

Learning Systems – Assignment 2 Fuzzy Logic

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Report

1. What is the AND-Operator in Fuzzy Logic?

The AND-Operator is represented by a Min-value function which returns the minimal value of a list of numbers. For example: $0.3 \& 0.5 \& 0.1 \Rightarrow \text{Min}(0.3, 0.5, 0.1) = 0.1$

2. What is the OR-Operator in Fuzzy Logic?

The OR-Operator is represented by a Max-value function which returns the maximum value of a list of numbers. For example: $0.3 \parallel 0.5 \parallel 0.1 \Rightarrow \text{Max}(0.3, 0.5, 0.1) = 0.5$

The following Fuzzy-Rule: If ($x_3=\text{short} \vee \text{medium}$) and ($x_4=\text{short}$) Then iris **setosa** is represented with the following function:

```
function rule2(short, medium, long)
    x3 = maximum([short[3], medium[3]])
    x4 = short[4]
    return minimum([x3,x4])
end
```

The Accuracy is 78%.

Fuzzy-Decision with hand

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$$X = \begin{matrix} x_1 & x_2 & x_3 & x_4 \\ (0.3, & 0.8, & 0.2, & 0.7) \end{matrix}$$

$$\text{membership_short}(x) = \begin{cases} -\frac{1}{0.6} \cdot x + 1 & \text{if } x \leq 0.6 \\ 0 & \text{if } x > 0.6 \end{cases}$$

$$\text{membership_long}(x) = \begin{cases} \frac{1}{0.4} \cdot x - 1.5 & \text{if } x \leq 1 \\ 0 & \text{if } x < 0.6 \end{cases}$$

$$\text{membership_medium}(x) = \begin{cases} -\frac{1}{0.4} \cdot x + 2.5 & \text{if } x \geq 0.6 \\ \frac{1}{0.6} \cdot x & \text{if } x < 0.6 \end{cases}$$

	x_1	x_2	x_3	x_4
membership_short	0.5	0	0.666	0
membership_medium	0.5	0.5	0.333	0.75
membership_long	0	0.5	0	0.25

$r_1: (x_1 = \text{short} \vee \text{long}) \text{ and } (x_2 = \text{medium} \vee \text{long}) \text{ and } (x_3 = \text{medium} \vee \text{long})$
and $(x_4 = \text{medium})$

$$\Rightarrow \text{Min}(\text{Max}(0.5, 0), \text{Max}(0.5, 0.5), \text{Max}(0.333, 0), 0.75)$$

$$\Rightarrow \text{Min}(0.5, 0.5, 0.333, 0.75) \Rightarrow \underline{\underline{0.333}}$$

$r_2: (x_3 = \text{short} \vee \text{Medium}) \text{ and } (x_4 = \text{short})$

$$\Rightarrow \text{Min}(\text{Max}(0.666, 0.333), 0) \Rightarrow \text{Min}(0.666, 0) = \underline{\underline{0}}$$

$r_3: (x_2 = \text{short} \vee \text{medium}) \text{ and } (x_3 = \text{long}) \text{ and } (x_4 = \text{long})$

$$\Rightarrow \text{Min}(\text{Max}(0, 0.5), 0, 0.25) \Rightarrow \text{Min}(0.5, 0, 0.25) = \underline{\underline{0}}$$

$r_4: (x_1 = \text{medium}) \text{ and } (x_2 = \text{short} \vee \text{medium}) \text{ and } (x_3 = \text{short}) \text{ and } (x_4 = \text{long})$

$$\Rightarrow \text{Min}(0.5, \text{Max}(0, 0.5), 0.666, 0.25)$$

$$\Rightarrow \text{Min}(0.5, 0.5, 0.666, 0.25) = \underline{\underline{0.25}}$$

$$\text{Maximum}(r_1, r_2, r_3, r_4) = \text{Max}(0.333, 0, 0, 0.25) = 0.333 \Rightarrow r_1$$

$r_1 \Rightarrow \underline{\underline{\text{versicolor}}}$

