

Fuzzy Logic

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Smart Bike

- Perception
 - User age
 - Physical condition
- Actuator
 - self-balance motor

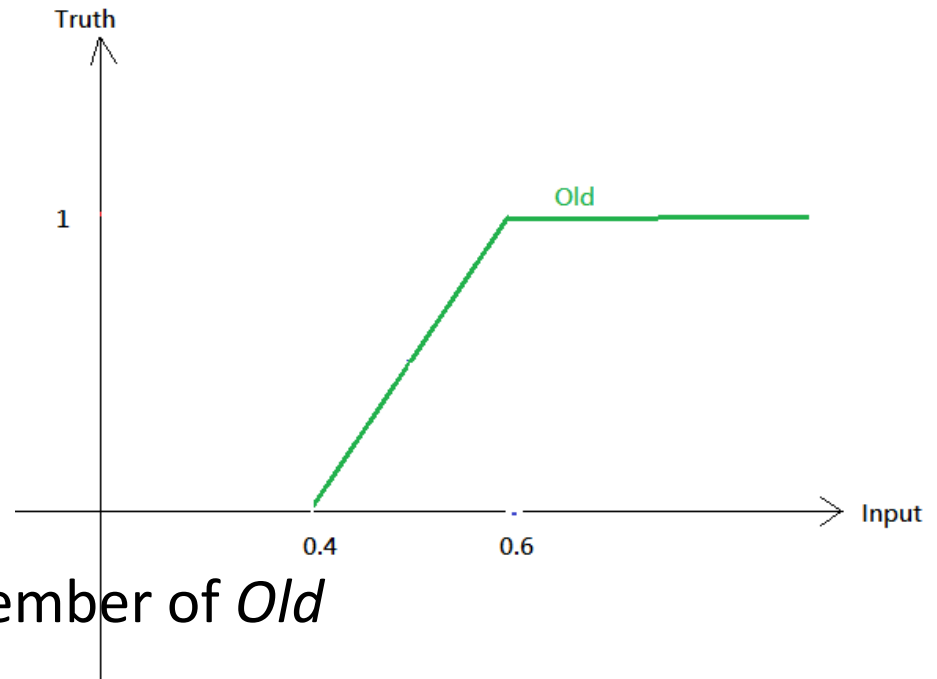


Input Scaling

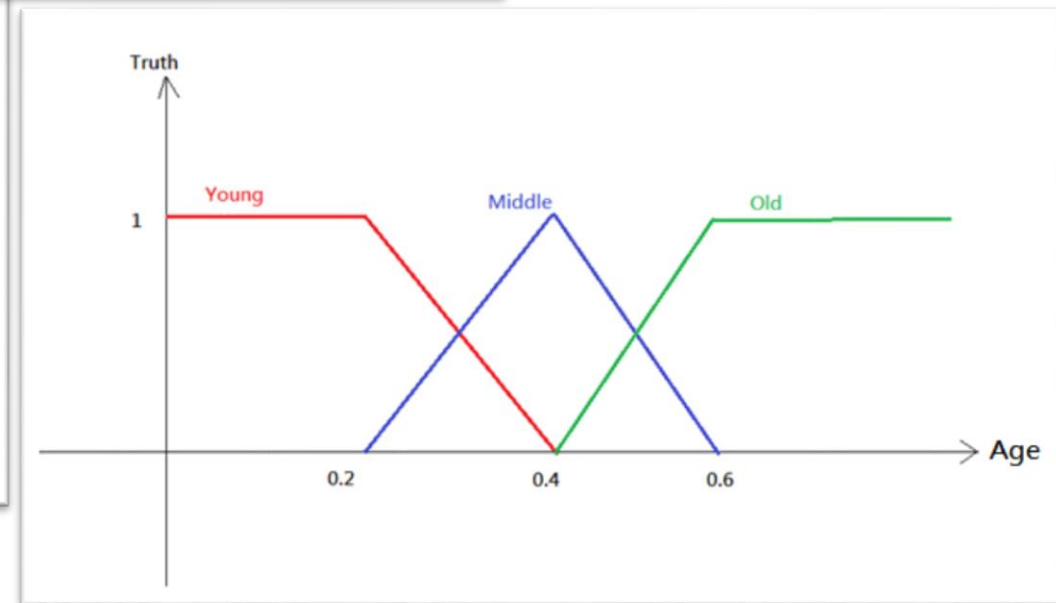
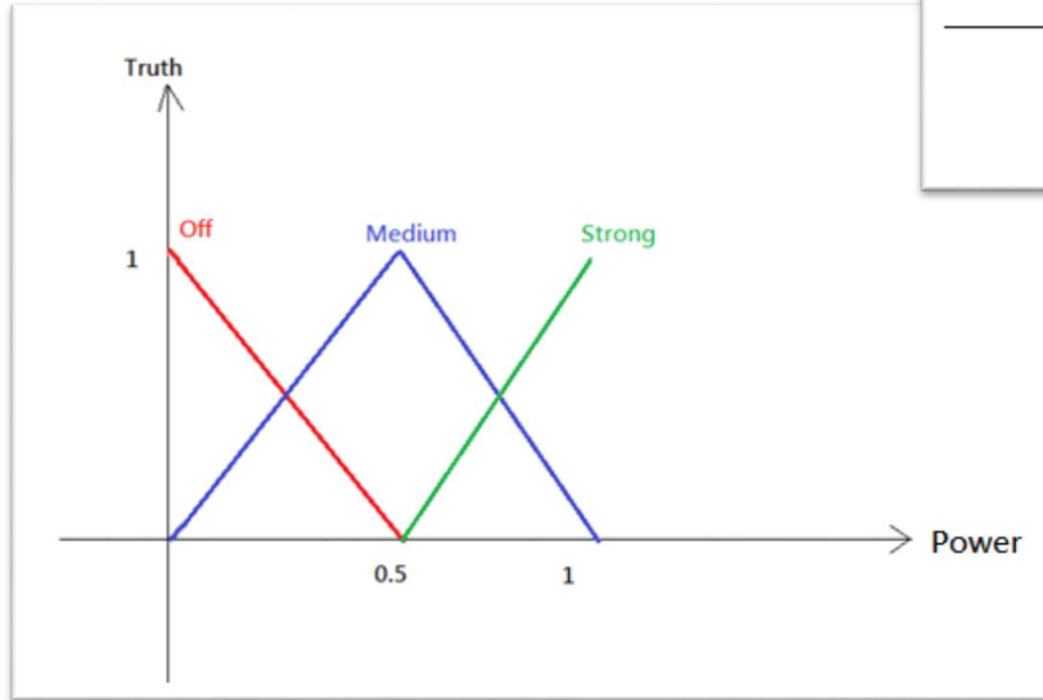
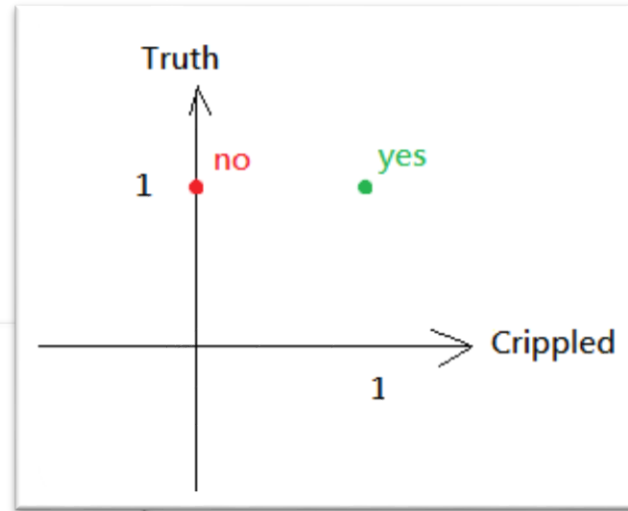
- Scaling function
 - Scaling factor
 - Linear scaling
 - ...
- *Age(x) clips and maps [0,100] to [0,1]*

Fuzzy Set

- (U, m)
 - Universe set + membership function
- $Crippled = (\{0,1\}, x: x)$
- $Old = ([0,1], Old)$
 - 華仔(54) is a $\frac{0.54-0.4}{0.6-0.4} \approx 70\%$ fuzzy member of Old
 - 阿輝伯(92) is a full member of Old



