

SUGENO FUZZY INFERENCE SYSTEM

Let be a system with two inputs (temperature and humidity) and one output (fan speed). The designed system by sugeno fuzzy inference system is given as,

For the temperature input, it can be between $[-50\ 50]^{\circ}\text{C}$, and we decide 2 fuzzy sets (trapezoid) as

- $A_1(0, 0, 0.5, 1)$
- $A_2(0, 0.5, 1, 1)$

For the humidity input, it can be between $[0\ 100]$ percentage, and we decide 3 sets (triangle) as

- $B_1(0, 0, 0.5)$
- $B_2(0, 0.5, 1)$
- $B_3(0.5, 1, 1)$

For the fan speed output, it can be between $[0\ 400]$ rpm, and , we decide 3 singleton sets as

- $C_1(0)$
- $C_2(0.5)$
- $C_3(1)$

Also we decide three rules as

Rule 1. IF x is A_1 AND y is B_1 THEN z is C_1

Rule 2. IF x is A_1 AND y is B_2 THEN z is C_2

Rule 3. IF x is A_2 AND y is B_3 THEN z is C_3

a. Compute the fan speed for 0°C temperature and 50% humidity.

At first, we should normalize the inputs.

$x=0.5$ (according to $[-50\ 50]^{\circ}\text{C}$) $y=0.5$ (according to $[0\ 100]\%$)

Then, we find the membership values for each set.

$\mu_{A_1}(x=0.5)=1$ $\mu_{A_2}(0.5)=1$ $\mu_{B_1}(y=0.5)=0$ $\mu_{B_2}(0.5)=1$ $\mu_{B_3}(0.5)=0$

And, the outputs of rules (according to some papers, we could get the *min* value.)

$R_1 = \mu_{A_1} * \mu_{B_1} = 1 * 0 = 0$ $R_2 = 1 * 1 = 1$ $R_3 = 1 * 0 = 0$

Finally, defuzzification with weighted average, and denormalization.

$z_{\text{norm}} = (0 * 0 + 1 * 0.5 + 0 * 1) / (0 + 1 + 0) = 0.5 \rightarrow [0\ 400]\text{rpm}$

$z_{\text{real}} = 0 + 0.5 * (400 - 0) = 200\text{ rpm}$

b. Compute the fan speed for 25°C temperature and 75% humidity.

$x=0.75$ $y=0.75$

$\mu_{A_1}(x=0.75)=0.5$ $\mu_{A_2}(0.75)=1$ $\mu_{B_1}(y=0.75)=0$ $\mu_{B_2}(0.75)=0.5$ $\mu_{B_3}(0.75)=0.5$

$R_1 = \mu_{A_1} * \mu_{B_1} = 0.5 * 0 = 0$ $R_2 = 0.5 * 0.5 = 0.25$ $R_3 = 1 * 0.5 = 0.5$

$z_{\text{norm}} = (0 * 0 + 0.25 * 0.5 + 0.5 * 1) / (0 + 0.25 + 0.5) = 0.833 \rightarrow [0\ 400]\text{rpm}$

$z_{\text{real}} = 0 + 0.833 * (400 - 0) = 333\text{ rpm}$