Intelligent Control

Fuzzy Logic (3c)

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Expert System by
N.M.A Ghani

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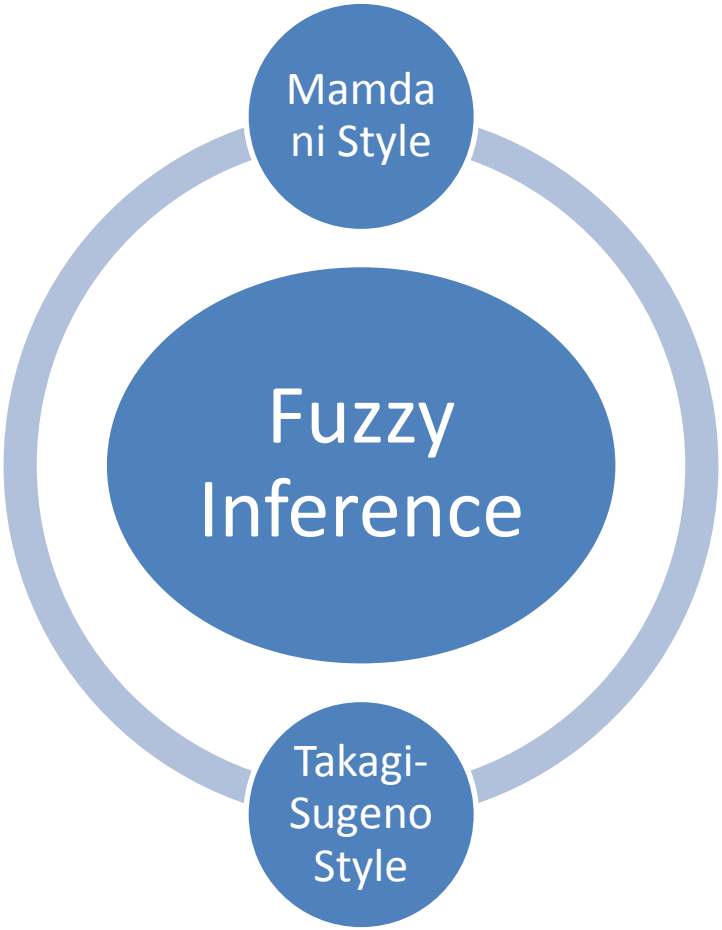
Definition



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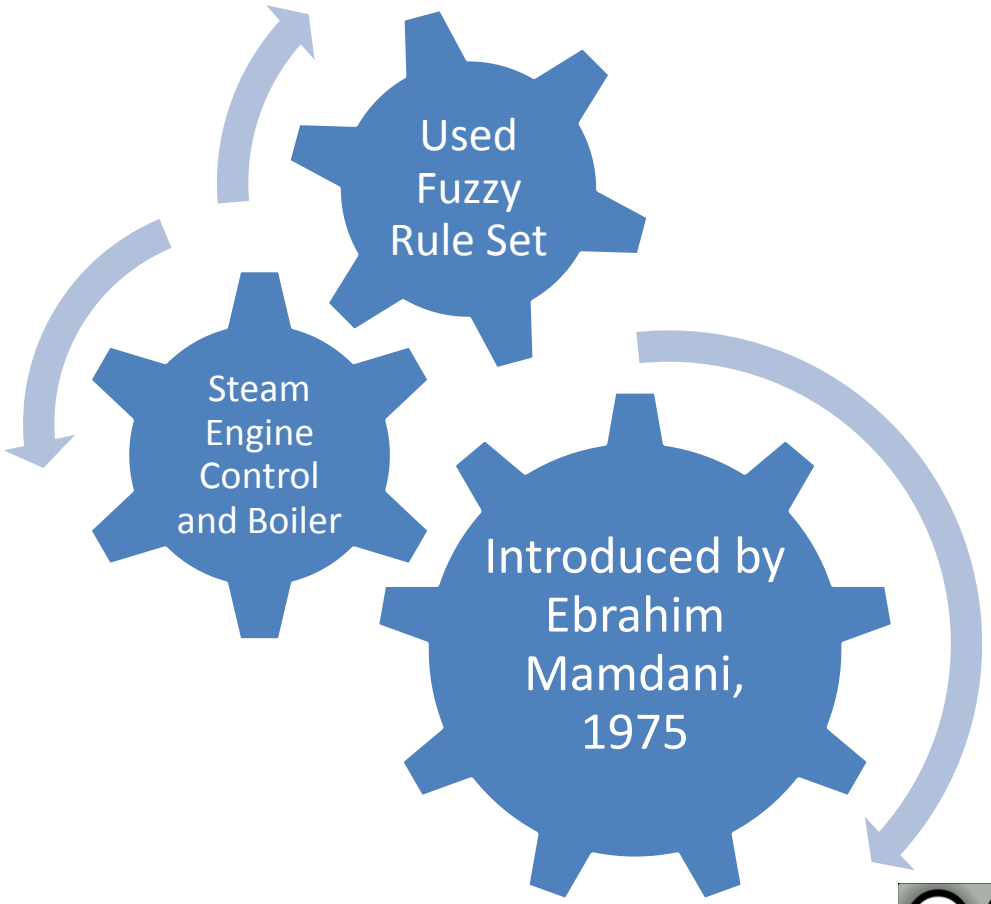
Mamdani Style



