Intelligent Control

Fuzzy Logic (3b)

by
Dr. Nor Maniha Abdul Ghani
(Credit to D.Pebrianti)
FKEE
normaniha@ump.edu.my

Contents

3.3 Fuzzy Set Operation

3.4 Fuzzy Relation

Fuzzy Set Operation

3.3

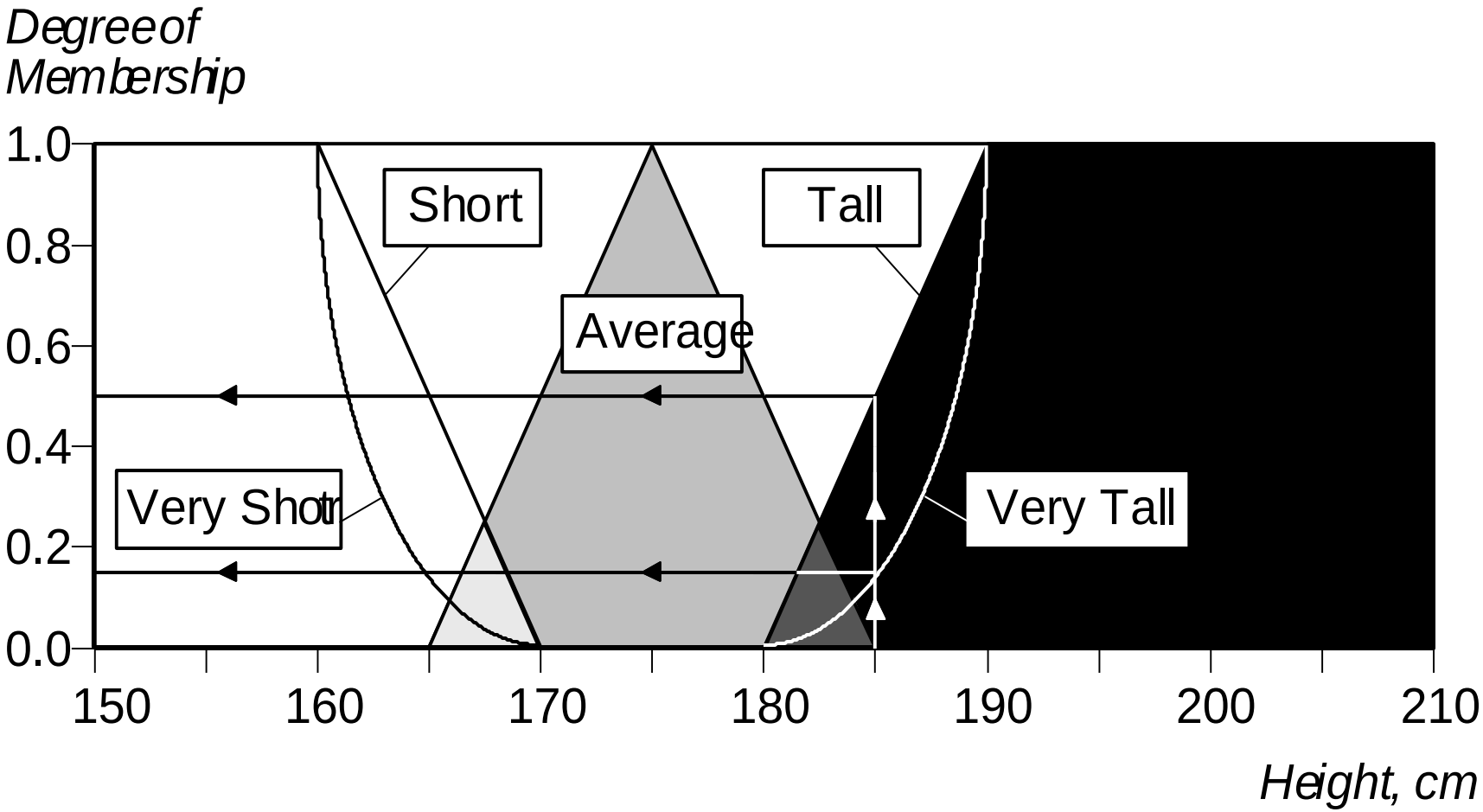
Linguistic: Affection in Fuzzy

- IF sun is shining, THEN temperature is hot.
- IF people is happy, THEN society is at peace.
- IF stomach is full, THEN ?

Linguistic variable→fuzzy variable

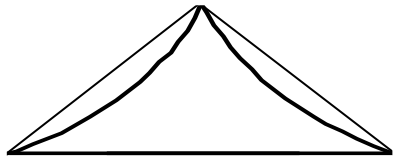
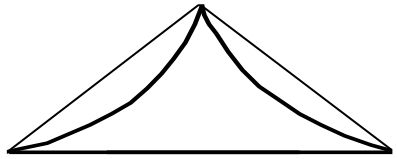
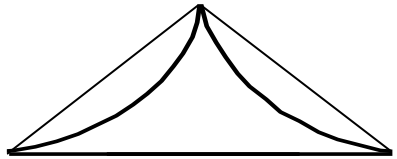
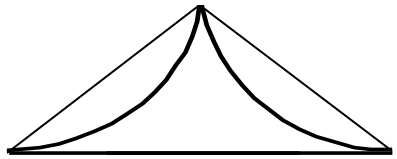
- Linguistic variable has hedges
  - Hedges
    - Act as fuzzy set qualifiers
    - Expression on adverbs ; little, few, most, extreme, some
    - Reflects human thinking
    - Creates sets of individual operation; dilation(expansion), concentration
    - Continuum→fuzzy intervals; from tall, average, short to slightly tall, tall, moderately tall etc.

