Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	FUZZY STATISTICS
COURSE CODE	:	BWB 44303
PROGRAMME CODE	:	BWQ
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Describe the meaning of complexity and uncertainty. Then, discuss the relationship of complexity and uncertainty.

(3 marks)

(b) Describe **ONE (1)** similarity and **ONE (1)** difference between classical set theory and crisp set theory.

(2 marks)

(c) Consider the following two fuzzy sets :

$\underset{\sim}{D}$ is representing a diabetes mellitus

$$\underset{\sim}{D} = \left\{\frac{0.7}{Patient\ A} + \frac{0.3}{Patient\ B} + \frac{0.9}{Patient\ C} + \frac{0.2}{Patient\ D} + \frac{0.3}{Patient\ E}\right\}$$

$\underset{\sim}{B}$ is representing a high blood pressure

$$\underset{\sim}{B} = \left\{\frac{0.7}{Patient\ A} + \frac{0.4}{Patient\ B} + \frac{0.5}{Patient\ C} + \frac{0.7}{Patient\ D} + \frac{0.2}{Patient\ E}\right\}$$

Solve the following operations :

(i) $\underset{\sim}{D} \cap \underset{\sim}{\bar{B}}$

(3 marks)

(ii) $\underset{\sim}{\bar{D}} \cup \underset{\sim}{B}$

(3 marks)

(iii) $\overline{\underset{\sim}{D} \cup \underset{\sim}{B}}$

(3 marks)

(d) The Matlab program code for the certain operation for D and B in **Q1(c)** is given in **Table Q1.1**.

Table Q1.1

```
% enter the two matrix
u=input('enter the first matrix');
v=input('enter the second matrix');
% first find u's complement
[m,n]=size(u);
ucomp=ones(m)-u;
% second to find v's complement
[a,b]=size(v);
vcomp=ones(a)-v;
p=min(ucomp,v)
q=max(ucomp,v)
fprintf(p)
fprintf(q)
```

Solve the following operations :

(i) Identify the first and second matrix.

(2 marks)

(ii) Show your work to indicate the Matlab program code output.

(8 marks)

Q2 (a) Given the two fuzzy sets $\underset{\sim}{Y}$ and $\underset{\sim}{Z}$ as follow :

$$\underset{\sim}{Y} = \begin{matrix} \\ x1 \\ x2 \end{matrix} \begin{matrix} \begin{matrix} y_1 & y_2 \end{matrix} \\ \begin{bmatrix} 0.4 & 0.4 \\ 0.4 & 0.7 \end{bmatrix} \end{matrix}$$

$$\underset{\sim}{Z} = \begin{matrix} \\ x1 \\ x2 \end{matrix} \begin{matrix} \begin{matrix} y_1 & y_2 & y_3 & y_4 & y_5 & y_6 \end{matrix} \\ \begin{bmatrix} 0.3 & 0.7 & 0.6 & 1 & 0.6 & 0.5 \\ 0.3 & 0.7 & 0.3 & 0.4 & 1 & 0.5 \end{bmatrix} \end{matrix}$$

(i) Compute the fuzzy Cartesian product of $\underset{\sim}{T} = \underset{\sim}{Y} \times \underset{\sim}{Z}$.

(5 marks)

(ii) Analyze the relation between two fuzzy sets $\underset{\sim}{Y}$ and $\underset{\sim}{Z}$ using min-max composition.

(6 marks)

(iii) Analyze the relation between two fuzzy sets $\underset{\sim}{Y}$ and $\underset{\sim}{Z}$ using max-product composition.

(6 marks)

(b) Classify whether the given matrix is equivalance by checking the reflexitivity, symmetry and transitivity properties.

$$R = \begin{bmatrix} 1 & 0.5 & 0.3 & 0.5 \\ 0.5 & 1 & 0.4 & 0.3 \\ 0.3 & 0.4 & 1 & 0.4 \\ 0.5 & 0.3 & 0.4 & 1 \end{bmatrix}$$

(5 marks)

(c) Given the graphical output for Sugeno rule as in **Figure Q2.1**. Write the fuzzy rule equation based on the **Figure Q2.1.**