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Fuzzy Logic Control

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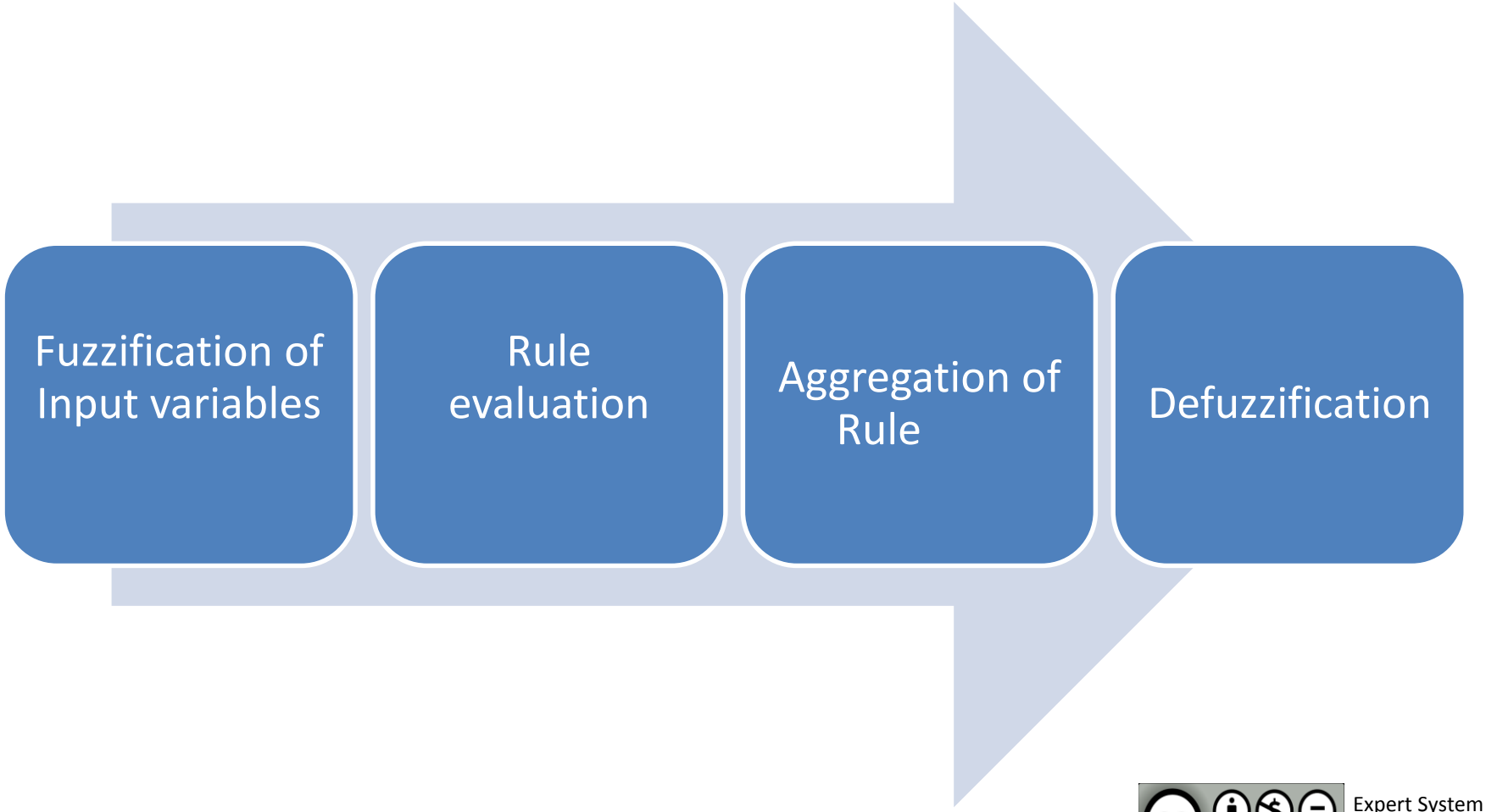
Mamdani Inference



