MMTE-007

ASSIGNMENT BOOKLET

M.Sc. (Mathematics with Applications in Computer Science)
SOFT COMPUTING AND ITS APLICATIONS (MMTE-007)
(1st July, 2020 – 30th June, 2021)

It is compulsory to submit the assignment before filling in the exam form.

School of Sciences
Indira Gandhi National Open University
Maidan Garhi,
New Delhi-110068
2020-2021

Dear Student,

Please read the section on assignments and evaluation in the Programme Guide for Elective courses that we sent you after your enrolment. A weightage of 20 per cent, as you are aware, has been assigned for continuous evaluation of this course, **which would consist of one tutor-marked assignment**. The assignment is in this booklet.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO.:……

NAME :……

ADDRESS :……

……

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COURSE CODE : …….

COURSE TITLE : …….

ASSIGNMENT NO.: ……..…

STUDY CENTRE : ……..….. DATE : ……..……...

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate which part of which question is being solved..

6) This assignment is to be submitted to the Programme Centre as per the schedule made by the programme centre. Answer sheets received after the due date shall not be accepted.

   We strongly suggest that you retain a copy of your answer sheets.

7) This assignment is valid only upto June, 2021. For submission schedule please read the section on assignments in the programme guide. If you have failed in this assignment or fail to submit it by June 2021, then you need to get the assignment for the July 2021 and submit it as per the instructions given in the programme guide.

8) **You cannot fill the exam form for this course** till you have submitted this assignment. So solve it and **submit it to your study centre at the earliest.**

We wish you good luck.

Assignment (MMTE – 007)

Course Code: MMTE-007
Assignment Code: MMTE-007/TMA/2020-21
Maximum Marks: 100

1. a) 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 (6)

   b) Use a binary-coded Genetic algorithm (GA) to minimize the function $f(x_1, x_2) = x_1 + x_2 - 2x_1^2 - x_2^2 + x_1, x_2$, 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. (4)

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

   b) Define the following operations in Genetic algorithm with one example of each

   i) Crossover

   ii) Mutation (6)

3. a) 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

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

   What is the filter output? (4)

   b) 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 $\left[\frac{2}{\sqrt{5}}, \frac{-1}{\sqrt{5}}\right]$, calculate the resulting weight found after training the competitive layer with the Kohonen's rule and a learning rate α of 0.4 on the input series in order I_1, and I_2. (6)

4. a) Differentiate between bounded sum and algebraic sum of two fuzzy sets. (4)

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

5. a) 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 crossover sites, find the children solution. (4)

b) 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.

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. (6)

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

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

$-3x + 2y \leq 3$

$2x + y \leq 4$

$0 \leq x \leq 2$

Using genetic algorithm. (10)

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

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

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

(4)

b) 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? (6)

8. a) Consider the problem of finding the shortest route through several cities, such that each city is visited only once and in the end traveler 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 $DM = MD$.

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? (4)

b) What is competitive learning? How does it differ from Hebbian learning? (2)

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

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

b) Find the length and order of the following schema:

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

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

iii) $S_3 = (* \ * * 1 * * *)$ (3)

c) Let an activation function be defined as $\phi(v) = \dfrac{1}{1 + e^{-av}}$, $a > 0$. Show that $\dfrac{d\phi}{dv} = a\phi(v)\,[1 - \phi(v)]$. What is the value of $\phi(v)$ at the origin? Also, find the value of $\phi(v)$ as v approaches $+\infty$ and $-\infty$. (4)

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

a) 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 .

b) The SOM is useful for classification.

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

d) The α -cut of a fuzzy set A in $\cup$ is defined as $A\alpha_0 = \{x \in \cup \mid \mu_A(x) \leq \alpha_0\}$.

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