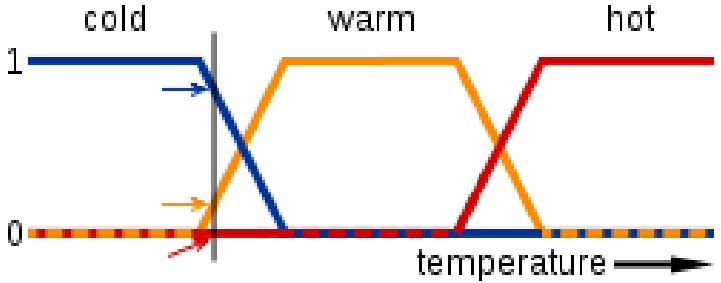
EcoStruxure Control Expert Libraries - Overview

Fuzzy Control

Value

Why use Fuzzy Control

- Some process are easier to explain than to model mathematically.
  - The loop control is easier to explain in examples
  - The examples can for a generalised set of responses
  - The rules are based on fuzzy concepts (eg. warm)
- Fuzzy Logic controllers contain rules engines which process generalised (fuzzy) rules to produce a crisp output.
  - The output is driven by the rules and performance is managed by the accuracy of the rules.
  - The rules need to be maintained to deliver optimal control.



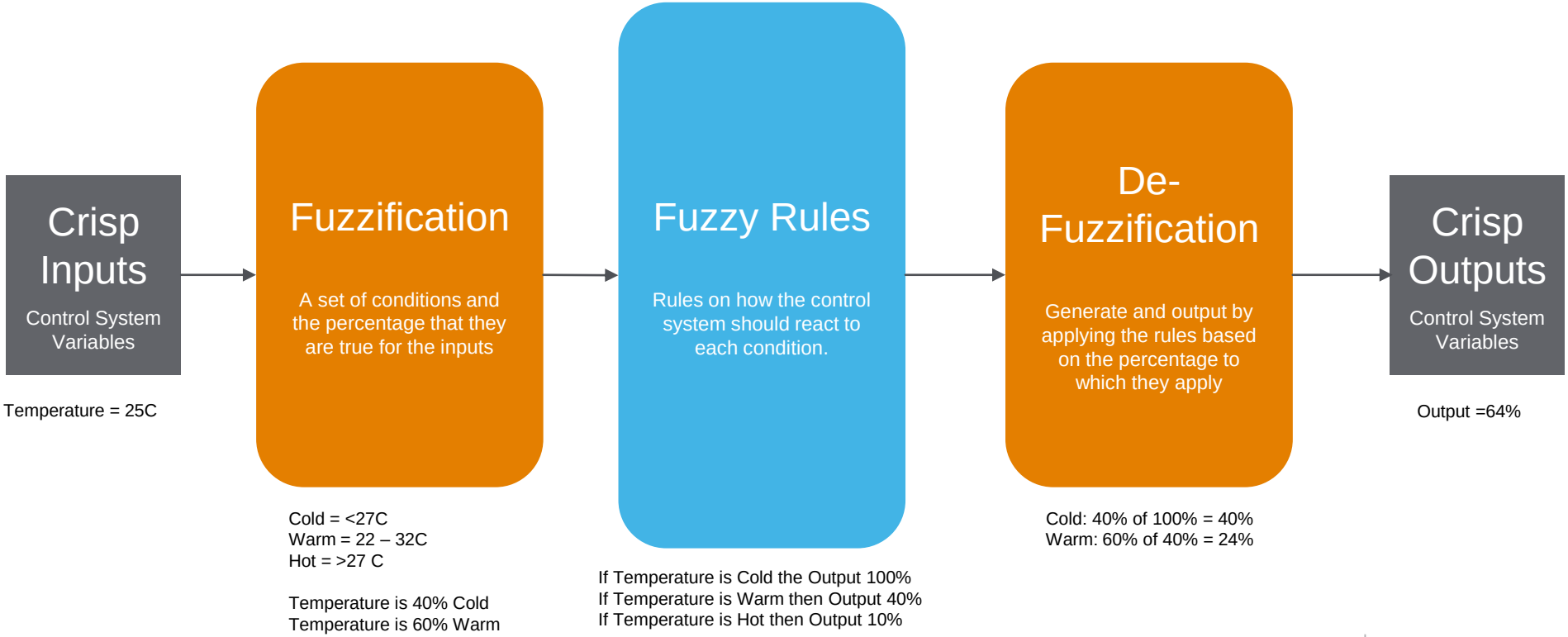
By fullofstars: Image:Warm fuzzy logic member function.gif, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2870420