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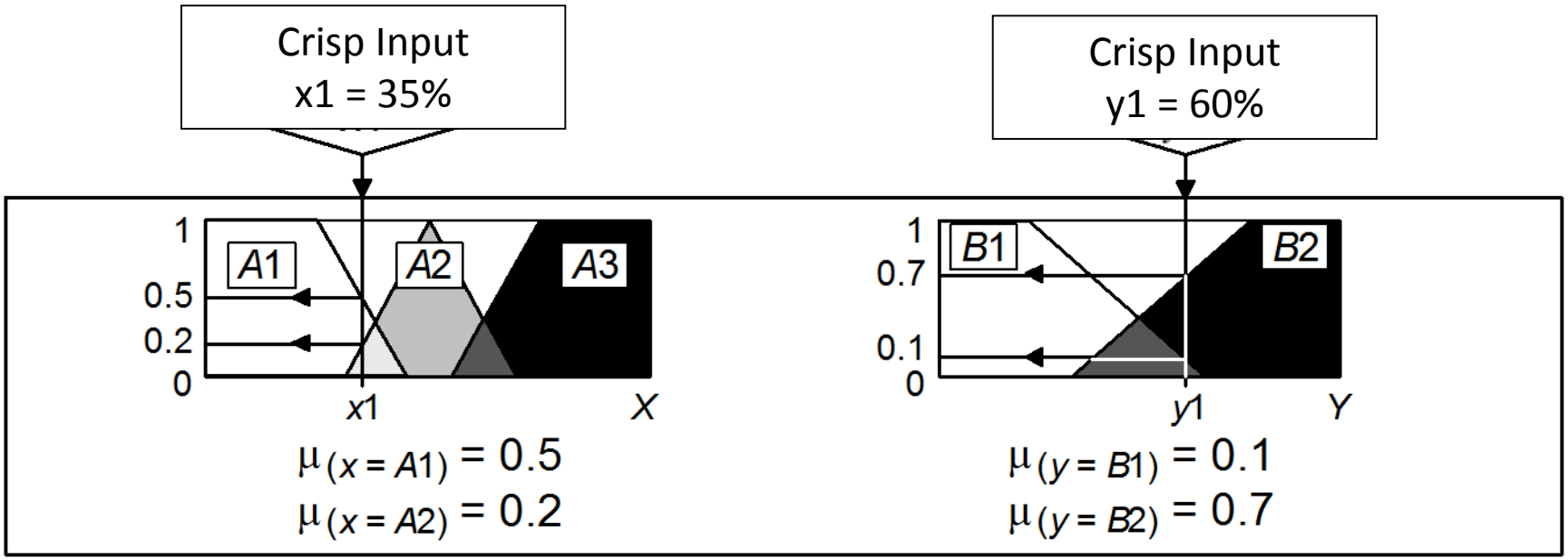
Step 1 : Fuzzification : Fuzzy sets of inputs



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Step 2 : Rule Evaluation

- Union Fuzzy Set.
  - Maximum of fuzzy combination set.
  - OR fuzzy operation.
- Intersection Fuzzy Set.
  - Minimum of fuzzy combination
  - AND fuzzy operation.

