Birla Institute of Technology and Science-Pilani, Hyderabad campus
First Semester 2021-2022

Mid-Semester Examination

Course Title: Neural Network and Fuzzy Logic [BITS F312]

Date 2.10.2022 Maximum Marks: 30, Duration: 90 minutes

1. Fuzzy set A= motor speed is good= [0.2/21, 0.5/31, 0.7/41,0.9/51, 0.6/61, 0.5/71]
   Fuzzy set B= motor voltage normal = [0.2/1, 0.35/2, 0.9/3, 0.8 /4, 0.75/5, 0.5/6, 0.25/7]

   a. Find a relation for the following compound propositions: If the motor speed is good, then the motor voltage is nominal. [4]
   b. Now for new antecedent A'= " motor speed is little slow, A' = [0.4/21, 0.7/31, 1/41, 0.6/51, 0.3/61, 0.1/71], using max-min composition, find the new consequent [2]
   c. Define the following: very, very good motor speed and not slightly normal motor voltage [4]

2. For the following data,

Characteristics	O1	O2	O3
p1	0.55	0.65	0.35
p2	0.20	0.15	0.25
p3	0.25	0.20	0.40

Develop similarity relation using the cosine-amplitude method **for all pairs** and present them neatly in a table. Verify for equivalence relation for links 1-3-2 & 1-2-3. [3+2]

3. Determine defuzzified values for the following data using the Centre of gravity approach. Use equations of membership functions for the analysis. Fuzzy set 1 represents [a, b, c, d] with values: [0,20,30,40] with membership value 0.8; Fuzzy set 2 represents [a, b, c, d] with values: [20,30,40,60] with membership value 1. Show membership function equations, and corresponding ranges in the table neatly. [7]

4. Each question is for two marks:
   a) What is the difference between Feedforward with backpropagation and kohenon Neural Networks? Explain mathematically.
   b) Compare Artificial Neural Network and regression in a tabular format. Which do you prefer and why?
   c) Neural network consisting of 3 inputs x1, x2, x3 i.e. 0.3,0.4,0.5 and three outputs y1 and y2, y3 (0.6,0.7,0.8) with one hidden layer with 2 neurons. Compute the error with detailed steps.
   d) What is the physical meaning/ role of weights and the purpose of activation function in Artificial Neural Networks?

Birla Institute of Technology and Science-Pilani, Hyderabad campus
First Semester 2022-2023
Comprehensive Examination
Course Title: Neural Network and Fuzzy Logic [BITS F312]
Date 22.12.2022 Maximum Marks: 40, Duration: 3 hours
Answer in the same sequence

1. Four datasets are <u>expected to be divided into 2 clusters</u>. Information about datasets is as follows: S1 = [6,7], S2= [8,9], S3 = [9,12], S4 = [12,13]. Conduct fuzzy cluster analysis to determine the optimum partition for one iteration. Start with the following initial 2-partition **[6]**

$$U(0) = \begin{bmatrix} 0.9 & 0.8 & 0.4 & 0.2 \\ 0.1 & 0.2 & 0.6 & 0.8 \end{bmatrix}; \text{ Take } \mathbf{m'} \text{ value as } 2.333.$$

2. Fuzzy set P= slow speed of the fan [0.8/1, 0.5/2, 0.1/3, 0.5/4, 0.7/5] ; Fuzzy set Q= counter clockwise direction= [0.1/0, 0.2/45, 0.3/90, 0.5/135, 1/180]; Establish a relationship for " If very slow speed then <u>mostly</u> <u>not</u> counterclockwise direction. Use max-min composition **[6]**

3. Four alternatives are evaluated on three criteria [maximization in nature]. Weights of the criteria are [0.3,0.4,0.5], [0.35,0.45,0.55], [0.55,0.57,0.75]. The payoff matrix [refer to Table 1] is as follows:
Table 1.

Alternative	Criteria 1	Criteria 2	Criteria 3
1	[7,8,9]	[2,5,9]	[3,4,9]
2	[1,3,9]	[3,4,9]	[4,5,9]
3	[2,8,9]	[4,6,9]	[3,4,9]
4	[1,7,9]	[3,7,9]	[3,5,9]

Weighted Ideal values for each criterion are [1.0, 1.0, 1.0], whereas weighted anti-ideal values for each criterion are [0.0, 0.0, 0.0]

[a] Determine normalized values and present them in a table.   **[2]**
[b] Determine the weighted normalized payoff matrix and present it in a table **[2]**
[c] Determine positive and negative separation measures for each alternative **[2]**
Use Fuzzy TOPSIS for the same. **Present the results in a Table neatly.**

4. For the below problem, compute weighted preference function values for criteria C1 and C2. Please assume that the below values are dimensionless. Weighting factor of criteria C1 and C2 are 0.3 and 0.7. Assume that criteria 1 follows the usual criterion whereas criterion 2 follows quasi criterion with a threshold value of 2 [refer to Table 2] is follows: **[6]. Use Promethee method as the basis.**

Table 2

Criteria	A1	A2	A3	A4	A5
C1	5	6	7	8	3
C2	6	4	3	5	6

5. Formulate multiobjective optimization problem with the following data

Max Z_1 = $40x_1 + 60y_2 + 30$; Max Z_2 = $10x_1 + 17y_2 - 10$; Max Z_3 = $29x_1 + 28y_2 + 25$;

Subject to

$$22x_1 + 30y_2 \le 39$$

$$22x_1 + 59y_2 \ge 37$$

$$0 \le x_1 \le 8.0; \qquad 3.0 \le y_2 \le 7.5$$

Assume upper and lower bounds for each objective function Z1[28,14], Z2[25,14], Z3[14,8] Using **hyperbolic membership function** environment, <u>formulate the problem in fuzzy programming perspective.</u>

[4]

6. <u>**Answer all questions. Each question carry two marks. Answer in the same sequence.**</u>

a. Check the transitivity relationship for A1-A2-A3 [refer to Table 3]. Using λ-cut approach [with λ value of 0.4] establish crisp relation for the data mentioned in Table 3.

Table 3

	A1	A2	A3	A4
A1	1.00	0.68	0.01	0.18
A2		1.00	0.40	0.50
A3			1.00	0.70
A4				1.00

b. Compute degree of similarity for alternative A1 for the following data. Use reference criteria as [0.9, 0.9], [0.8 ,0.8], [0.8, 0.8]. Weight of the criteria as 0.3, 0.5, 0.2. Refer Table 4

Table 4.

Criteria	Alternative
C1	0.4,0.6
C2	0.2,0.4
C3	0.3,0.4

c. Fuzzy Synthetic extent values for criteria 1 and criteria 2 are S1= (0.14, 0.25, 0.41) and S2= (0.147, 0.24, 0.39). Compute the degree of possibility V (S_2 >=S_1)

d. Compare bagging and boosting characteristics in terms of model building, variance & bias, weights in a tabular column

e. What is the adjacency matrix in fuzzy cognitive mapping? Explain the same technically with an example from your domain in detail.

f. Draw the architecture of ANFIS? Technically explain each layer?