The Fuzzy Process

How fuzzy works

Temperature	22	23	24	25	26	27	28	29	30	31	32
Output	100	88	76	64	52	40	34	28	22	16	10

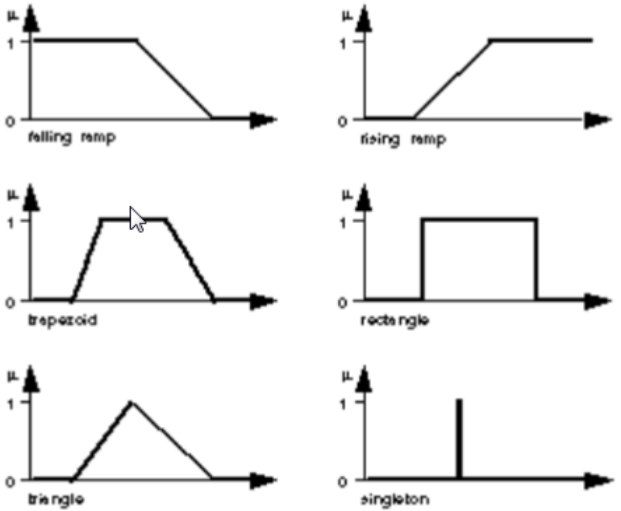
Non-linear Response



Fuzzy Conditions

Fuzzification

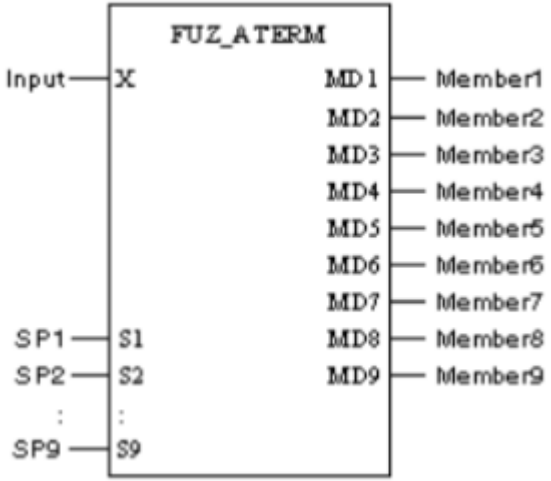
- Fuzzy Member Forms
  - Falling Ramp (lower extent)
  - Rising Ramp (upper extent)
  - Triangle (common)
  - Rectangle (fixed condition)
  - Trapezoid (mixed)
  - Singleton (instance)



