Fuzzy Systems

made by Bartosz Paulewicz

fuzzy

ˈfəzē

fuzzy – definicje

Przymiotnik

1. having a frizzy, fluffy, or frayed texture or appearance.
   "a girl with fuzzy dark hair"

   Synonimy:

   frizzy | fluffy | woolly | downy | soft

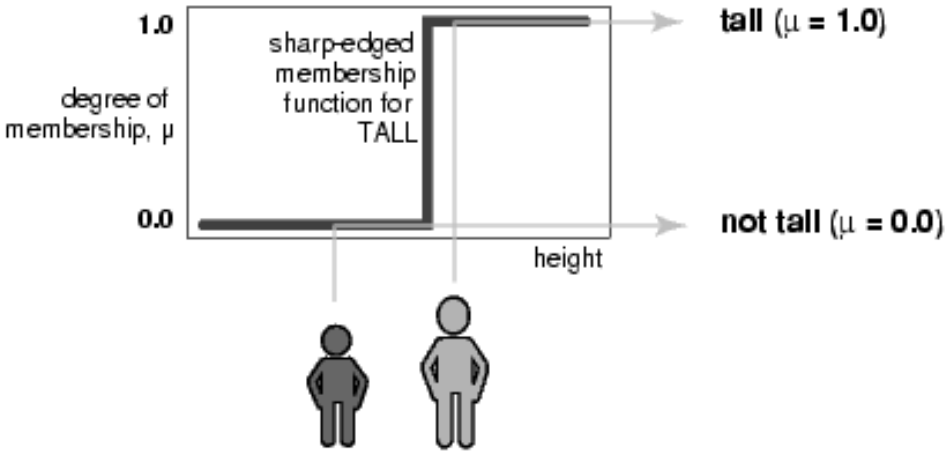
2. difficult to perceive clearly or understand and explain precisely; indistinct or vague.
   "the picture is very fuzzy"

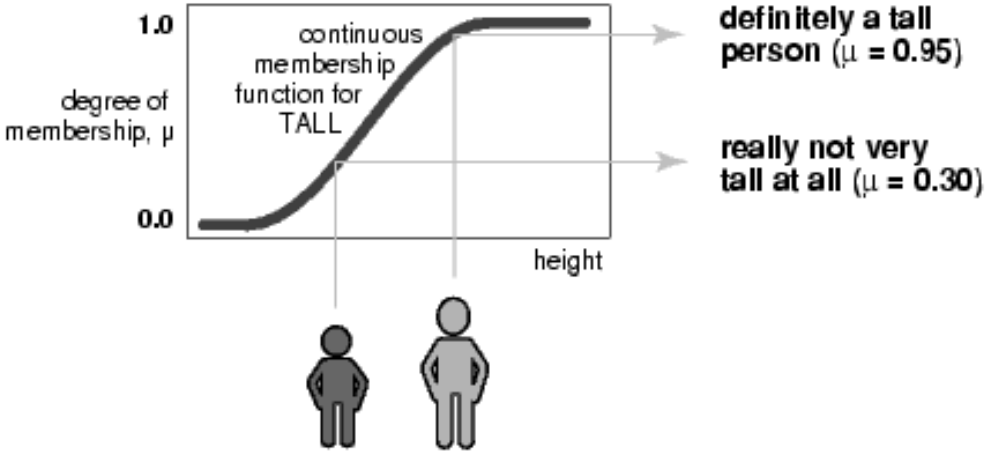
   Synonimy:

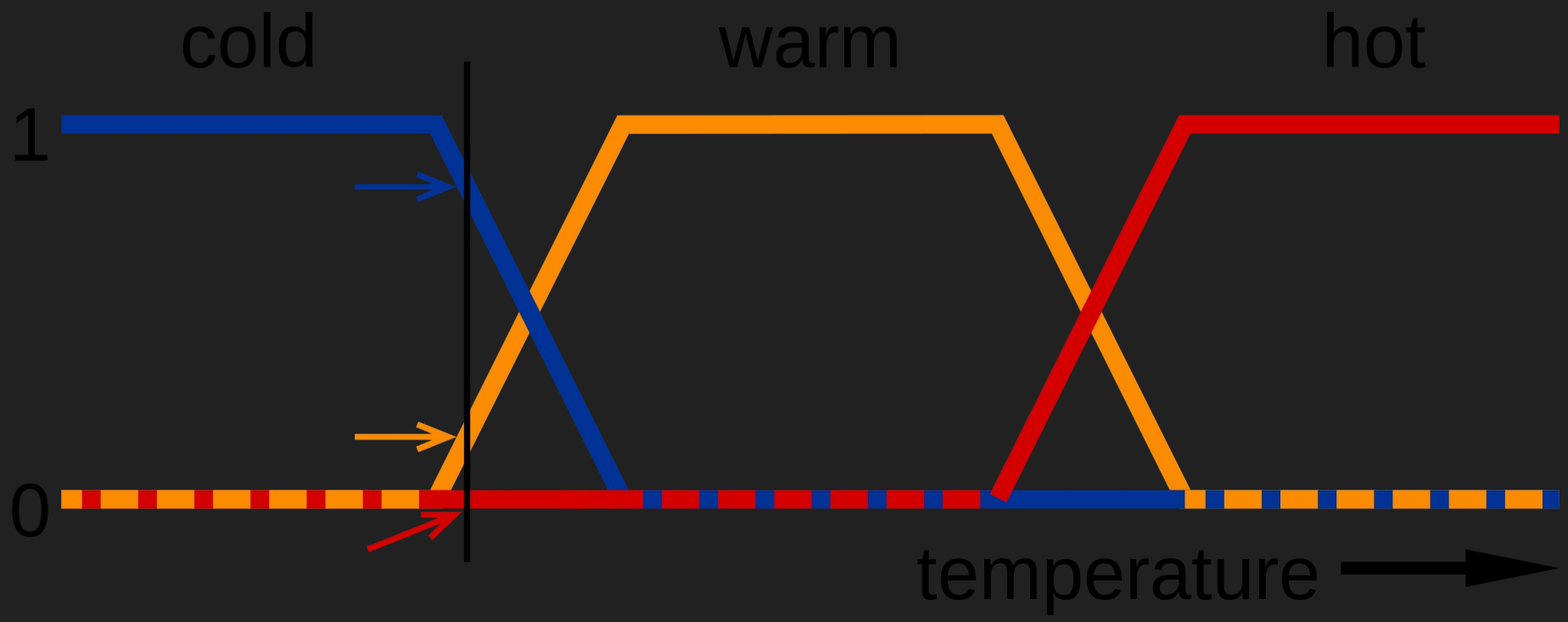
   blurry | blurred | indistinct | unclear | bleary | misty | distorted | out of focus | unfocused | lacking definition | nebulous | ill-defined | indefinite | vague | hazy | imprecise | inexact | loose | woolly

