11. Sugeno - Takagi Controller

Rules: $L_1, ..., L_n$

L_i : <u>if</u> x_1 is $\mu_{i,1}$ <u>and</u> x_2 is $\mu_{i,2}$ <u>and</u> ... <u>and</u> x_p is $\mu_{i,p}$

<u>then</u> $y_i = c_{0,i} + c_{1,i}\, x_1 + ... + c_{p,i}\, x_p$

Matching degree for input $(x_1^0, ..., x_p^0)$ and rule L_i

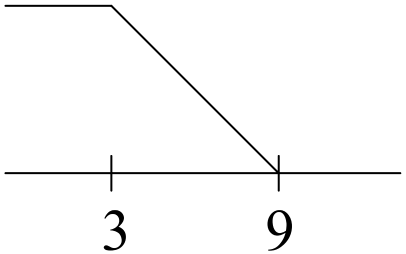
$$w_i = \mu_{i,1}(x_1^0) \wedge ... \wedge \mu_{i,p}(x_p^0)$$

Output for (x_1^0, x_p^0)

$$y^0 = \sum_{i=1}^{p} w_i \cdot y_i^0 \Big/ \sum_{i=1}^{p} w_i \qquad , y_i^0 = c_{0,i} + ... + c_{p,i} x_p^0$$