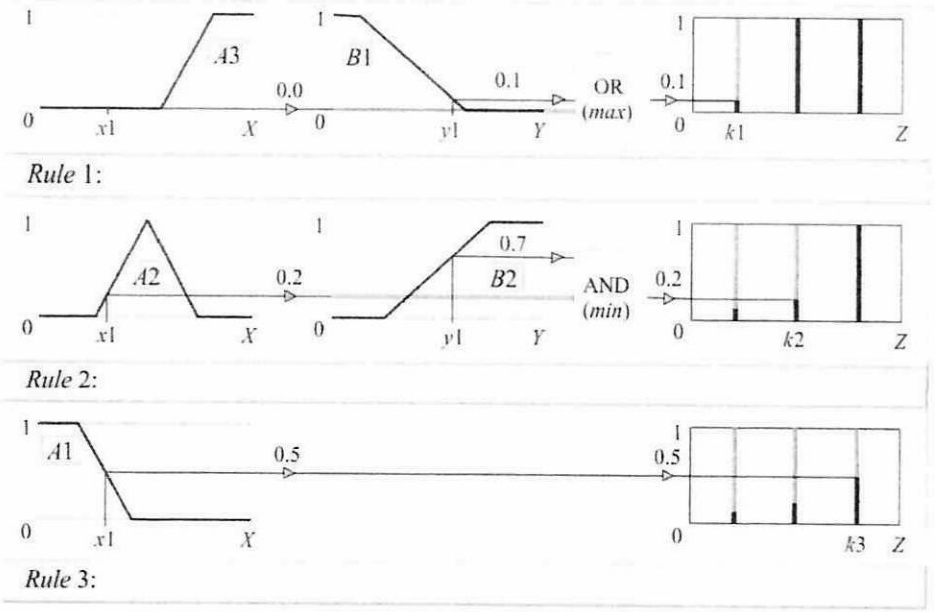

Figure Q2.1

(3 marks)

Q3 (a) The fuzzy set $\underset{\sim}{M}$ and $\underset{\sim}{N}$ are defined as universe, $x = \{0, 1, 2, 3\}$ with the following membership functions :

$$\mu_{\underset{\sim}{M}}(x) = \frac{1}{x+3}$$

$$\mu_{\underset{\sim}{N}}(x) = \frac{2x}{3x-1}$$

Sketch the graph for the intervals along x-axis corresponding to the λ-cut sets for each fuzzy set $\underset{\sim}{M}$ and $\underset{\sim}{N}$ for following values of $\lambda = 0.1$ and 0.7.

(10 marks)

(b) Compare the defuzzification value by using 'centroid' and 'last of maxima' method as shown in **Figure Q3.1**.

Given that, centroid,

$$z^* = \int \frac{\mu_{\underset{\sim}{C}}(z)\, z\, dz}{\mu_{\underset{\sim}{C}}(z)\, dz}$$

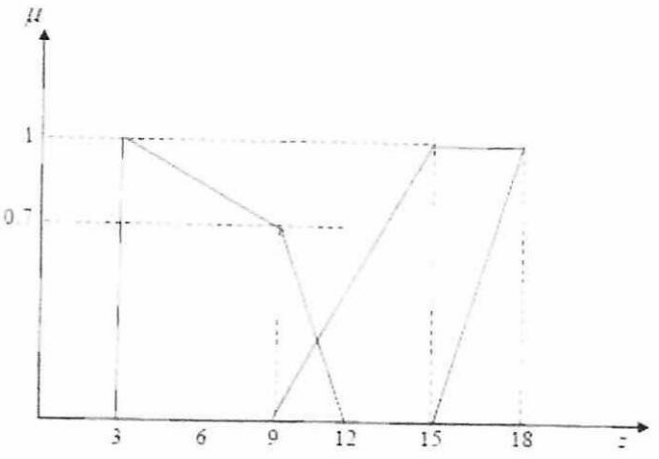

Figure Q3.1

(10 marks)

(c) The energy E of a particle spinning is a magnetic field B is given by the equation $E = \mu B \sin 2\theta$, where μ is complement angle of magnetic moment with respect to direction of the magnetic field. Assuming the magnetic field B and magnetic moment μ to be constant, linguistic terms for the complement angle of magnetic moment is given as follows:

High moment (H) $\theta = \Pi/4$

Slightly high moment (SH) $\theta = 3\Pi/4$

No moment $\theta = 0$

Slightly low moment (SL) $\theta = 3\Pi/4$

Low moment (L) $\theta = \Pi/4$

Compute the fuzzification values using the angular fuzzy set approach for these linguistic labels for the complement angles and plot these values versus θ.

(8 marks)

(d) State **ONE (1)** method of supervised machine learning and unsupervised machine learning. Hence, state **ONE (1)** advantage of using supervised machine learning.

(3 marks)

- END OF QUESTIONS -