3. of or relating to a form of set theory and logic in which predicates may have degrees of applicability, rather than simply being true or false. It has important uses in artificial intelligence and the design of control systems.
   "An adaptive fuzzy control system prioritizes files for broadcast delivery or acquisition."

Fuzzy logic


1.0
degree of membership, μ
0.0
sharp-edged membership function for TALL
height
tall (μ = 1.0)
not tall (μ = 0.0)


1.0
degree of membership, μ
0.0
continuous membership function for TALL
height
definitely a tall person (μ = 0.95)
really not very tall at all (μ = 0.30)


cold
warm
hot
1
0
temperature

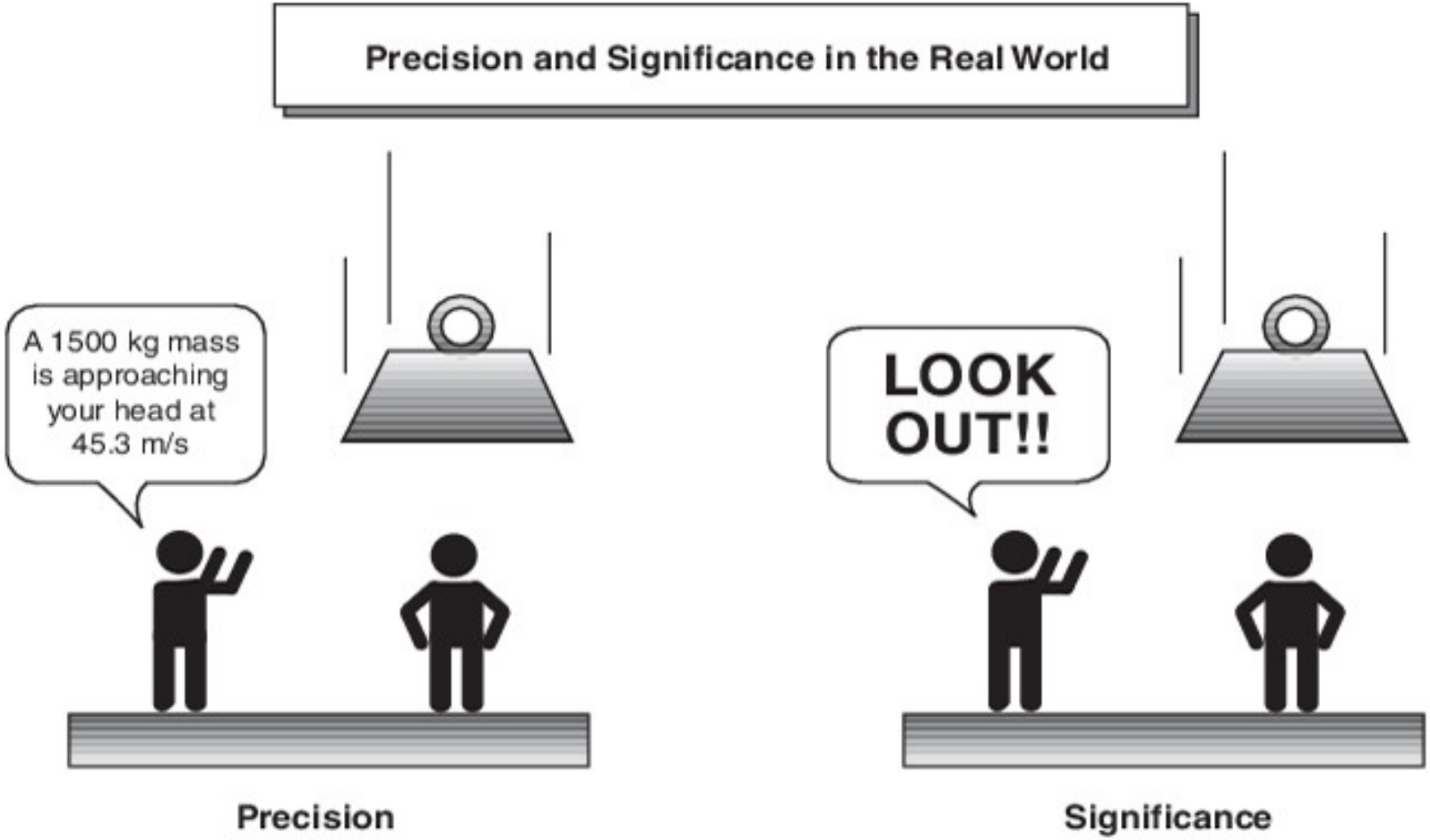
Fuzzy Logic Interface System