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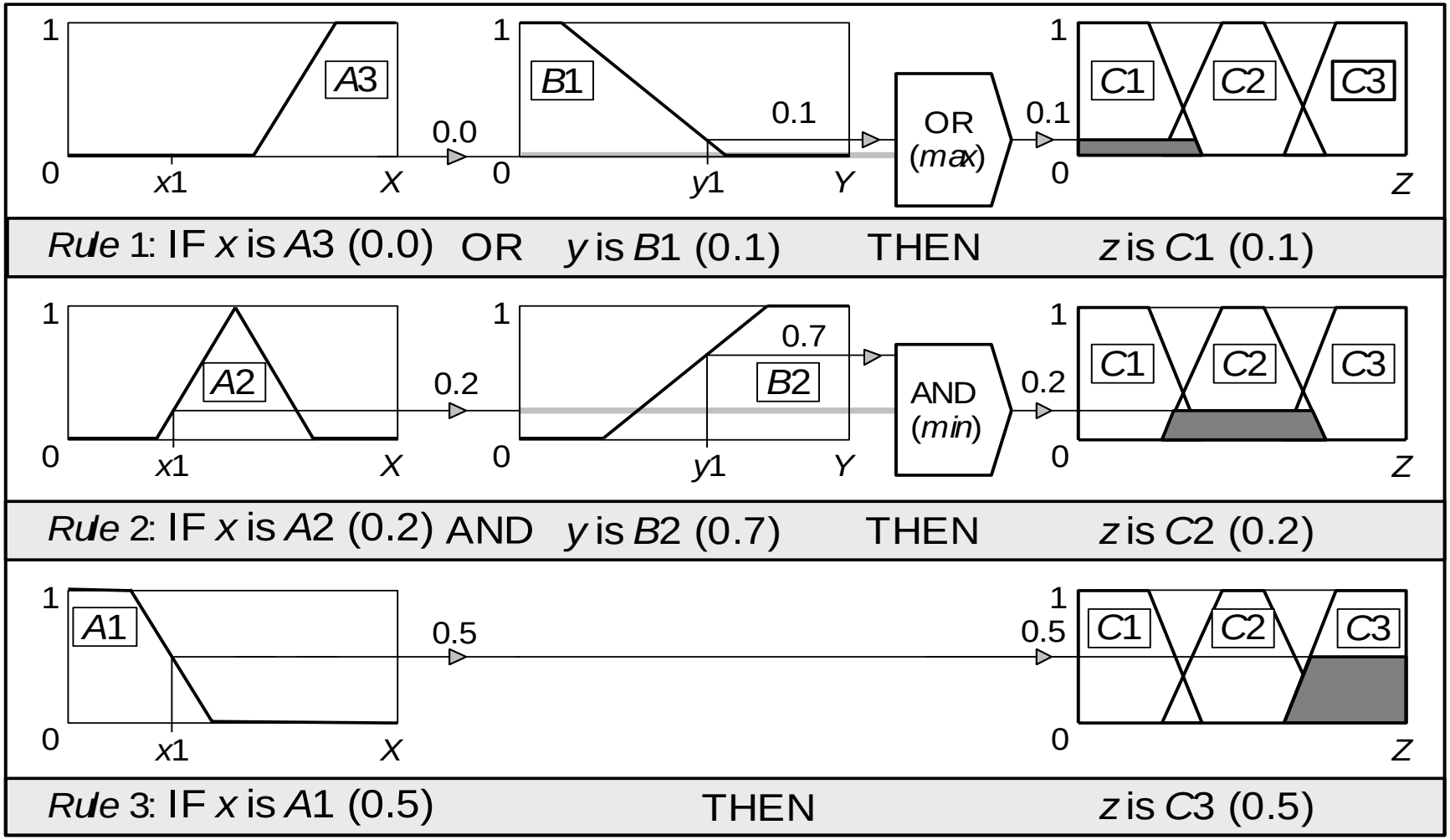
Mamdani-style rule evaluation



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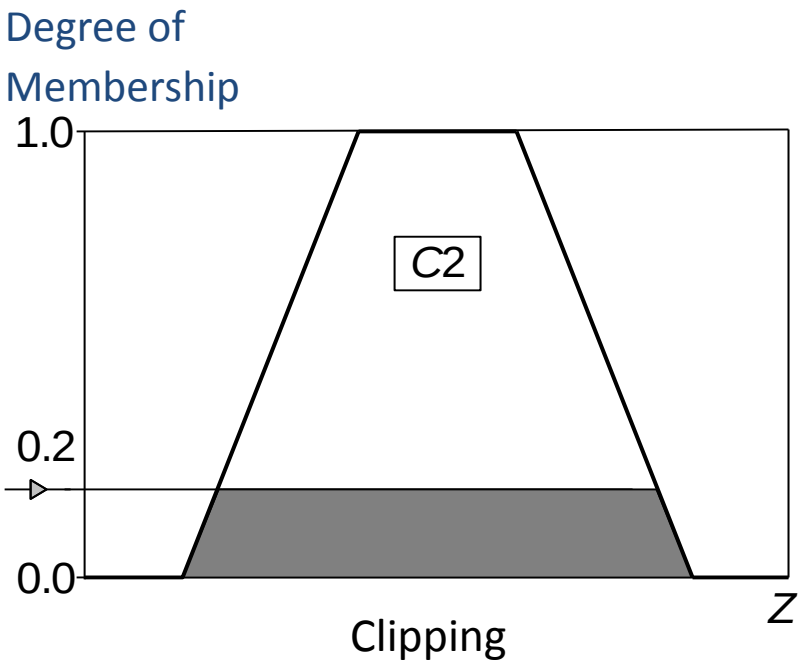
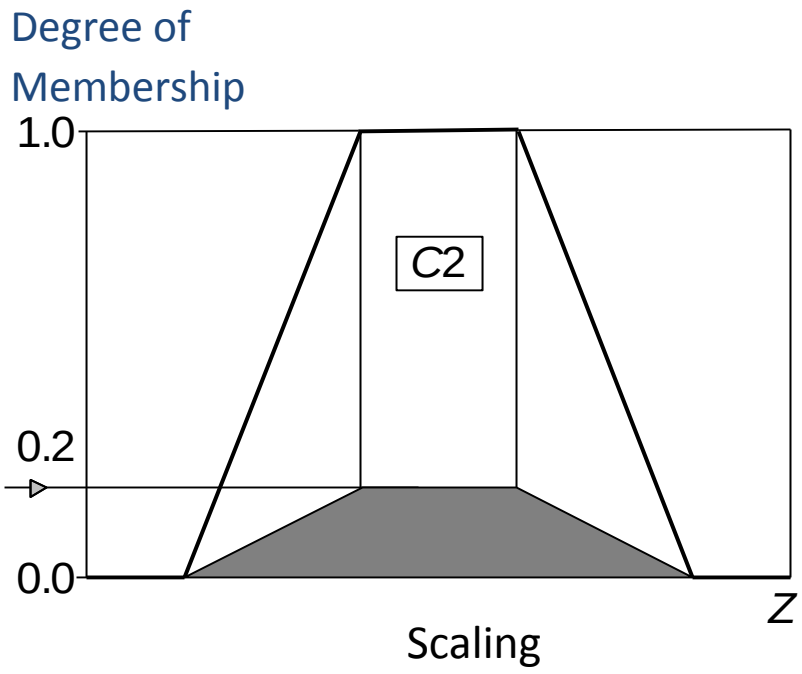
Clipping vs Scaling