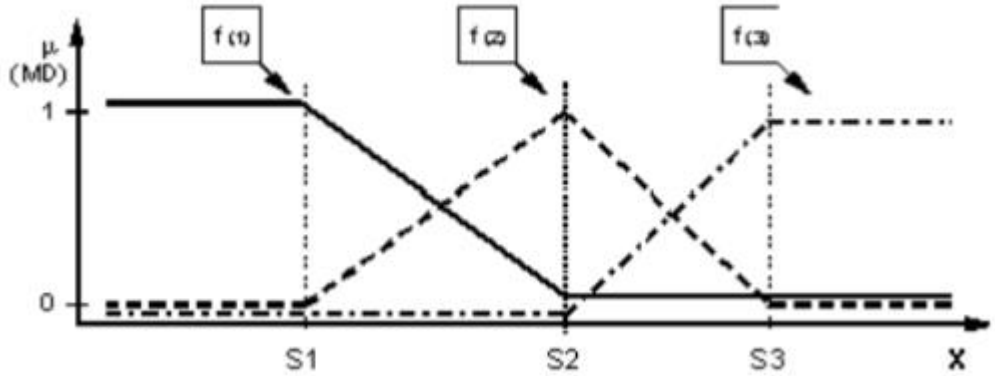
Fuzzy Condition Sets

Fuzzy Block ATERM

- Terms
  - First Term is Falling Ramp
  - Last Term is Rising Ramp
  - Intermediate Terms are Triangles
-
- Members
  - Individual Reals (% Membership)
  - Structure with array of Membership



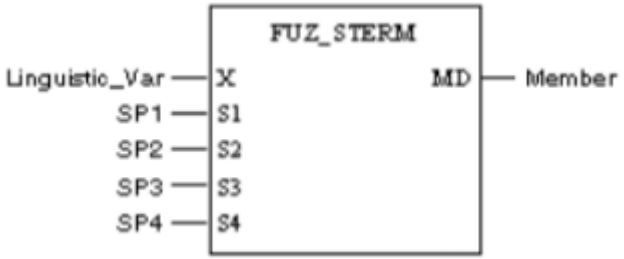
3 membership functions, 3 support points, 3 membership degrees



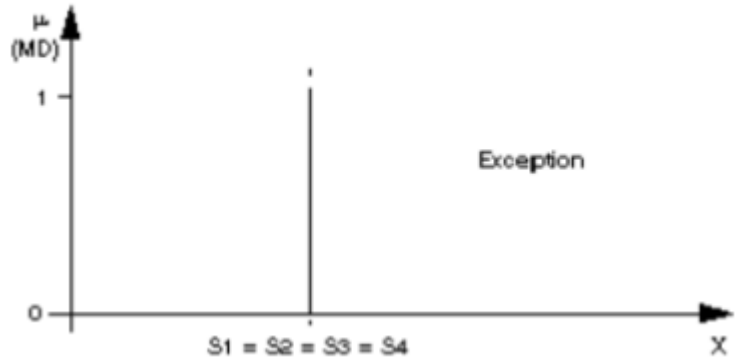
Fuzzy Individual Conditions

Fuzzy Block STERM

- Terms
  - 2 points (s1 = zero, S2 = max)
  - 3 points (s1,s3 = zero, s2 = max)
  - 4 points (s1,s4 = zero, s2,s3 = max)
  - Singleton (s1,s2,s3,s4 = value)
- Members
  - Single Member Structure



Singleton: `S1 = S2 = S3 = S4`

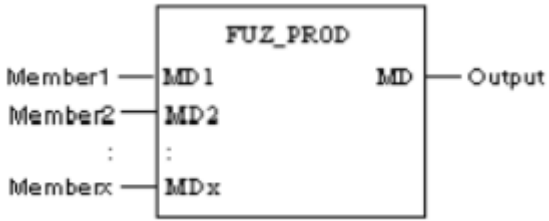


Fuzzy Rules

How we implement the rules

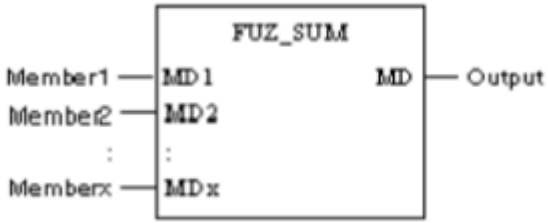
AND statements

Multiply the conditions then apply the output



Or Statements

Add the two conditions then apply the output

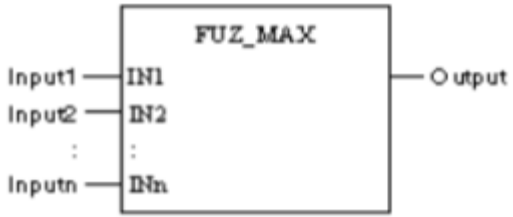


Fuzzy Helper Functions

Ensuring the we remain Fuzzy (between 0 and 1)

