



**MÄLARDALENS HÖGSKOLA
ESKILSTUNA VÄSTERÅS**

Assignment 2:

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1. And, OR operators:

In the fuzzy logic, elements belong to a set with a certain probability. Meaning that its membership is a value of $0 \leq x \leq 1$ equivalent to truth variables with a membership value $0 \leq y \leq 1$. The **AND** operator denotes the minimum of two actual values, And the **OR** operator denotes the maximum of two actual values. For example :

If : $F(Y = 1) = 0.5$, $F(Y = 2) = 0.4$) then:

(OR) $Y = 1 \vee Y = 2 = \max(0.5, 0.4) = 0.5$

(AND) $Y = 1 \wedge Y = 2 = \min(0.5, 0.4) = 0.4$

2.Example:

values as (0.3, 0.8, 0.2, 0.7)

- a. Compute the membership degree (short, medium, and long) foreach input:

$$\text{Short}(0.3) = -0.3/0.6 + 1 = 0.5$$

$$\text{Medium}(0.3) = 0.3/0.6 = 0.5$$

$$\text{Long}(0.8) = 0$$

$$\text{Short}(0.8) = 0$$

$$\text{Medium}(0.8) = -0.8/0.4 + 2.5 = 0.5$$

$$\text{Long}(0.8) = 0.8/0.4 - 1.5 = 0.5$$

$$\text{Short}(0.2) = -0.2/0.6 + 1 = 0.66$$

$$\text{Medium}(0.2) = 0.2/0.6 = 0.33$$

$$\text{Long}(0.2) = 0$$

$$\text{Short}(0.7) = 0$$

$$\text{Medium}(0.7) = -0.7/0.4 + 2.5 = 0.75$$

$$\text{Long}(0.7) = 0.7/0.4 - 1.5 = 0.25$$

- b. Calculate firing strengths of rules:

Rule1: If (x1=short long) and (x2=medium long) and (x3=medium long) and (x4=medium) Then iris **versicolor**

Fuzzy Rule 1:

$$\min(\max(\text{short}(x1), \text{long}(x1)), \max(\text{medium}(x2), \text{long}(x2)),$$

$$\max(\text{medium}(x3), \text{long}(x3)), \text{medium}(x4))$$

$$= \min(\max(0.5, 0), \max(0.5, 0.5), \max(0.5, 0.5), \max(0.33, 0), 0.75)$$

$$= \min(0.5, 0.5, 0.5, 0.33, 0.75)$$

$$= 0.33$$

Rule 2: If (x3=short medium) and (x4=short) Then iris **setosa**

Fuzzy Rule 2:

$$\begin{aligned} & \min(\max(\text{short}(x_3), \text{medium}(x_3)), \text{short}(x_4)) \\ &= \min(\max(0.66, 0.33), 0) \\ &= \min(0.66, 0) \\ &= 0 \end{aligned}$$

Rule 3: If $(x_2 = \text{short medium})$ and $(x_3 = \text{long})$ and $(x_4 = \text{long})$ Then iris **virginica**

$$\begin{aligned} & \min(\max(\text{short}(x_2), \text{medium}(x_2)), \text{long}(x_3), \text{long}(x_4)) \\ &= \min(\max(0, 0.5), 0, 0.25) \\ &= \min(0.5, 0, 0.25) \\ &= 0 \end{aligned}$$

Rule 4: If $(x_1 = \text{medium})$ and $(x_2 = \text{short medium})$ and $(x_3 = \text{short})$ and $(x_4 = \text{long})$ Then iris **versicolor**

$$\begin{aligned} & \min(\text{medium}(x_1), \max(\text{short}(x_2), \text{medium}(x_2)), \text{short}(x_3), \text{long}(x_4)) \\ &= \min(0.5, \max(0, 0.5), 0.66, 0.25) \\ &= \min(0.5, 0.5, 0.66, 0.25) \\ &= 0.25 \end{aligned}$$

Probability versicolor = $\max(0.33, 0.25) = 0.25$

Probability setosa = 0

Probability virginica = 0

Regarding the probability we figure out the iris will be versicolor because it is the maximum probability and the other probability it is equal zero.

3. Accuracy:

The classifier has an accuracy of 77%.