Advantages of Fuzzy Logic Systems and why should we use them

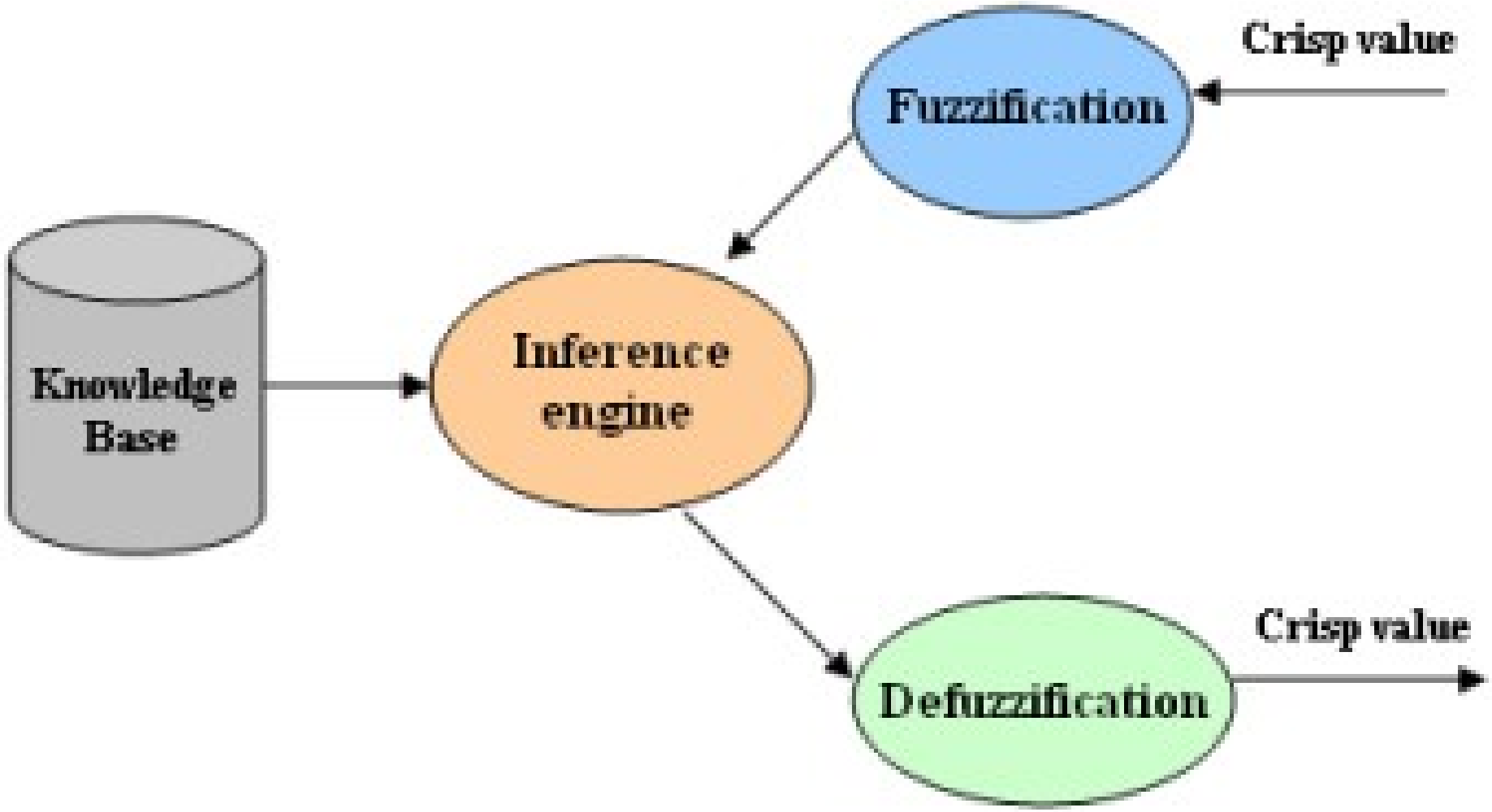
- highly suitable for data with imprecision, distortion noise and nonlinearity.
- convenient way to map input space to the output space.
- flexible and easy to modify
- can use the knowledge and experience of experts
- can be combined with other control techniques
- the structure and math behind are relatively simple and understandable
- mimics the logic of human thoughts
- built on the structures of qualitative description used in everyday language, and therefor easy to use.
- As Lotfi Zadeh, who is considered to be the father of fuzzy logic, once remarked: "In almost every
case you can build the same product without fuzzy logic, but fuzzy is faster and cheaper."