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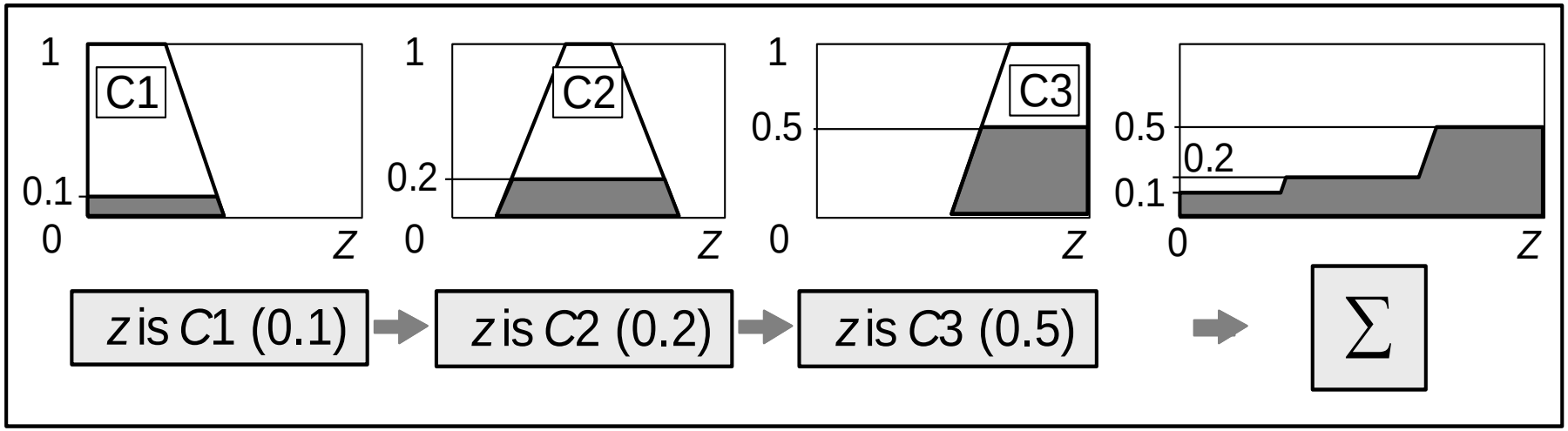
Step 3: Aggregation of the rule outputs



