Defuzzification

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Referensi : Neuro Fuzzy and Soft Computing
J.-S. Roger Jang

- Fuzzy inference is a computer paradigm based on fuzzy set theory, fuzzy if-then-rules and fuzzy reasoning
- Applications: data classification, decision analysis, expert systems, times series predictions, robotics & pattern recognition
- Different names; fuzzy rule-based system, fuzzy model, fuzzy associative memory, fuzzy logic controller & fuzzy system

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- Structure
  - Rule base ← selects the set of fuzzy rules
  - Database (or dictionary) ← defines the membership functions used in the fuzzy rules
  - A reasoning mechanism ← performs the inference procedure (derive a conclusion from facts & rules!)
- Defuzzification: extraction of a crisp value that best represents a fuzzy set
  - Need: it is necessary to have a crisp output in some situations where an inference system is used as a controller

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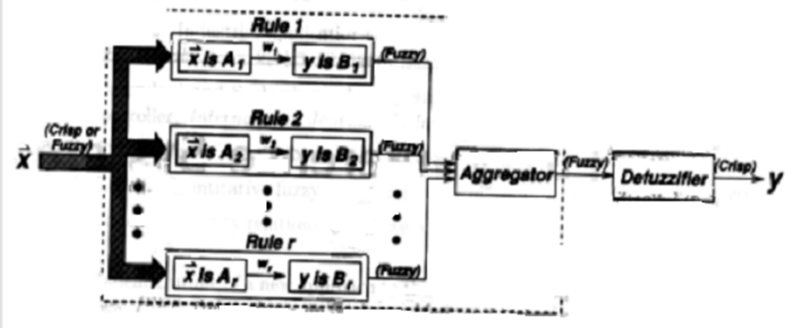

Block diagram for a fuzzy inference system

Defuzzification [definition]

"It refers to the way a crisp value is extracted from a fuzzy set as a representative value"

- There are five methods of defuzzifying a fuzzy set A of a universe of discourse Z
  - Centroid of area zCOA
  - Bisector of area zBOA
  - Mean of maximum zMOM
  - Smallest of maximum zSOM
  - Largest of maximum zLOM

- Centroid of area zCOA

$$z_{COA} = \frac{\int_Z \mu_A(z) z dz}{\int_Z \mu_A(z) dz},$$

where $\mu A(z)$ is the aggregated output MF.

- Bisector of area zBOA
  this operator satisfies the following;

$$\int_{\alpha}^{z_{BOA}} \mu_A(z) dz = \int_{z_{BOA}}^{\beta} \mu_A(z) dz,$$

where α = min {z; z $\in$Z} & β = max {z; z $\in$Z}. The vertical line z = zBOA partitions the region between z = α, z = β, y = 0 & y = $\mu A(z)$ into two regions with the same area

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- Mean of maximum z_{MOM}

This operator computes the average of the maximizing z at which the MF reaches a maximum μ^*. It is expressed by :

$$z_{MOM} = \frac{\int_{Z'} z\,dz}{\int_{Z'} dz},$$

$$\text{where } Z' = \{z; \mu_A(z) = \mu^*\}$$

$$\text{By definition : if } \mu_A(z) \text{ has a single maximum at } z = z^* \text{ then } z_{MOM} = z^*$$

$$\text{However : if } \max_z \mu_A(z) = [z_1, z_2] \text{ then } z_{MOM} = \frac{z_1 + z_2}{2}$$

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- Smallest of maximum z_{SOM}

Amongst all z that belong to $[z_1, z_2]$, the smallest is called z_{SOM}

- Largest of maximum z_{LOM}

Amongst all z that belong to $[z_1, z_2]$, the largest value is called z_{LOM}

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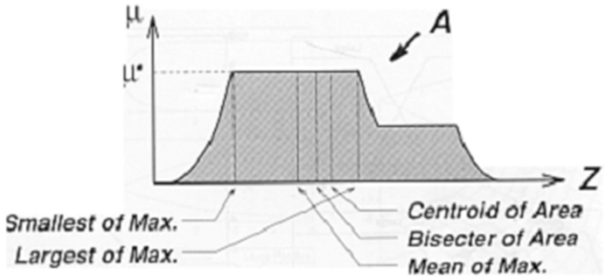

Various defuzzification schemes for obtaining a crisp output