = \begin{bmatrix} 0.1 & -0.2 \end{bmatrix} \text{ and bias } \phi^{(2)}_{(0)} = \begin{bmatrix} 0.5 \end{bmatrix}$$

The initial input is 1. 10

Draw the architecture of the model. Perform one iteration.

5. (a) Consider a dataset of five observations given in the following table, each of which has two features $f_1$ and $f_2$ :

| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
|---|---|---|---|---|---|
| $f_1$ | 2 | 3 | 4 | 3 | 5 |
| $f_2$ | 6 | 7 | 5 | 4 | 6 |

Assume the number of cluster $c = 3$ and the real number $m = 2$. Also, assume the initial cluster centers as $V_1 = (1, 1)$ and $V_2 = (2, 2)$. Apply fuzzy $c$-mean algorithm to find the modified cluster center after one iteration. 6

(b) Generate the population in the next iteration by using Roulette-Wheel criterion : 4

| $k$ | $F_k$ |
|---|---|
| 1 | 3.5 |
| 2 | 4.6 |
| 3 | 5 |
| 4 | 2.8 |
| 5 | 1.8 |

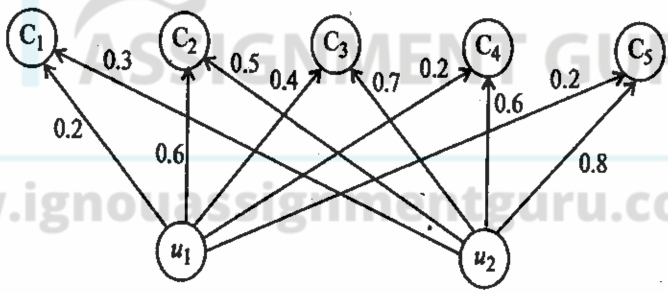
6. (a) Out of three genetic operators viz. selection, cross-over and mutation, list and

justify which operator or combination there of will be required for the following : 2

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

(ii) For the convergence of an algorithm to good but sub-optimal solution.

(b) A Kohonen self-organizing map with weights in shown below : 6




Find cluster unit $C_j$, $j = 1, 2, 3, 4, 5$ that is closest to the input vector (0.3, 0.6) by using square of the Euclidean distance.

(c) Consider a two-input neuron with $b = 1.5, w = [2, 3]$ and $x^t = [6 \quad -5]$. Find the neuron output for the following transfer function : 2

(i) linear transfer function

(ii) tan sigmoid transfer function

7. State whether the following statements are true or false. Give a short proof or a counter example in support of your answer : 10

(a) A multilayer network with linear transfer function is equivalent to a single-layer network.

(b) Radial basis function (RBF) is a function, whose, response function has a constant distance from a central point.

(c) The order of schema ** 10** is 6.

(d) Every original pattern of a discrete Hopfield network with a synchronous update provides a global minimum.

(e) If **R** is a Fuzzy relation between the Fuzzy sets A and B, then the membership function of **R** is :

$$\mu_{\mathbf{R}}(x, y) = \max(\mu_{\mathrm{A}}(x), \mu_{\mathrm{B}}(y))$$

No. of Printed Pages : 7 **MMTE-007**

# M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE) (MACS)

## Term-End Examination
## December, 2020

### MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

*Time : 2 Hours* *Maximum Marks : 50*

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***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.*

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1. (a) Determine the fuzzy relation T as a composition between the fuzzy relations R and S given below by using max-min and max-product : 4

$$R = \begin{array}{c c} & \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{array}{c} x_1 \\ x_2 \end{array} & \begin{bmatrix} 0.6 & 0.3 \\ 0.2 & 0.9 \end{bmatrix} \end{array}$$

and $$S = \begin{array}{c c} & \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{array}{c} y_1 \\ y_2 \end{array} & \begin{bmatrix} 1 & 0.5 & 0.3 \\ 0.8 & 0.4 & 0.7 \end{bmatrix} \end{array}$$

(b) Solve the network to approximate the function : 6

$$g(x) = 1 + \sin\left(\frac{\pi x}{2}\right)$$

for $-1 \leq x \leq 1$, choosing the initial weights and bias as the random numbers.

2. (a) Find the length and order of the following schema : 4

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

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

(iii) $S_3 = * * * 0 * * * *$

(iv) $S_4 = * 1 * 0 1 *$

(b) Consider the fuzzy sets A and B defined on the interval [0, 5]. Their membership functions are :

$$\mu_A(x) = \frac{x}{x+1}$$

and $$\mu_B(x) = 2^{-x}$$

Determine the membership function and graph them for each of the following : 6

(i) $A^C, B^C$

(ii) $A \cup B$

(iii) $A \cap B$

(iv) $(A \cup B)^C$

(v) $(A \cap B)^C$

3. (a) Verify whether the Genetic Algorithm (GA) improves the solution from one generation to the next generation, for the function given below :

maximize :

$$f(x) = \sqrt{x}$$

subject to :

$$1 \leq x \leq 16$$

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

(b) A single layer neural network is to have six inputs and three outputs. The outputs are continuous over the range 0 to 1. Now answer the following : 4

(i) How many neurons are required ?