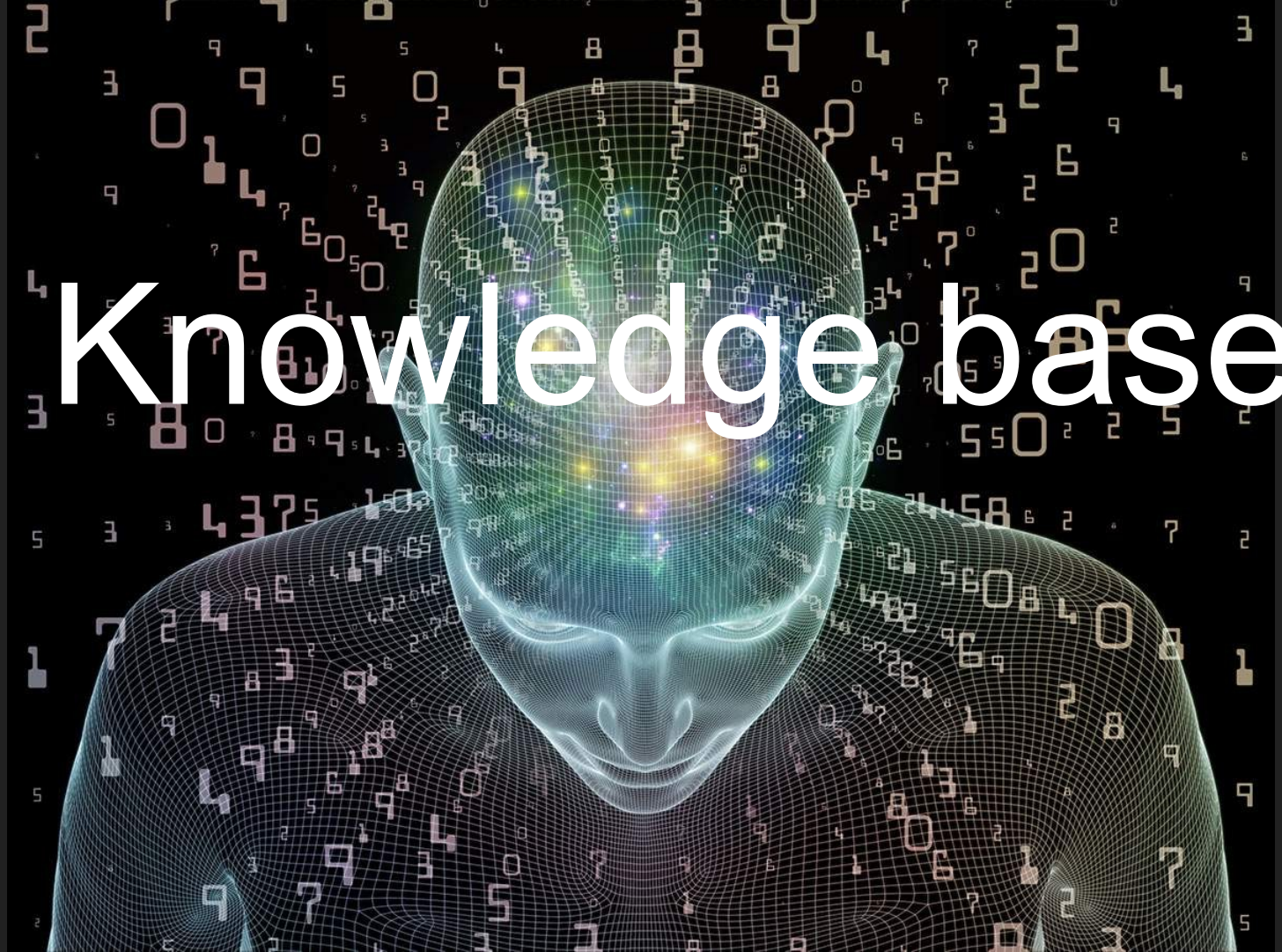
Disadvantages of Fuzzy Logic Systems

• Many researchers proposed different ways to solve a given problem through fuzzy logic which lead
to ambiguity. There is no systematic approach to neither system designing nor solving a given
problem through fuzzy logic
• Sometimes accuracy of Fuzzy Logic Systems can be low, so they are suitable only for the problems
which do not necessarily need that
• Validation and verification of a fuzzy knowledge-based system needs extensive testing
• Setting exact, fuzzy rules and, membership functions is a difficult task


Precision and Significance in the Real World
A 1500 kg mass is approaching your head at 45.3 m/s
LOOK OUT!!
Precision
Significance

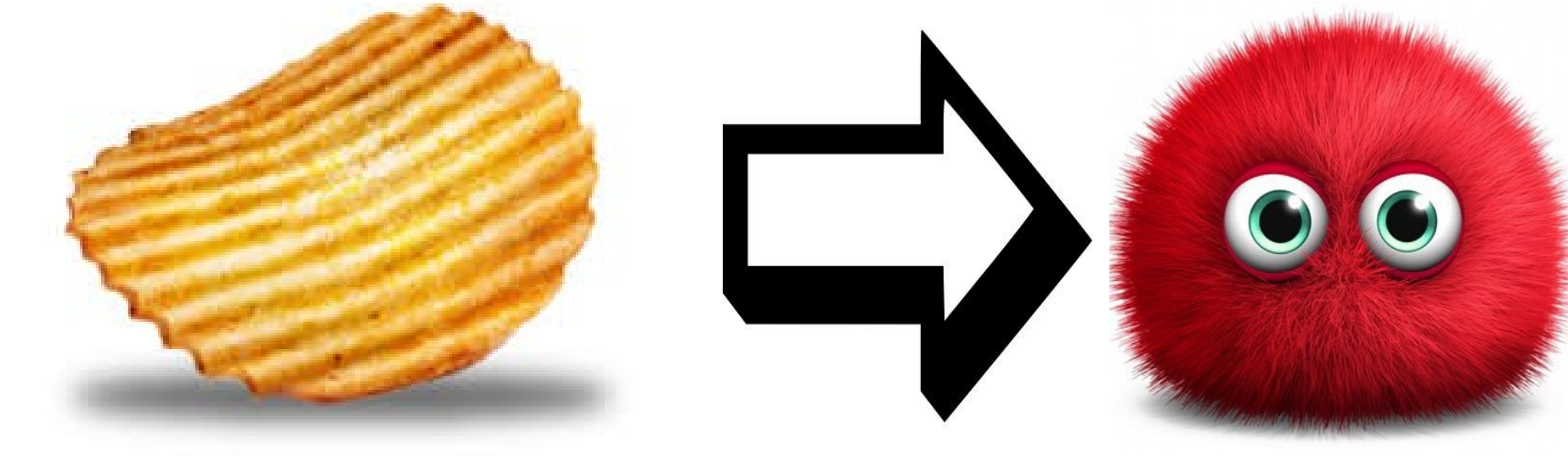
Architecture


Crisp value
Fuzzification
Knowledge Base
Inference engine
Crisp value
Defuzzification


