

Indian Institute of Technology Delhi
Major Examination
Fuzzy Sets & Applications: MTL 717

Venue: LH111

Duration: 3:30 – 5:30 PM

Full Marks : 30

Q1. An Engineer designs an Air Conditioner which calculates the Compressor Speed (S) based on the Room Temperature (T) and Humidity (H) using the following Rules:

R_1 : If T is High Or H is High, then S is Fast

R_2 : If T is Low Or H is Low, then S is Slow

The range of the temperature measured in Celsius is [0 50], humidity measured in percentage is [0,100] and compressor speed is between [0, 100].

There are two linguistic values for T: {Low, High} and two variables for H: {Low, High} which are defined as semi-trapezoidal such that

$$\begin{aligned} \text{Low Temperature} &= [0 \ 0 \ 20 \ 30], & \text{High Temperature} &= [25 \ 30 \ 50 \ 50], \\ \text{Low Humidity} &= [0 \ 0 \ 30 \ 60] & \text{High Humidity} &= [45 \ 60 \ 100 \ 100]. \end{aligned}$$

The Compressor Speed (S) has linguistic values: {Slow, Fast} such that
 $\text{Slow} = [0 \ 0 \ 20 \ 30]$, $\text{Fast} = [70 \ 80 \ 100 \ 100]$.

Note that all fuzzy linguistic variables are *trapezoidal* or *half-trapezoidal* in shape.

Suppose the temperature is 27.5 and the humidity is 45%.

Find the compressor speed using Mamdani inference if the output is de-fuzzified using Centre of Maxima Method and also Centroid method the given rule(s) is/are applied.

[3 + 1 + 3 =7]

Q2.

(a) Let $R = \begin{bmatrix} 1 & 0 & 0.8 \\ 0 & 1 & 1 \\ 0.8 & 0 & 1 \end{bmatrix}$ be a fuzzy relation on $X \times X$. Let R_T be the transitive closure

with max-min composition and standard union .

(b) Let $antique = \left\{ \frac{0.7}{x_1} + \frac{0.6}{x_2} + \frac{0.8}{x_3} + \frac{0.6}{x_4} + \frac{0.9}{x_5} \right\}$, $expensive = \left\{ \frac{0.4}{x_1} + \frac{0.6}{x_2} + \frac{0.5}{x_3} + \frac{0.5}{x_4} + \frac{0.7}{x_5} \right\}$

$$\text{and } \mu_{most}(x) = \begin{cases} \frac{x-0.65}{0.15} & 0.65 \leq x < 0.8 \\ 1 & 0.8 \leq x < 1 \\ 0 & \text{otherwise} \end{cases}$$

What is the truth value of the proposition

'Most antique things are expensive'?

(c) Consider the quantified propositions:

p_1 = About half of the people in the room were army men.

p_2 = At least about three-fourth of the army men were Brigadiers.

The quantifier *about half* = [0.40 0.50 0.60] (Triangular Fuzzy Number) and

at least about three-fourth = [0.50 0.75 1 1] (semi-trapezoidal).

Let the conclusion be 'Q people were Brigadiers. Find Q

[3 x 3 = 9]

Q3. A Nuclear Power Facility with three reactors A, B and C malfunctioned. Two investigation officers interviewed 20 nuclear scientists working at the facility to determine which of the reactors caused the malfunction. Each officer interviewed 10 scientists.

Officer 1 reported that:

- 3 scientists suggest that the reactor B failed.
- 5 scientists suspect that the reactor A or B failed.
- 2 scientists said that the data was inconclusive and that failure could be caused by any of the reactors.

Office 2 reported that:

- 4 scientists suggest that the reactor B failed.
- 1 scientist suspect that the reactor B or C failed.
- 5 scientists said that the data was inconclusive and that failure could be caused by any of the reactors.

(a) Suppose m_1 is the basic assignment obtained from the reports of Officer 1 and m_2 is the basic assignment obtained from the reports of Officer 2.

(b) Apply Dempster's rule of combination to calculate the joint basic assignment $m_{1,2}$.

(c) Calculate $Bel_{1,2}$ and $Pl_{1,2}$

[1 + 4 + 2 = 7]

Q4. Explain in detail your self-study component.

[7]