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Step 4: Defuzzification

$$COG = \frac{\int_a^b \mu_A(x)\, x\, dx}{\int_a^b \mu_A(x)\, dx}$$

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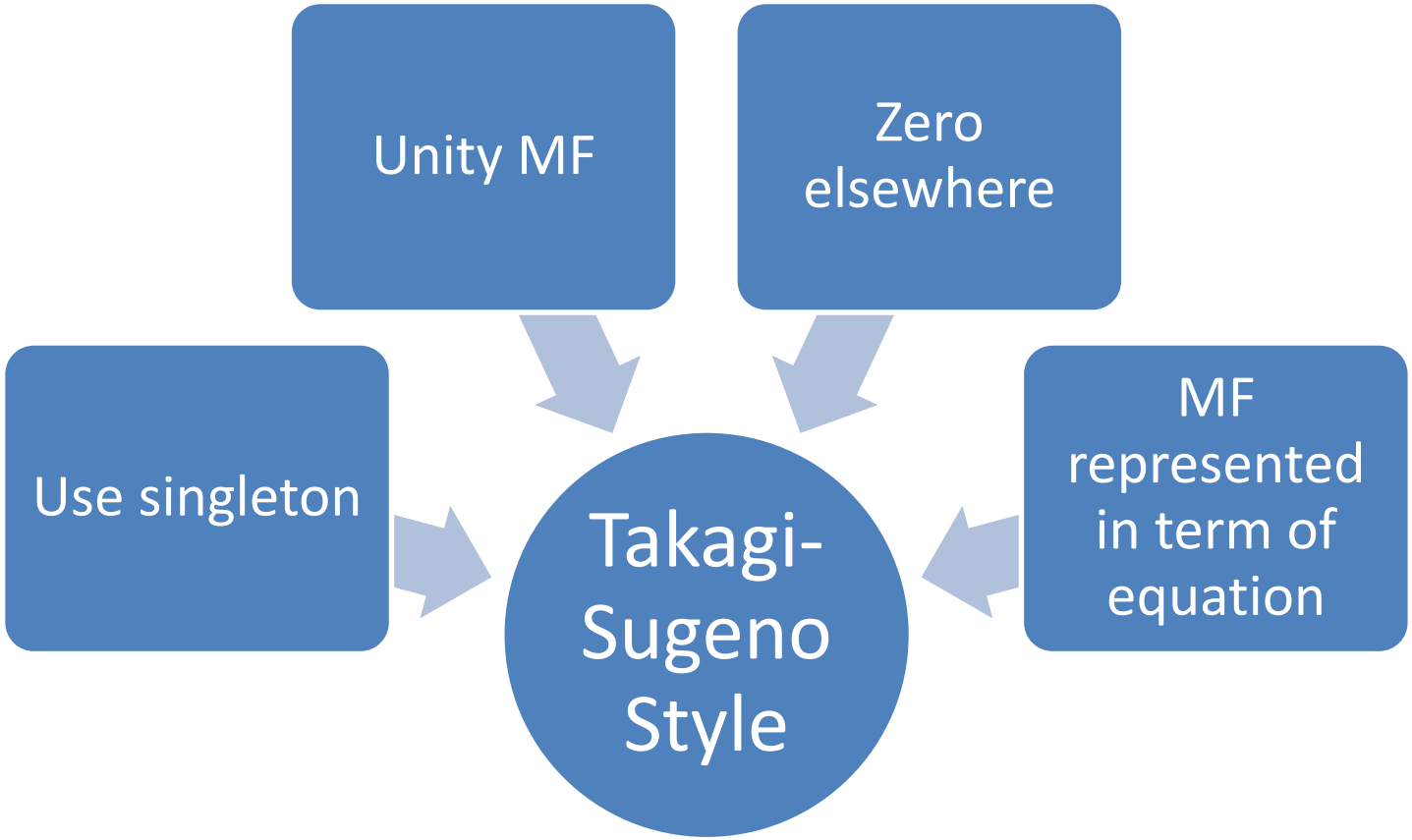
Sugeno-style Inference



