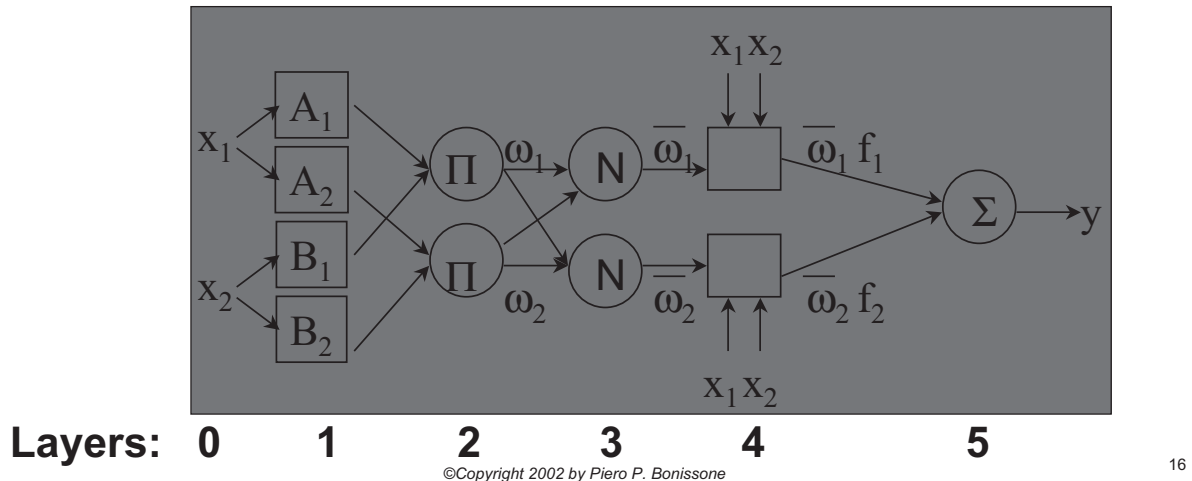


ANFIS Architecture

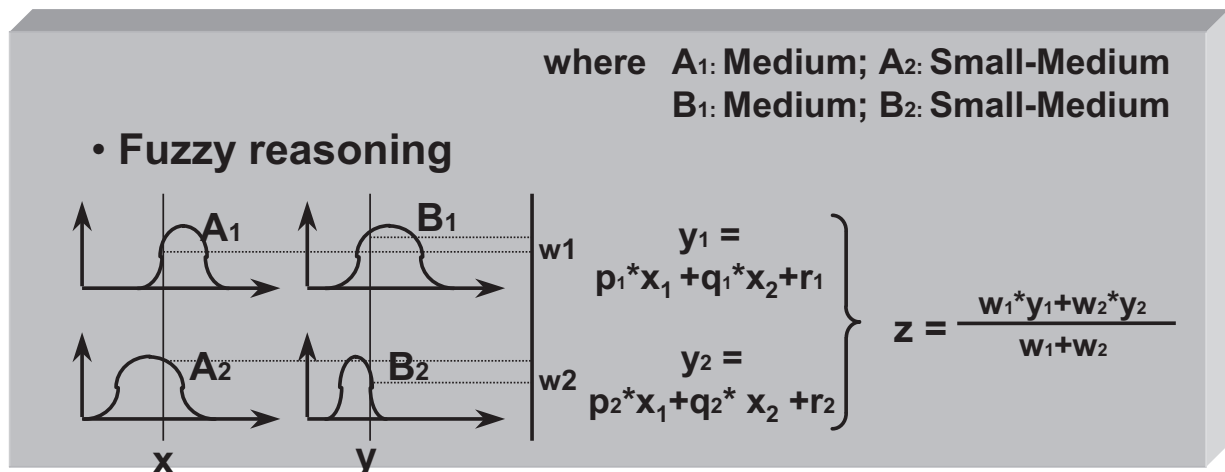
Rule Set:

IF (x_1 is A_1) AND (x_2 is B_1) THEN $f_1 = p_1 x_1 + q_1 x_2 + r_1$
 IF (x_1 is A_2) AND (x_2 is B_2) THEN $f_2 = p_2 x_1 + q_2 x_2 + r_2$
 ...