Knowledge base

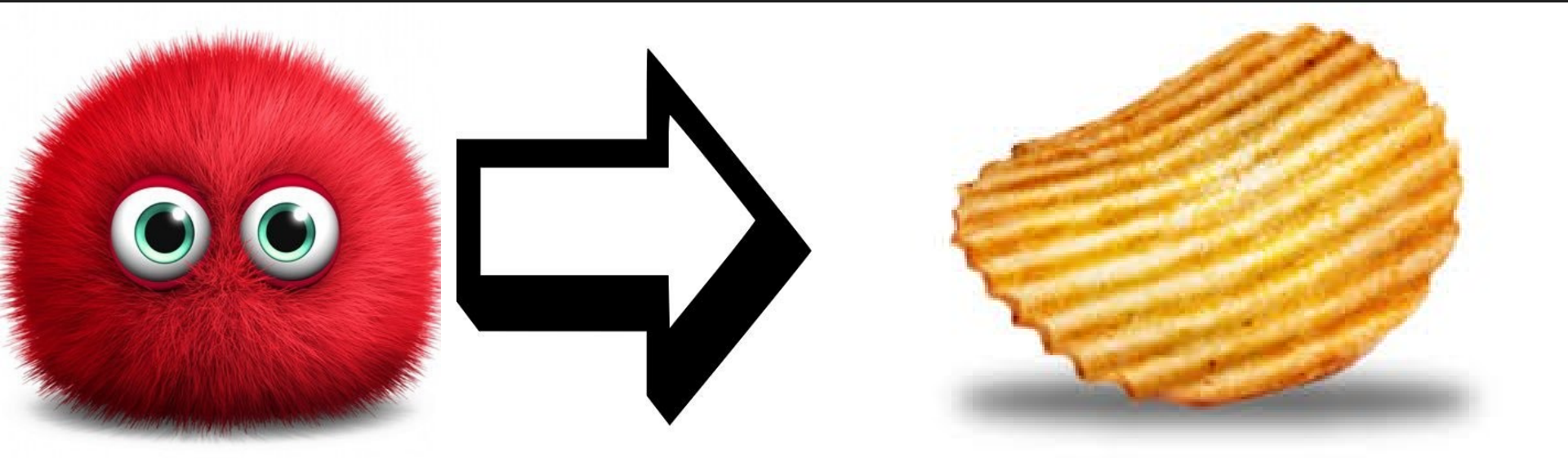
Rules

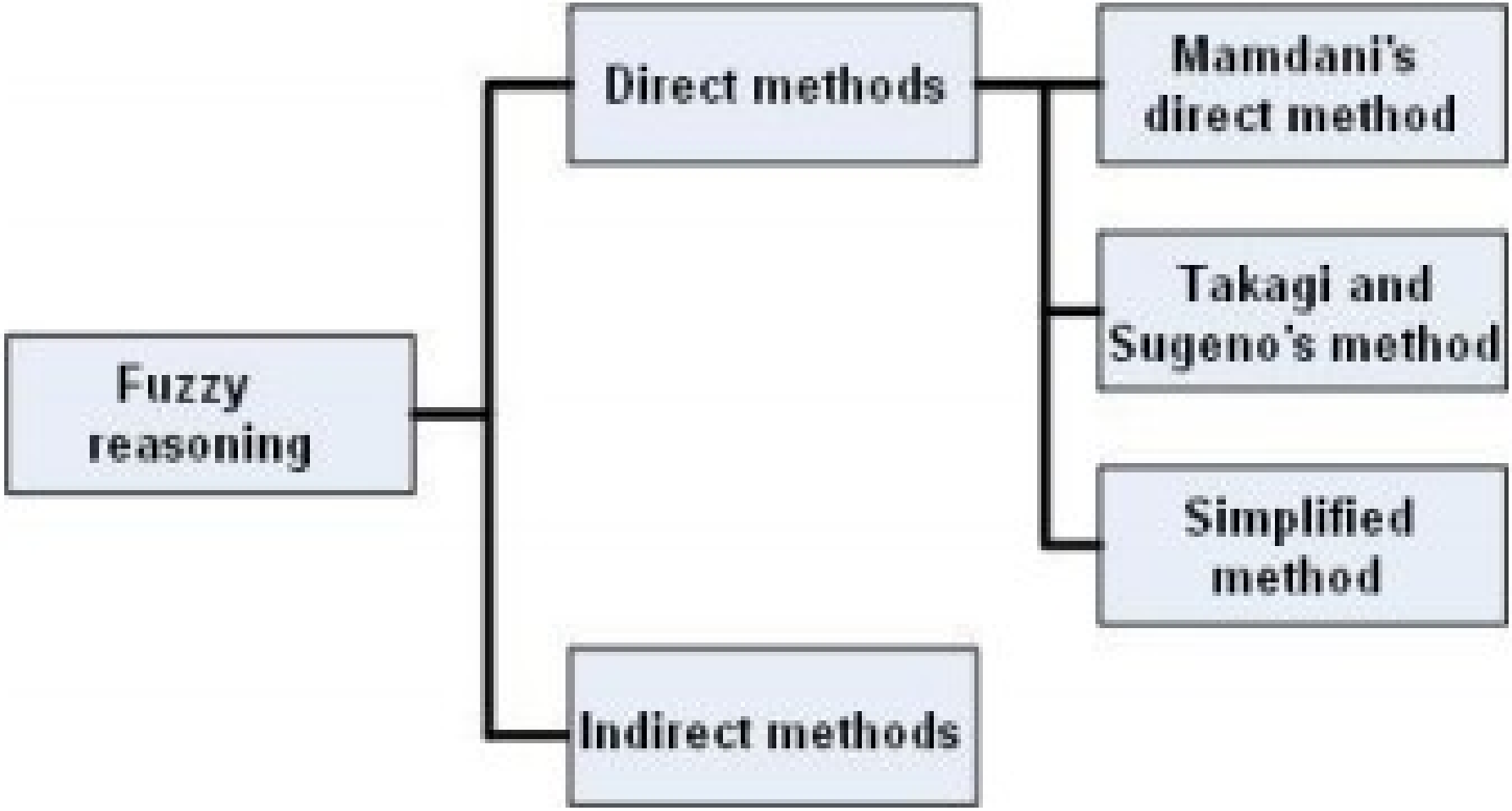
Fuzzification



Inference engine

Defuzzification




Fuzzy reasoning
Direct methods
Indirect methods
Mamdani's direct method
Takagi and Sugeno's method
Simplified method

Short description of our task

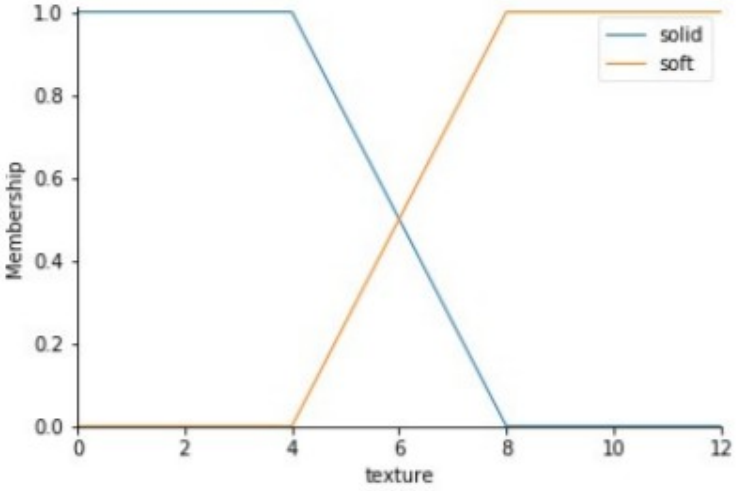
Step 1: Define linguistic inputs and outputs