(ii) What are the dimensions of the weight matrix ?

(iii) What kind of transfer function could be used ?

(iv) Is a bias required ? Give reasons.

4. (a) Compute the output for the neurons in the Kohonen networks, the related data is given below : 6

(i) Input to Kohnen neural network :

Input Neuron-1 $(I_1) = 0.5$

Input Neuron-2 $(I_2) = 0.75$

(ii) Connected weights between the neurons are as given below :

$I_1 \to O_1 : 0.1$

$I_2 \to O_1 : 0.2$

$I_1 \to O_2 : 0.3$

$I_2 \to O_2 : 0.4$



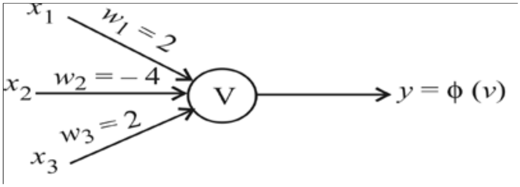
(b) Consider the two parents which are participating in partially mapped cross over as shown below :

Parent 1 : C D | E A B I | H G F

Parent 2 : A B | C D E F | G H I

Using partially mapped crossover assuming 2nd and 6th as the cross over sites, find the children solution. 4

5. (a) Consider the single layer perceptron given below : 6




The activation function is :

$$\phi(v) = \begin{cases} 1; & v \geq 0 \\ 0; & v < 0 \end{cases}$$

Obtain the output for each of the following input pattern :

| Patterns | $p_1$ | $p_2$ | $p_3$ | $p_4$ |
|---|---|---|---|---|
| $x_1$ | 1 | 0 | 1 | 1 |
| $x_2$ | 0 | 1 | 0 | 1 |
| $x_3$ | 0 | 1 | 1 | 1 |

(b) Consider the ADALINE filter with three neurons in the input layer having weights 3, 1 and –2 and the input sequence {......, 0, 0, 0, –4, 5, 0, 0, 0,......}. Find the filter output. 4

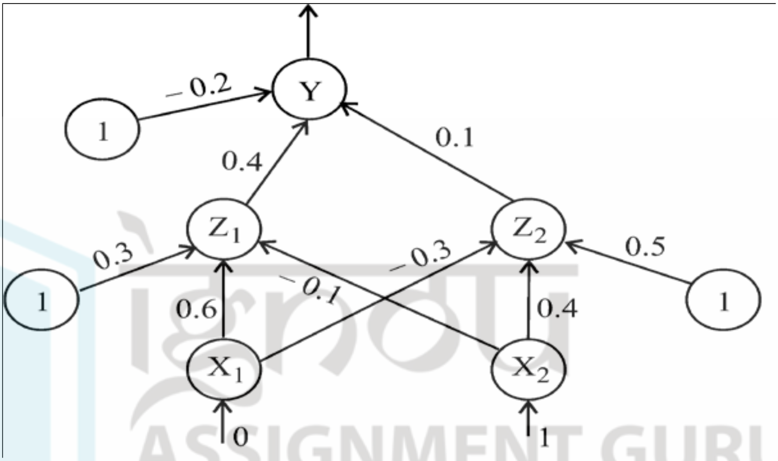
6. Determine the new weights for the following network by using Back propagation algorithm (perform one iteration). Given that : 10

(i) Input pattern is [0, 1]

(ii) Target output is 1

(iii) Learning rate $\alpha = 0.25$

(iv) Activation function is binary sigmoidal.




7. State whether the following statements are true or false. Give a short proof *or* a counter-example in support of your answer. 10

(i) The length of chromosomes to determine the maximum value of the set :

$$S = \{x \mid 0 \leq x \leq 4096\} \text{ is } 12.$$

(ii) In the Hopfield network, the neurons belonging to the same layer receive input from the neurons of the previous layer and send their value only to the neurons of the next layer.

(iii) In a single layer neural network, if $\sum_{i=1}^{n} x_i \omega_i > 0$, then the output is –1.

(iv) The fuzzy relation (R) given below, is an equivalence relation

$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 \\ 0.6 & 1 & 0.4 & 0 \\ 0 & 0.4 & 1 & 0 \\ 0.2 & 0 & 0 & 1 \end{bmatrix}$$

(v) The Self Organizing Map (SOM) is a supervised learning technique.