Fuzzy sets with the hedge *very*



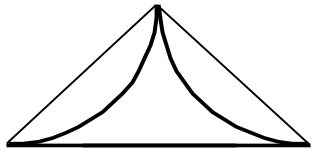
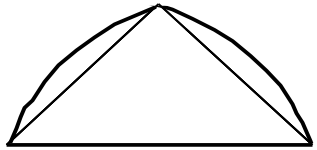
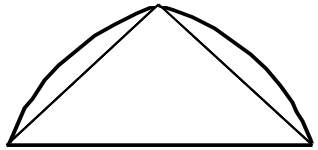
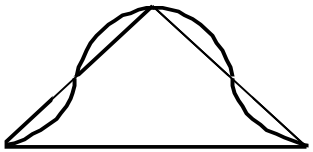
http://slideplayer.com

Hedges in fuzzy logic

Hedge	*Mathematical Expression*	*Graphical Representation*
A little	$[\mu_A(x)]^{1.3}$	
Slightly	$[\mu_A(x)]^{1.7}$	
Very	$[\mu_A(x)]^{2}$	
Extremely	$[\mu_A(x)]^{3}$	

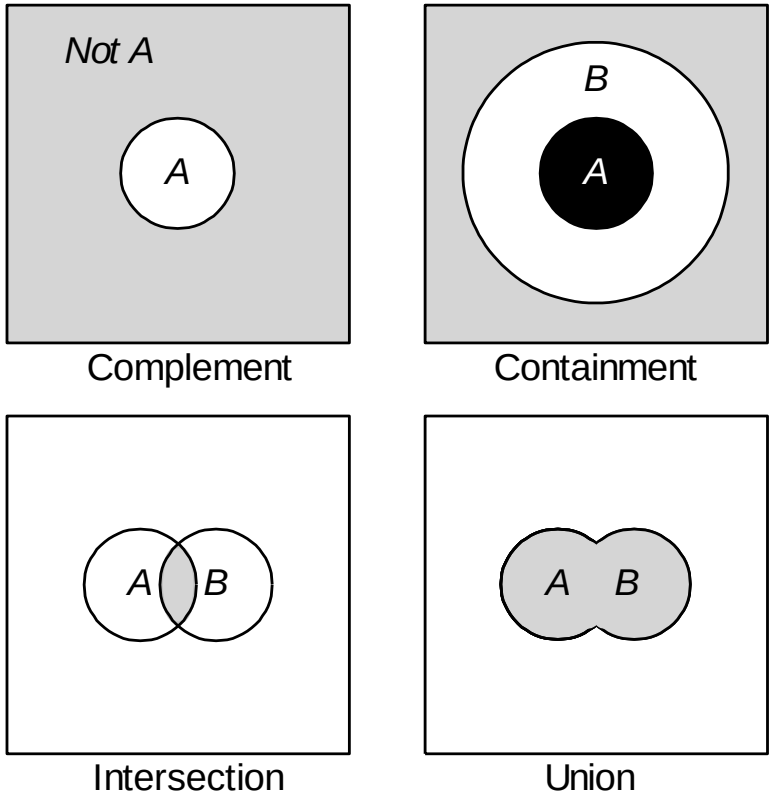
http://slideplayer.com

Hedges in fuzzy logic (cont'd)

Hedge	*Mathematical Expression*	*Graphical Representation*
Very very	$[\mu_A(x)]^4$	
More or less	$\sqrt{\mu_A(x)}$	
Somewhat	$\sqrt{\mu_A(x)}$	
Indeed	$2\,[\mu_A(x)]^2$ if $0 \le \mu_A \le 0.5$ $1 - 2\,[1 - \mu_A(x)]^2$ if $0.5 < \mu_A \le 1$	

Operations of fuzzy sets

The classical set theory developed in the late 19th century by Georg Cantor describes how crisp sets can interact. These interactions are called **operations**.



http://slideplayer.com

Complement

Complement
A'

$$\mu_{A'}(x) = 1 - \mu_A(x) \qquad \text{for all } x \in X$$

Tall men : (0/180, 0.25/182.5, 0.5/185, 0.75/187.5, 1/190)
NOT Tall men : (1/180, 0.75/182.5, 0.5/185, 0.25/187.5, 0/190)

Containment

Containment

$A \subseteq B$

$\mu_A(x) \leq \mu_B(x)$ for all $x \in X$

Tall men : (0/180, 0.25/182.5, 0.5/185, 0.75/187.5, 1/190)

Very tall men : (0/180, 0.1/182.5, 0.4/185, 0.3/187.5, 1/190)