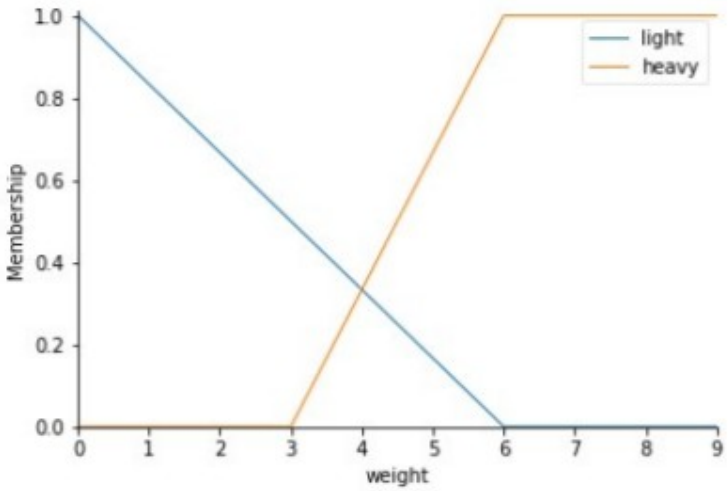
TEXTURE(x) = { SOFT, SOLID }

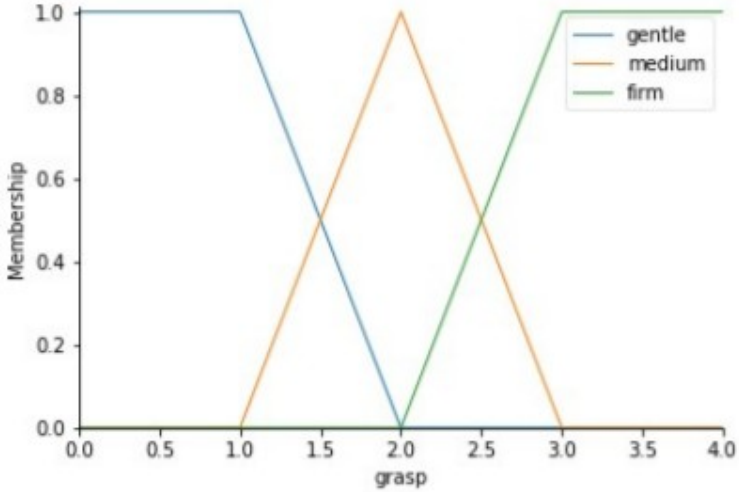
WEIGHT(x) = { LIGHT, HEAVY }

GRIP(x) = {GENTLE, MEDIUM, FIRM }

Step 2: Define membership functions


solid
soft
Membership
texture
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12


light
heavy
Membership
weight
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
6
7
8
9