MAX

Taking the maximum value (above zero)



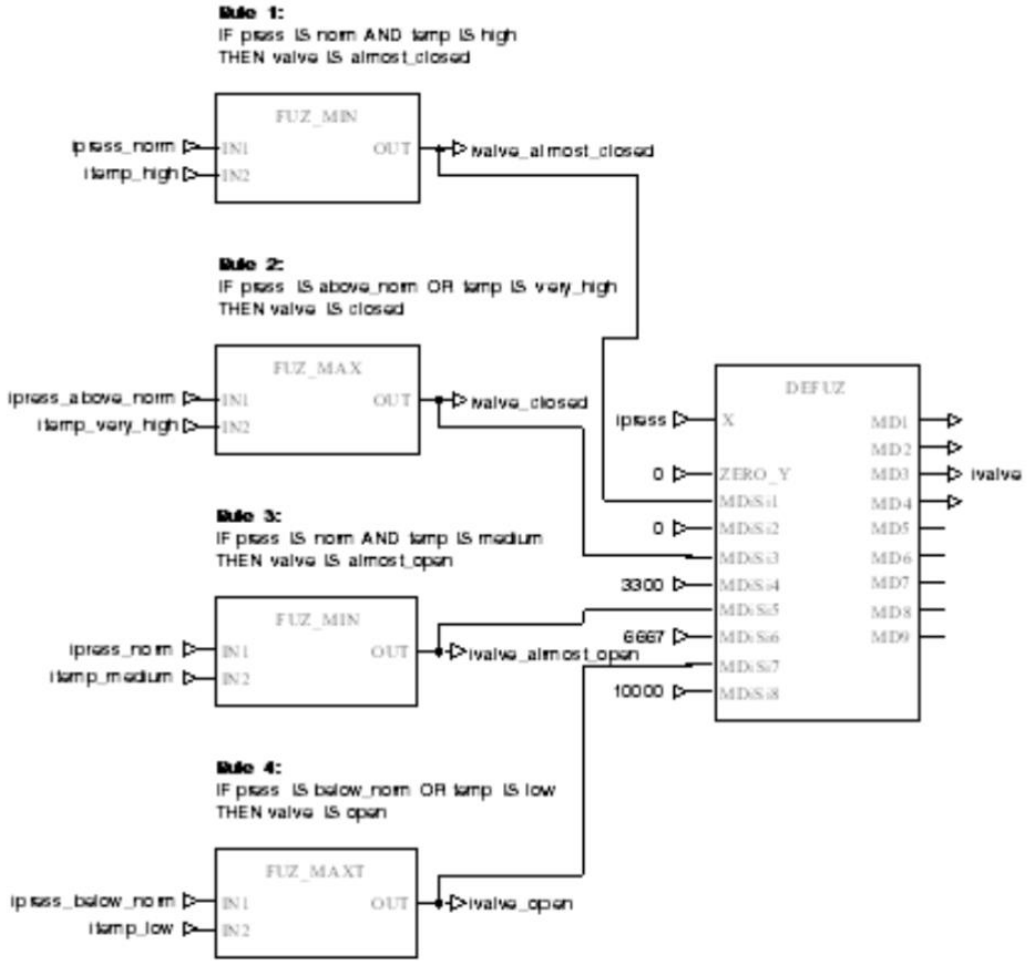
MIN

Taking the minimum value (below one)

Defuzzification

Making sharp with singletons

- Singletons make outputs complex
  - Defuzz does the work



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