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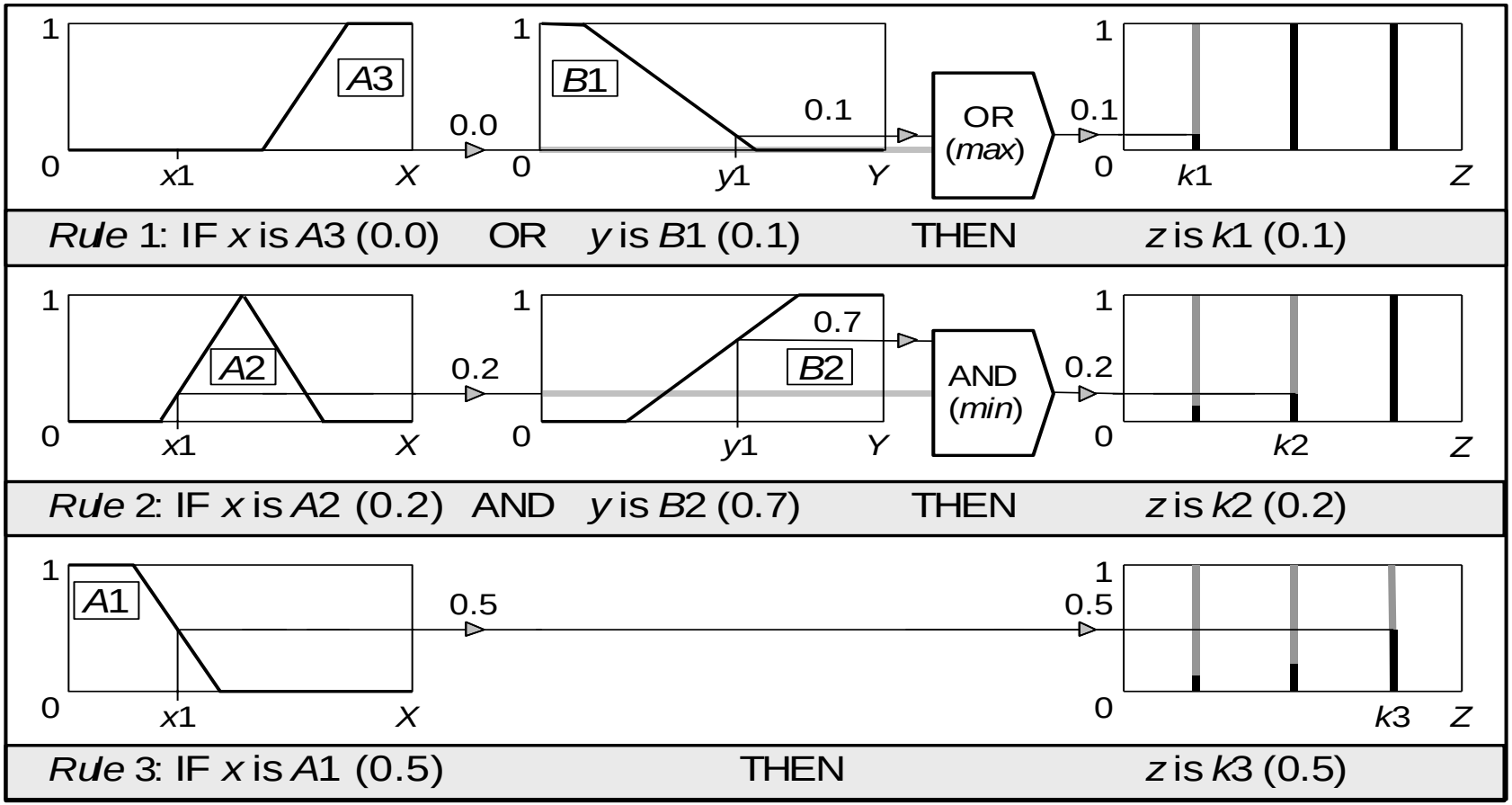
Sugeno-style inference



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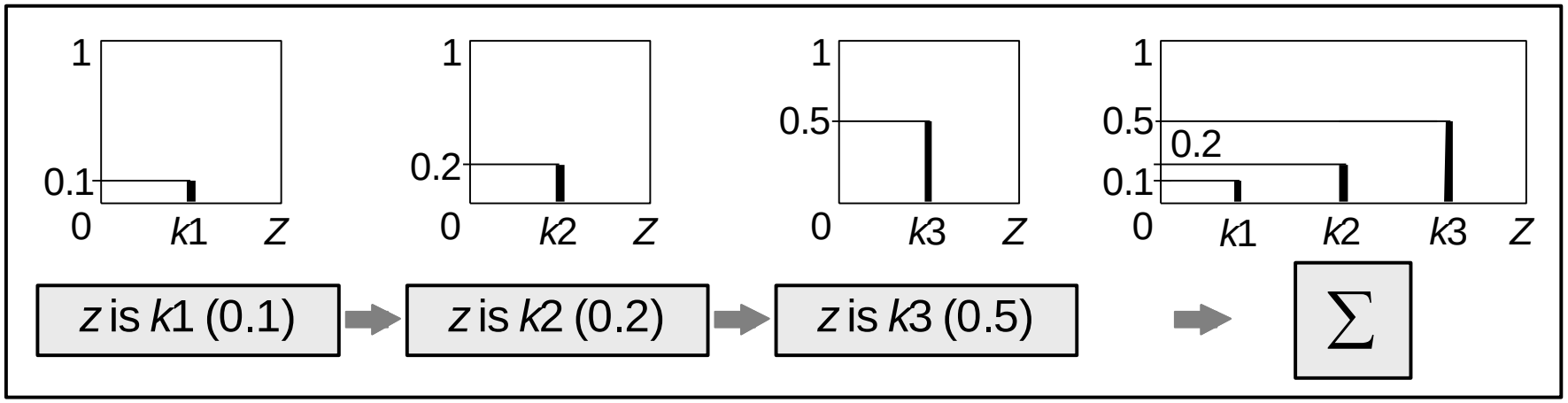
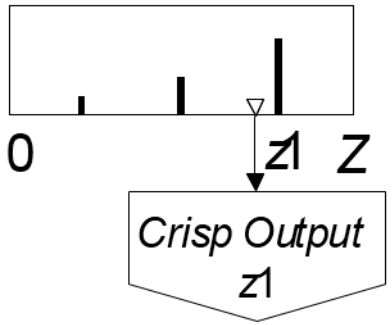