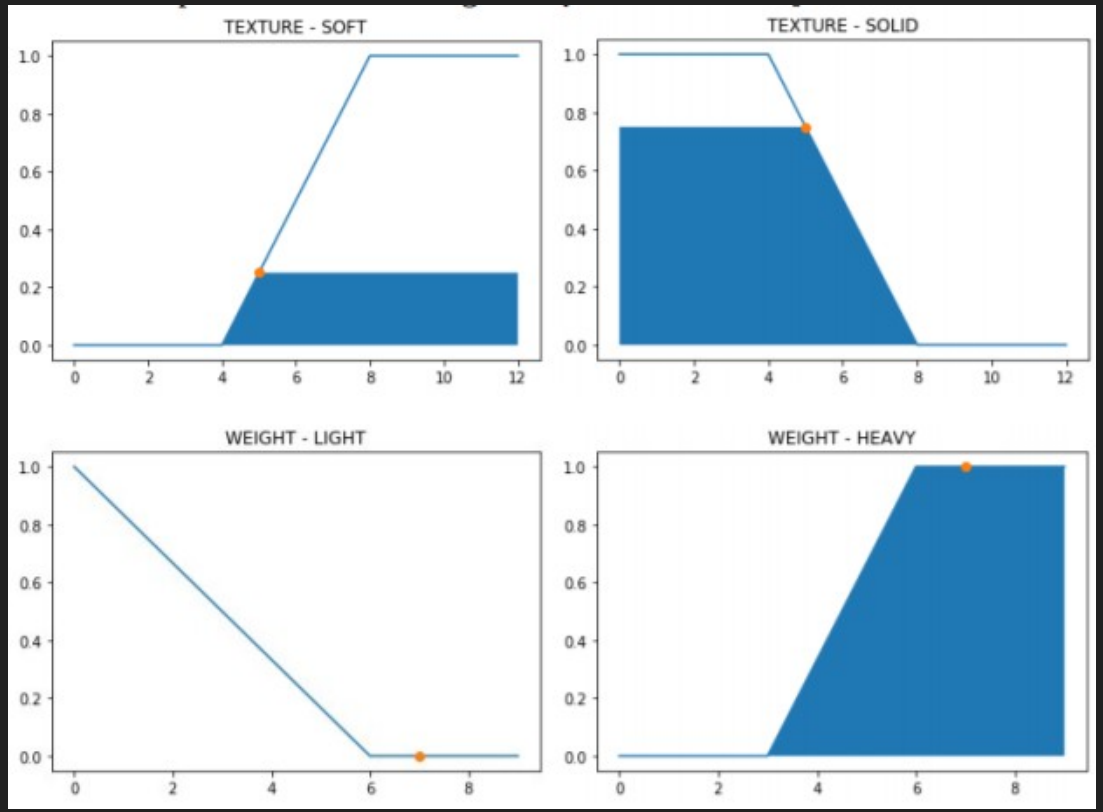

gentle
medium
firm
Membership
grasp
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

Step 3: Define knowledge base of rules

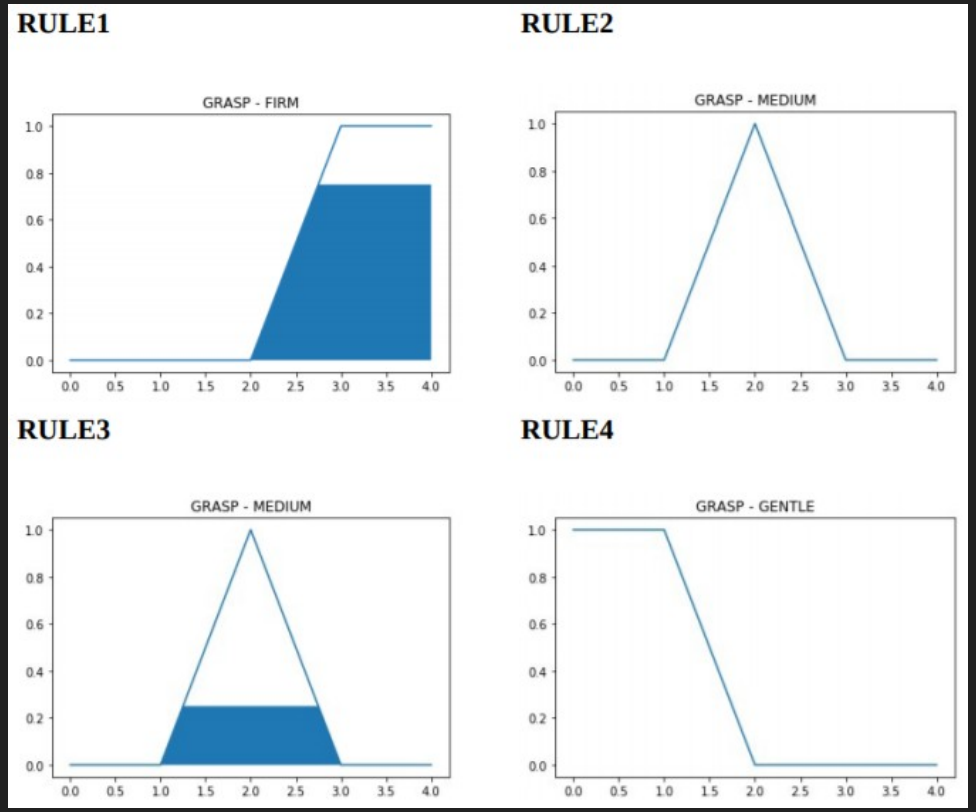
RULE 1: if texture is SOLID and weight is HEAVY then apply FIRM grasp
RULE 2: if texture is SOLID and weight is LIGHT then apply MEDIUM grasp
RULE 3: if texture is SOFT and weight is HEAVY then apply MEDIUM grasp RULE 4: if texture is SOFT and weight is LIGHT then apply GENTLE grasp

