Department of Computer Science & Engineering
Indian Institute of Technology Kharagpur

Mid-Semester Test

Soft Computing Applications: CS60108

Spring Semester – 2023

Full Marks: 60 *Time: 2 hours*

*Answer **ALL** Questions*

Q. 1

Suppose, *age* is defined over a set of real numbers in the range [0…100]. Three fuzzy sets *Young*, *MA* and *Old* are defined with their respective membership functions given below.

Young(x) = {

1, if age(x) ≤ 25,

(35-age(x))/10, if 25<age(x) ≤35,

0, if age(x) > 35

}

MA(x) = {

0, if age(x) ≤ 25,

1- (47.5-age(x))/22.5, if 25<age(x) ≤47.5,

70-age(x)/22.5, if 47.5<age(x) ≤ 70

}

Old(x) = {

0, if age(x) ≤ 65,

1-(75-age(x))/10, if 65<age(x) ≤75,

1, if age(x) > 75

}

Find the fuzzy sets for the following:

a) Not Old
b) Either Young or MA
c) Neither Young nor Old

[3+3+4]

Q. 2

Given the following rule:

IF *resistance is High* THEN *current is Low*

Also, given the following relational matrix:

$$R = \begin{array}{c} \\ 10K \\ 50K \\ 100K \end{array} \begin{array}{c} \begin{array}{ccc} 150mA & 50mA & 10mA \end{array} \\ \begin{bmatrix} 0.8 & 0.7 & 0.9 \\ 0.6 & 0.4 & 0.3 \\ 0.2 & 0.5 & 0.1 \end{bmatrix} \end{array}$$

Suppose, the membership distribution of very high (VH) resistance is given by

$$\mu_{VH}(resistnace) = \{(10K, 0.7), (50K, 0.8), (100K, 0.9)\}$$

Determine the membership distribution of very low (VL) current (i.e., $\mu_{VL}(current)$) from the above data.

[10]

Q. 3

Suppose, we have a universe of integers, Y = {1, 2, 3, 4, 5}. We define the following linguistic terms as mapping onto Y:

"*Small*" = {(1, 1), (2, 0.8), (3, 0.6), (4, 0.4), (5, 0.2)}

"*Large*" = {(1, 0.2), (2, 0.4), (3, 0.6), (4, 0.8), (5, 1)}

Construct the following phrase (as a fuzzy set, say *A*) with the help of the above linguistic terms with hedges:

"*not very Small and not very, very Large*"

[2+3+5]

Q. 4

a) Draw the schematic diagram of the simple model of perception. Clearly indicates what are the unknown parameters in your model.

[2+1]

b) The following is a training set for a 2-class (as 0 and 1) classification problem. Iterate the perceptron through the training set and obtain the weights. The algorithm which you followed preferably be stated before. You may make a reasonable assumption if any.

INPUT		OUTPUT
X_1	X_2	Y
0.25	0.353	0
0.25	0.471	1
0.50	0.353	0
0.50	0.647	1
0.75	0.705	0
0.75	0.882	1
1.0	0.705	0
1.0	1.0	1

[3+4]

Q. 5

a) Clearly draw the Vanilla neural network with all hyperparameters in it.

[4]

b) Explain the Steppes descent method and hence the delta rule to learn an unknown parameter in the network.

[4]

c) Give a detailed account of all layers in the Vanilla neural network in terms of their input and output.

[3×2]

d) Following the Back propagation algorithm, derive the modified values of v_{ij} and w_{jk}, where v_{ij} denotes the weight of the connection between the *i*-th perceptron in the input layer to the *j*-th perceptron in the hidden layer and w_{jk} denotes the weight of the connection between the *j*-th perceptron in the hidden layer to the *k*-th perceptron in the output layer.

[3+3]

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