Weighted average (WA) defuzzification:

$$WA = \frac{\mu(k1) X k1 + \mu(k2) X k2 + \mu(k3) X k3}{\mu(k1) + \mu(k2) + \mu(k3)} = \frac{0.1X20 + 0.2X50 + 0.5X80}{0.1 + 0.2 + 0.5} = 65$$



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Mamdani vs Sugeno

Mamdani	Sugeno
Output membership function	No output membership function
Output distribution	No output distribution only 'resulting action': Mathematical combination of the rule strength and the output
Crisp result obtained through defuzzification of rules' consequent	No defuzzification: crisp result is obtained using weighted average of the rules' consequent
Non-continuous output surface	Continuous output surface
MISO and MIMO systems	Only MISO systems [1]
Expressive power and interpretable rule consequents	Loss of interpretability
Less flexibility in system design	More flexibility in system design; more parameters in the output

Hamam, A.; Georganas, N.D.; 2008

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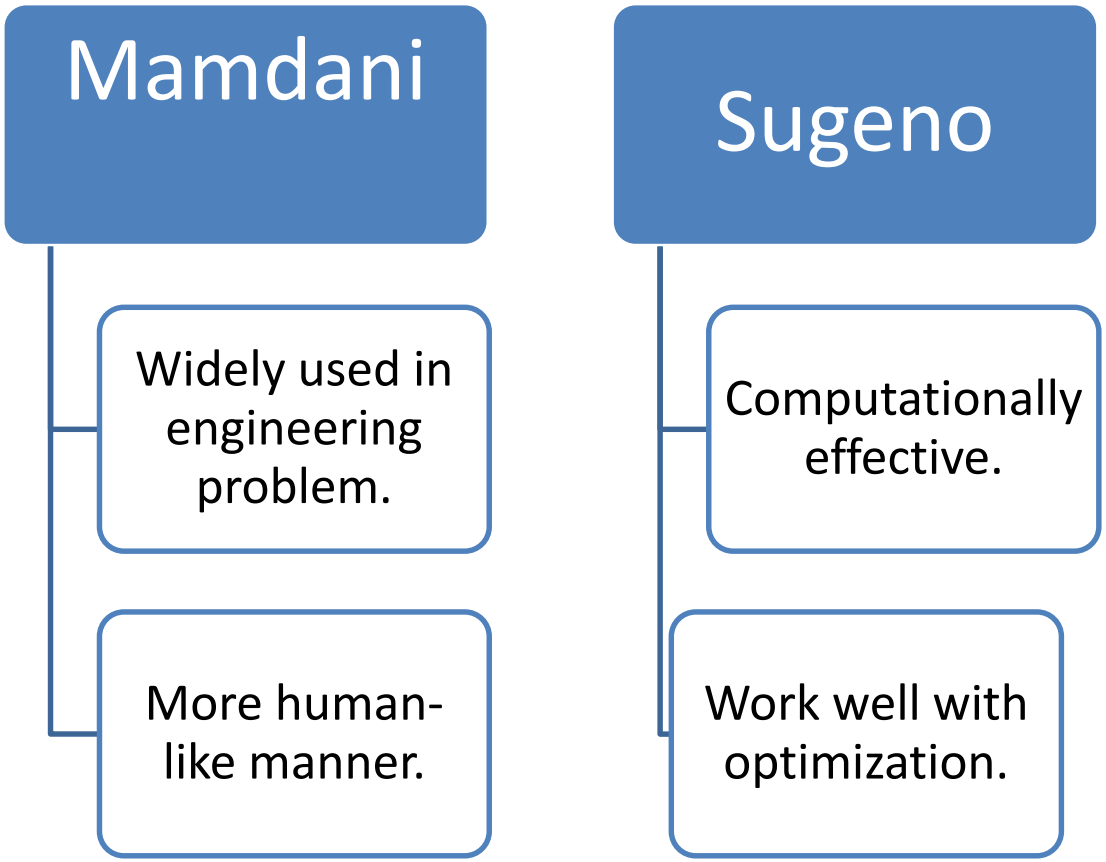
Mamdani vs Sugeno Cont'd



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