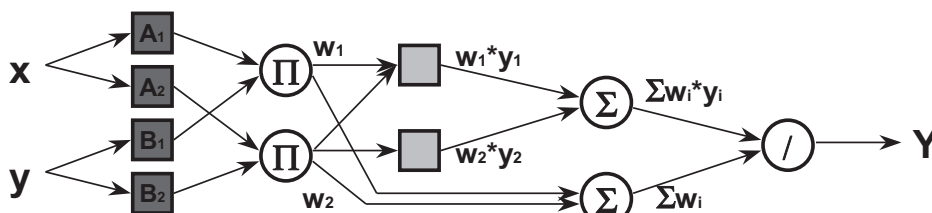


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ANFIS-Visualized (Example for n =2)



• ANFIS (Adaptive Neuro-Fuzzy Inference System)



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Layer 1: Calculate Membership Value for Premise Parameter

- Output $O_{1,i}$ for node $i=1,2$

$$O_{1,i} = \mu_{A_i}(x_1)$$

- Output $O_{1,i}$ for node $i=3,4$

$$O_{1,i} = \mu_{B_{i-2}}(x_2)$$

- where

A is a linguistic label (small, large, ...)

$$\mu_A(x_1) = \frac{1}{1 + \left| \frac{x_1 - c_i}{a_i} \right|^{2b}}$$

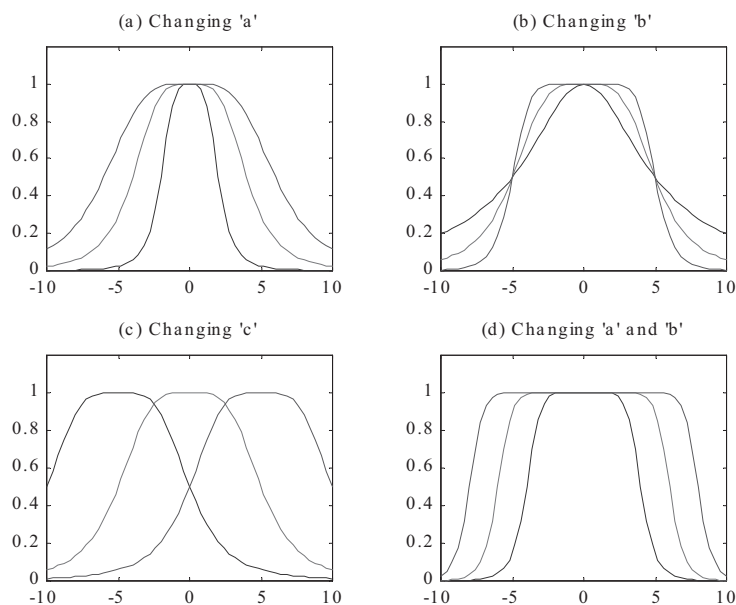
Node output: *membership value of input*

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Layer 1 (cont.): Effect of changing Parameters {a,b,c}

$$\mu_A(x) = \frac{1}{1 + \left| \frac{x - c_i}{a_i} \right|^{2b}}$$



Layer 2: Firing Strength of Rule

- Use T-norm (min, product, fuzzy AND, ...)

$$O_{2,i} = w_i = \mu_{A_i}(x_1) \mu_{B_i}(x_2)$$

(for i=1,2)

Node output: *firing strength of rule*

Layer 3: Normalize Firing Strength

- Ratio of ith rule's firing strength vs. all rules' firing strength

$$O_{3,i} = \bar{w}_i = \frac{w_i}{w_1 + w_2}$$

(for i=1,2)

Node output: *Normalized firing strengths*

Layer 4: Consequent Parameters

- Takagi-Sugeno type output

$$O_{4,i} = \bar{w}_i f_i = \bar{w}_i (p_i x_1 + q_i x_2 + r_i)$$

- Consequent parameters $\{p_i, q_i, r_i\}$

Node output: *Evaluation of Right Hand Side Polynomials*

Layer 5: Overall Output

$$O_{5,1} = \sum_i \bar{w}_i f_i = \frac{\sum_i w_i f_i}{\sum_i w_i}$$

- Note:
 - Output is linear in consequent parameters p, q, r .

$$\begin{aligned} &= \frac{w_1}{w_1 + w_2} f_1 + \frac{w_2}{w_1 + w_2} f_2 \\ &= \bar{w}_1 (p_1 x_1 + q_1 x_2 + r_1) + \bar{w}_2 (p_2 x_1 + q_2 x_2 + r_2) \\ &= (\bar{w}_1 x_1) p_1 + (\bar{w}_1 x_2) q_1 + (\bar{w}_1) r_1 + (\bar{w}_2 x_1) p_2 + (\bar{w}_2 x_2) q_2 + (\bar{w}_2) r_2 \end{aligned}$$

Node output: *Weighted Evaluation of RHS Polynomials*

ANFIS Network