Data Base



Fuzzy Operator

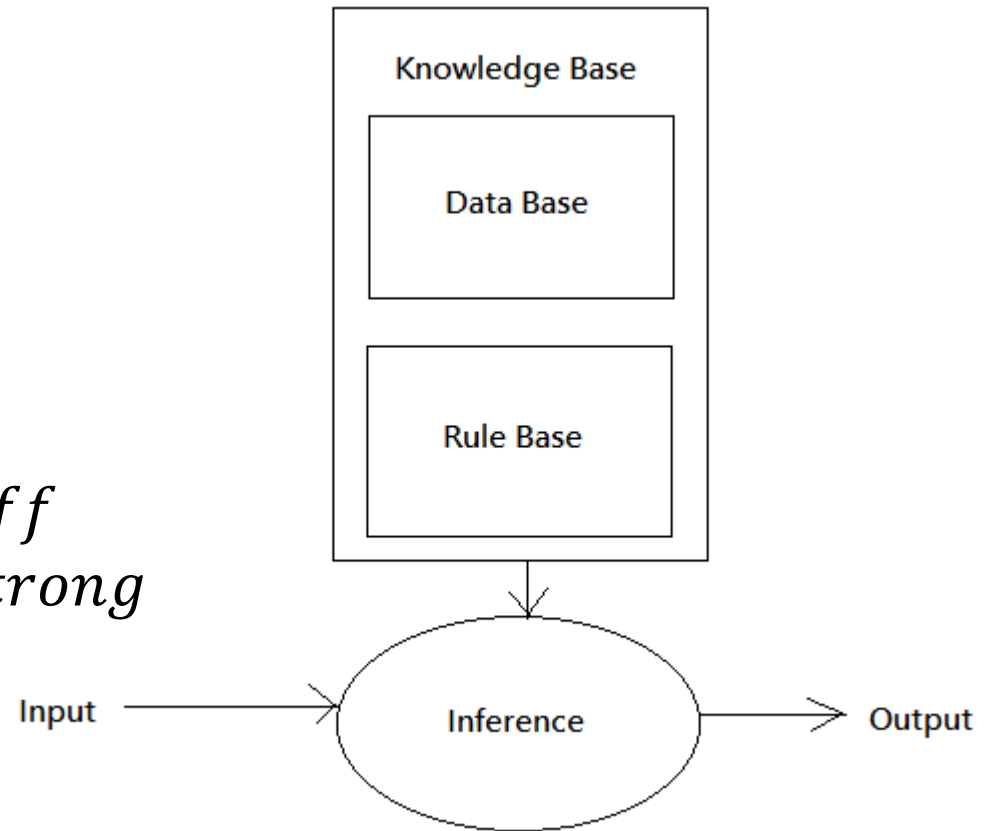
- AND: minimum
- OR: maximum
- NOT: complement

Rule Base

- $\left\{ \begin{array}{l} R1: \textit{IF crippled is no AND age is young THEN power is medium} \\ R2: \textit{IF crippled is no AND age is middle THEN power is off} \\ R3: \textit{IF crippled is no AND age is old THEN power is strong} \\ \dots \end{array} \right.$

Fuzzy Rule Based System

- 華仔(54, healthy)
 - Crippled 0
 - no = 1
 - Age 54
 - middle = 0.3
 - old = 0.7
- Inference
 - R2: *IF 1 AND 0.3 THEN power is off*
 - R3: *IF 1 AND 0.7 THEN power is strong*
- Power = 0.3 off + 0.7 strong = 0.7



Genetic Fuzzy System

- Tune data base
 - Each member function a 3-tuple
- Derive rule base
 - Pittsburgh
 - Each chromosome an RB
 - Encode whole decision table
 - Michigan
 - Each rule a chromosome, whole population an RB
 - Encode each rule

References

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 - Mamdani, E. H., & Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. *International journal of man-machine studies*, 7(1), 1-13.
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 - Takagi, T., & Sugeno, M. (1985). Fuzzy identification of systems and its applications to modeling and control. *Systems, Man and Cybernetics, IEEE Transactions on*, (1), 116-132.
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