Experiment 01 : Implement Fuzzy Relations. (Max-Min Composition).

Learning Objective : Implementation of Fuzzy Relation.

Tools : Python

Theory :

Max-Min composition is a fundamental operation in fuzzy logic that facilitates the integration of fuzzy relations, enabling the handling of uncertainty and imprecision in various applications such as control, decision support, pattern recognition, and expert systems.

Fuzzy composition can be defined just as it is for crisp (binary) relations. Suppose R is a fuzzy relation on X × Y, S is a fuzzy relation on Y × Z, and T is a fuzzy relation on X × Z; then,

Fuzzy Max–Min composition is defined as:

$$\underline{T} = \underline{R} \circ \underline{S} = \mu_{\bar{T}}(x,z) = \bigvee_{y \in Y} (\mu_{\bar{R}}(x,y) \wedge \mu_{\bar{S}}(y,z))$$

$$= max_{y \in Y}\{min(\mu_{\bar{R}}(x,y), \mu_{\bar{S}}(y,z))\}$$

Example :

X = {x1, x2}, Y = {y1, y2}, and Z = {z1, z2, z3}. Consider the following fuzzy relations:

$$\bar{R} = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.7 & 0.6 \\ 0.8 & 0.3 \end{bmatrix} \end{array} \qquad \bar{S} = \begin{array}{c} \\ y_1 \\ y_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} 0.8 & 0.5 & 0.4 \\ 0.1 & 0.6 & 0.7 \end{bmatrix} \end{array}$$

So ultimately, we have to find the elements of the matrix,

$$\bar{T} = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} & & \\ & & \end{bmatrix} \end{array}$$

Max-Min Composition :

Max-min composition is defined as,

From the given relations R and S,

$\mu T(x1, z1) = \max (\min(\mu R(x1, y1), \mu S(y1, z1)), \min(\mu R(x1, y2), \mu S(y2, z1)))$

$= \max(\min(0.7, 0.8), \min(0.6, 0.1)) = \max(0.7, 0.1) = 0.7$

$\mu T(x1, z2) = \max (\min(\mu R(x1, y1), \mu S(y1, z2)), \min(\mu R(x1, y2), \mu S(y2, z2)))$

$= \max(\min(0.7, 0.5), \min(0.6, 0.6)) = \max(0.5, 0.6) = 0.6$

$\mu T(x1, z3) = \max (\min(\mu R(x1, y1), \mu S(y1, z3)), \min(\mu R(x1, y2), \mu S(y2, z3)))$

$= \max(\min(0.7, 0.4), \min(0.6, 0.7)) = \max(0.4, 0.6) = 0.6$

$\mu T(x2, z1) = \max (\min(\mu R(x2, y1), \mu S(y1, z1)), \min(\mu R(x2, y2), \mu S(y2, z1)))$

$= \max(\min(0.8, 0.8), \min(0.3, 0.1)) = \max(0.8, 0.1) = 0.8$

$\mu T(x2, z2) = \max (\min(\mu R(x2, y1), \mu S(y1, z2)), \min(\mu R(x2, y2), \mu S(y2, z2)))$

$= \max(\min(0.8, 0.5), \min(0.3, 0.6)) = \max(0.5, 0.3) = 0.5$

$\mu T(x2, z3) = \max (\min(\mu R(x2, y1), \mu S(y1, z3)), \min(\mu R(x2, y2), \mu S(y2, z3)))$

$= \max(\min(0.8, 0.4), \min(0.3, 0.7)) = \max(0.4, 0.3) = 0.4$

$$\bar{T} = \begin{matrix} \\ x_1 \\ x_2 \end{matrix} \begin{matrix} z_1 & z_2 & z_3 \\ \end{matrix} \begin{bmatrix} 0.7 & 0.6 & 0.6 \\ 0.8 & 0.5 & 0.4 \end{bmatrix}$$

Implementation :

implementation of fuzzy logic(Max-min).py

C: > Users > Administrator > Desktop > implementation of fuzzy logic(Max-min).py > ...

```
1   m1 = [[0.7 , 0.6],[0.8 , 0.3]]
2   m2 = [[0.8 , 0.5 , 0.4],[0.1 , 0.6 , 0.7]]
3   result = [[0, 0, 0], [0 , 0 ,0]]
4
5   for i in range(len(m1)):
6       for j in range(len(m2[0])):
7           result[i][j] = max(min(m1[i][0] , m2[0][j]), min(m1[i][1], m2[1][j]))
8
9   for i in  result:
10      print(i)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
PS C:\Users\Administrator> & C:/Users/Administrator/AppData/Local/Programs/Python/Python310/python.exe
[0.7, 0.6, 0.6]
[0.8, 0.5, 0.4]
PS C:\Users\Administrator>
```

Result and discussion :

Learning Outcomes : Students should have the ability to

LO 1.1: Ability to understand the concept of Fuzzy Relations.
LO 1.2: Ability to compute the output of Max Min Composition.

Course Outcomes :

CO 1: Understand fundamental concepts of fuzzy logic and apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.

Conclusion :

Viva Questions :

Q1. Compare Crisp relation and Fuzzy Relation.
Q2. List types of composition in Fuzzy Relation.

For Faculty Use

Correction Parameters	Formative Assessment [40%]	Timely completion of Practical [40%]	Attendance / Learning Attitude [20%]	Total
Marks Obtained				