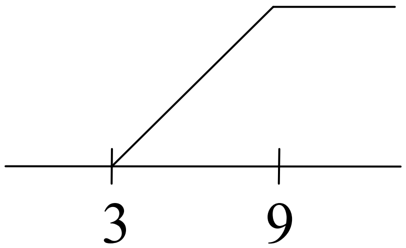
Examples

L_1 : if x_1 is

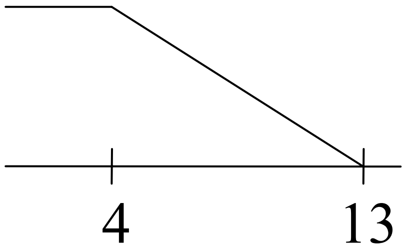


then $y_1 = 1 \cdot x_1 + 0.5\, x_2 + 1$

L_2 : if x_1 is

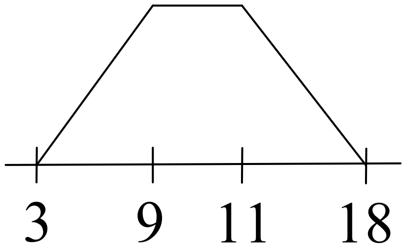


and x_2 is

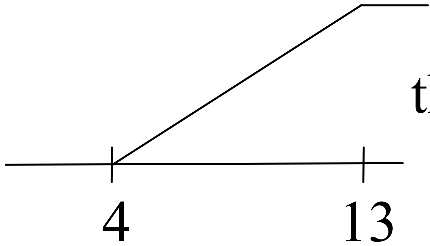


then $y_2 = -0.1x_1 + 4x_2 + 1.2$

L_3 : if x_1 is

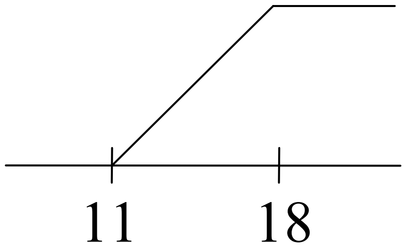


and x_2 is

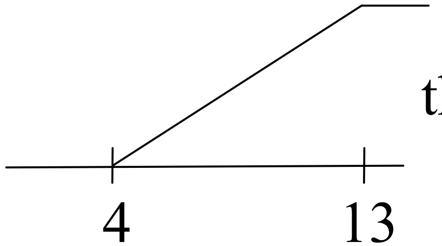


then $y_3 = 0.9x_1 + 0.7x_2 + 9$

L_4 : if x_1 is



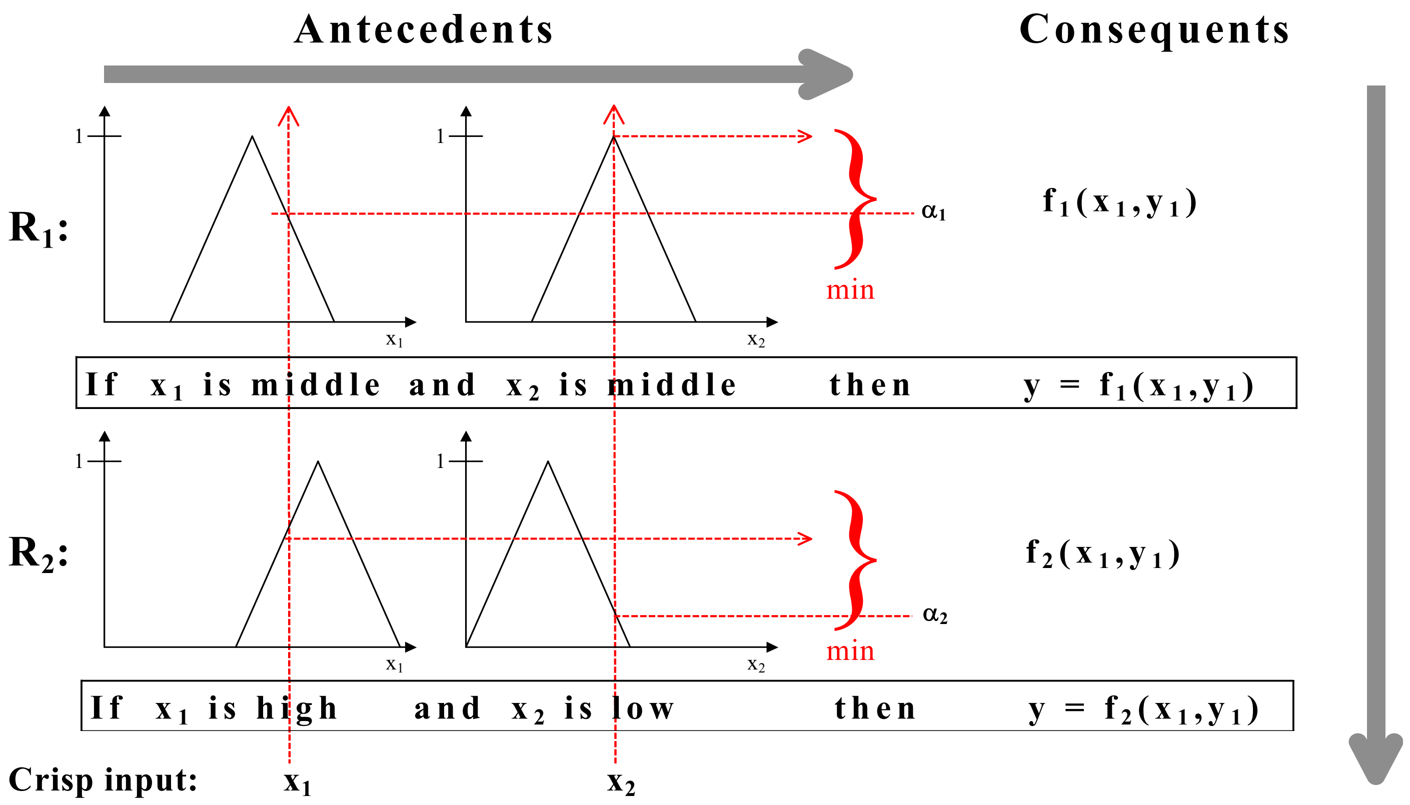
and x_2 is



then $y_4 = 0.2x_1 + 0.1x_2 + 0.2$

$(x_1^0, x_2^0) = (6,7),\ y^0 = 19.5$

Example 9.1 Computation of several fuzzy rules



Decision logic output:

$$y = \frac{\alpha_1 f_1(x_1, y_1) + \alpha_2 f_2(x_1, y_1)}{\alpha_1 + \alpha_2}$$

Definition 11.2 Sugeno-Takagi Fuzzy Control

A Sugeno Fuzzy Controller consists of a set of rules R_i, i=1,...,k :

R_i: if x_1 is A_{i1} and if x_2 is A_{i2} and ... and if x_n is A_{in}

then $y=f_i(x_1,x_2,...,x_n)$

where A_{ij} are fuzzy sets and $f_i(x_1,x_2,...,x_n)$ is linear.

$f_i(x_1,x_2,...,x_n)=a_1x_1+a_2x_2+...+a_nx_n+a_{n+1}$

The output is computed by $$y=\frac{\sum_{i=1}^{k}\alpha_i f_i(x_1,...,x_n)}{\sum_{i=1}^{k}\alpha_i}$$

where $\alpha_i \in [0,1]$ is the degree at which the antecedent of rule R_i holds.

α_i is computed as in Mamdani Fuzzy Control.