TEXTURE\WEIGHT	LIGHT	HEAVY
SOFT	GENTLE	MEDIUM
SOLID	MEDIUM	FIRM

Step 4: Convert crisp data into fuzzy data

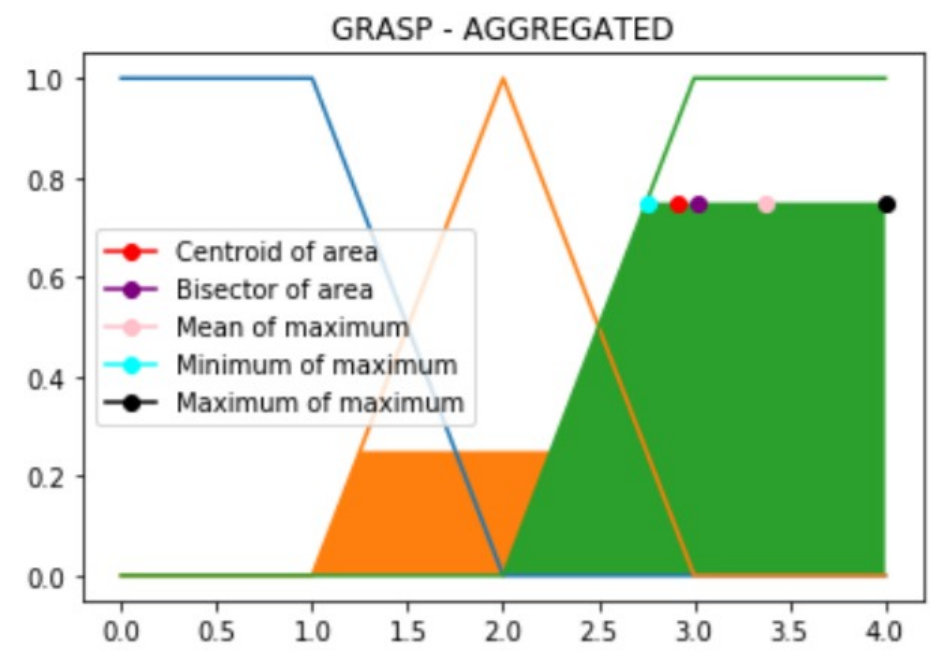


Step 5: Evaluate rules in the rule base

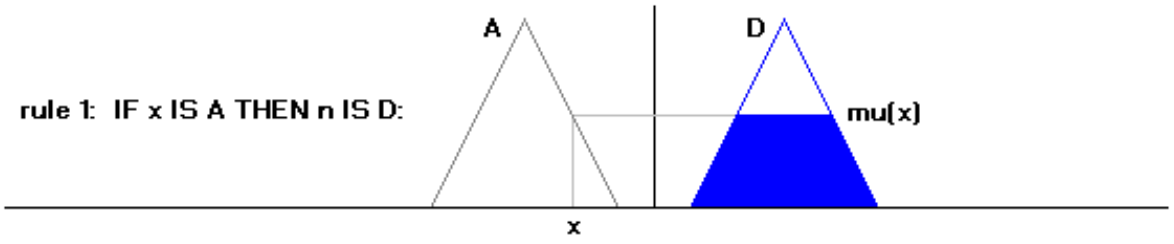


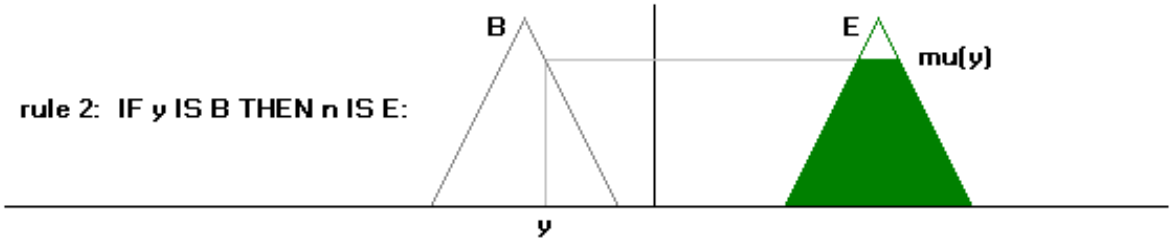
Step 6: Combine results from each rule

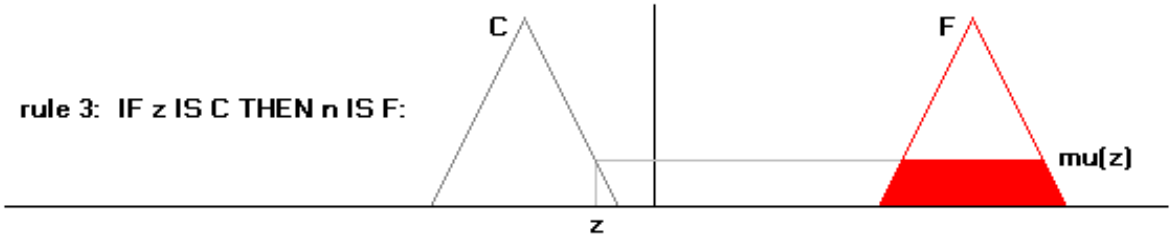
Step 7: Convert output data into crisp value

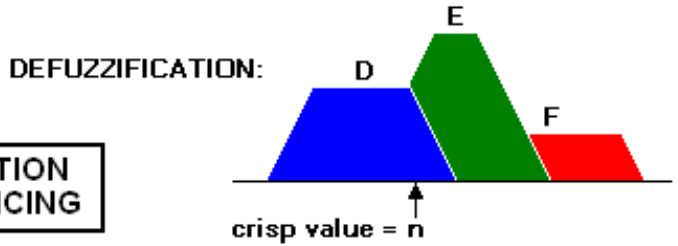


Centroid	Bisector	Mean	Minimum	Maximum
2.91	3.02	3.375	2.75	4.0









CENTROID DEFUZZIFICATION
USING MAX-MIN INFERENCING