

## M.T.C.T. FORTH SEMESTER EXAMINATION 2018

## Computational Intelligence

Time: 3 Hours

Full Marks: 100

Answer any **four** questions. *Different parts of the same question must be answered together*

1. a) Find the Cartesian product and intersection of the following fuzzy sets:

$$A = \{(3, 0.5), (5, 1), (7, 0.6), (9, 0.3)\}$$

$$B = \{(2, 0.5), (3, 1), (5, 0.6)\}$$

5+5

- b) Define the general form of extension principle.

5

- c) Let
- $A$
- and
- $B$
- be fuzzy sets defined on the universal set
- $X$
- as follows:

$$A = \{(1, 0.6), (2, 0.8), (3, 1), (4, 0.6)\}$$

$$B = \{(0, 0.5), (1, 0.7), (2, 0.9), (3, 1), (4, 0.4)\}$$

Let a function  $f: X \times X \rightarrow X$  be defined by  $f(x, y) = (x \cdot y)$ ,  $x \in A$ ,  $y \in B$ . Determine the image  $f(A \times B)$  by the extension principle.

10

2. a) Define a linguistic variable with an example.

5

- b) What is linguistic hedge? Discuss different types of linguistic hedges with examples.

10

- c) Construct suitable membership functions (MF) of the linguistic terms 'young' and 'old'. Determine the membership functions of the terms 'very young', 'not very old' and 'more or less old'.

10

3. a) Consider the following matrix defining a fuzzy relation
- $R$
- on
- $A \times B$
- .

	$y_1$	$y_2$	$y_3$	$y_4$	$y_5$
$x_1$	0.5	0	1	0.9	0.9
$x_2$	1	0.4	0.5	0.3	0.1
$x_3$	0.7	0.8	0	0.2	0.6
$x_4$	0.1	0.3	0.7	1	0

P.T.O.

Give the 1<sup>st</sup> and 2<sup>nd</sup> projection of  $R$ . Compute the cylindrical extension of the 1<sup>st</sup> projection.

5+5+5

- b) Compose the following two fuzzy relations R1 and R2 by using the *max-min composition*.

R1:

	$y_1$	$y_2$	$y_3$	$y_4$
$x_1$	0.3	0	0.7	0.3
$x_2$	0	1	0.2	0

R2:

	$z_1$	$z_2$	$y_3$
$y_1$	1	0	1
$y_2$	0	0.5	0.4
$y_3$	0.7	0.9	0.6
$y_4$	0.2	0.4	0

10

4. a) Describe the fuzzy c-means (FCM) clustering algorithm and derive its iterative equations for finding cluster centres and membership function. 10

- b) Consider the following fuzzy if-then rule:

(i) If  $x$  is  $A$  and  $y$  is  $B$  then  $z$  is  $C$

where  $A \in X$ ,  $B \in Y$  and  $C \in Z$  are fuzzy sets as follows:

$$A = 1/x_1 + 0.7/x_2 + 0.3/x_3$$

$$B = 0.9/y_1 + 0.5/y_2$$

$$C = 0.2/z_1 + 0.9/z_2 + 0.6/z_3$$

Given the fact:

$x$  is  $A'$  and  $y$  is  $B'$

where  $A' = 0.8/x_1 + 0.9/x_2 + 0.4/x_3$  and  $B' = 0.7/y_1 + 0.6/y_2$

Use the composition rule of inference to calculate the conclusion  $C'$

15

5. a) Let there are  $N$  training samples, each one has  $p$  features from  $C$  classes. Design a multilayer perceptron (MLP) with  $K$  hidden layer neurons. Write the back-propagation algorithm to train the MLP. 5+10

- b) State the functions of an RBF neural network. Write a training procedure of an RBF neural network with  $K$  hidden layer neurons and  $C$  output layer neurons using  $N$  training samples of  $p$  dimension. 10

6. a) Describe a computationally efficient method for finding the optimal hyperplane of a SVM. 15

- b) Describe the pattern classification procedure in a  $k$ -nearest neighbor classifier. 10