Intersection

Intersection

$A \cap B$

$$\mu_{A \cap B}(x) = \min(\mu_A(x), \mu_B(x)) \qquad \text{for all } x \in X$$

Tall men : (0/180, 0.25/182.5, 0.5/185, 0.75/187.5, 1/190)
Very tall men : (0/180, 0.1/182.5, 0.4/185, 0.3/187.5, 1/190)
So, $\mu_{A \cap B}(x)$ = (0/180, 0.1/182.5, 0.4/185, 0.3/187.5, 1/190)

Union

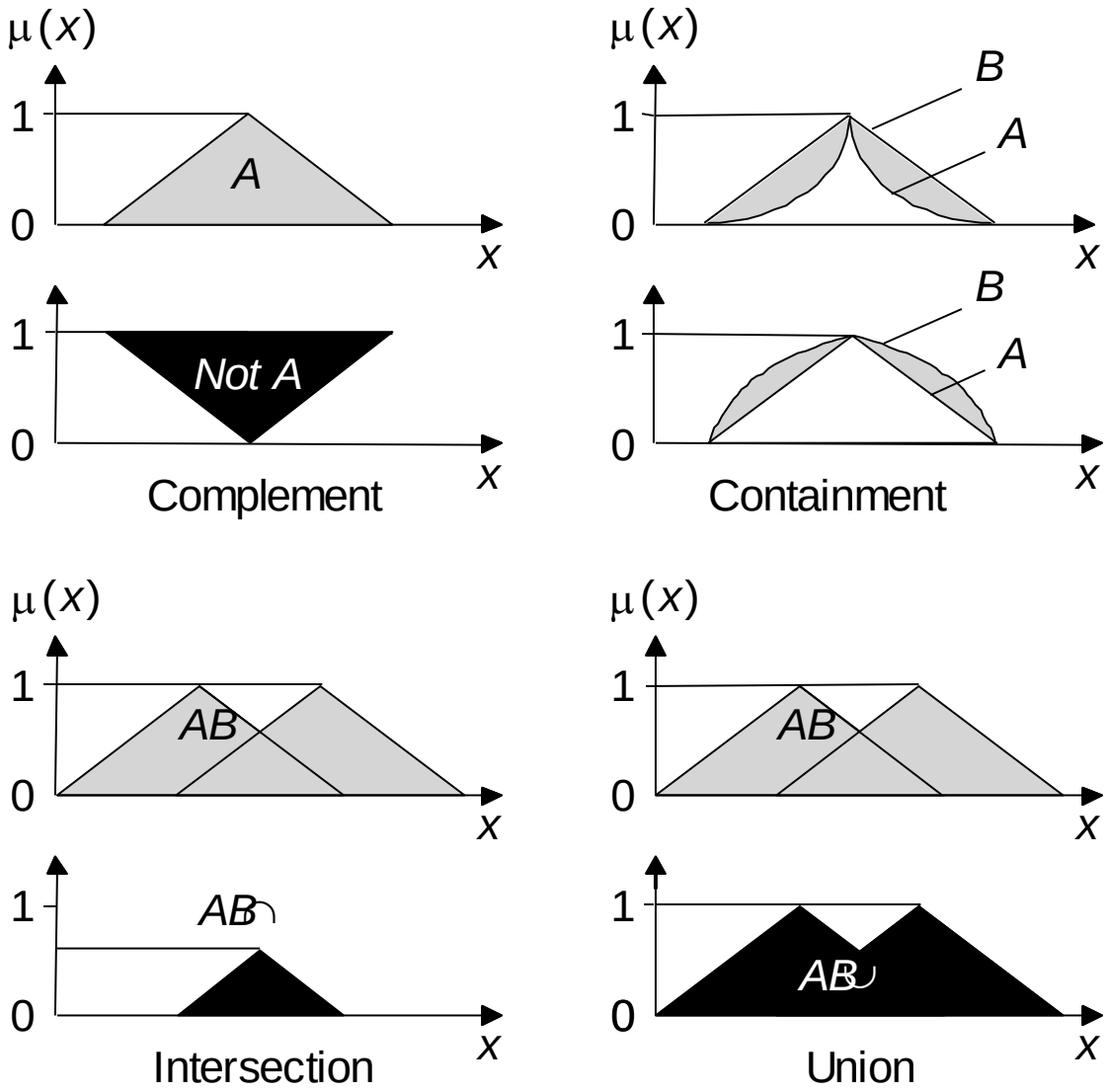
Union

$A \cup B$

$$\mu_{A \cup B}(x) = \max(\mu_A(x), \mu_B(x)) \qquad \text{for all } x \in X$$

Tall men : (0/180, 0.25/182.5, 0.5/185, 0.75/187.5, 1/190)
Very tall men : (0/180, 0.1/182.5, 0.4/185, 0.3/187.5, 1/190)
So, $\mu_{AUB}(x)$ = (0/180, 0.25/182.5, 0.5/185, 0.75/187.5, 1/190)

Operations of fuzzy sets



http://slideplayer.com

Fuzzy Relation

3.4

Fuzzy rules

First paper introduced fuzzy rules by Zadeh, 1973.

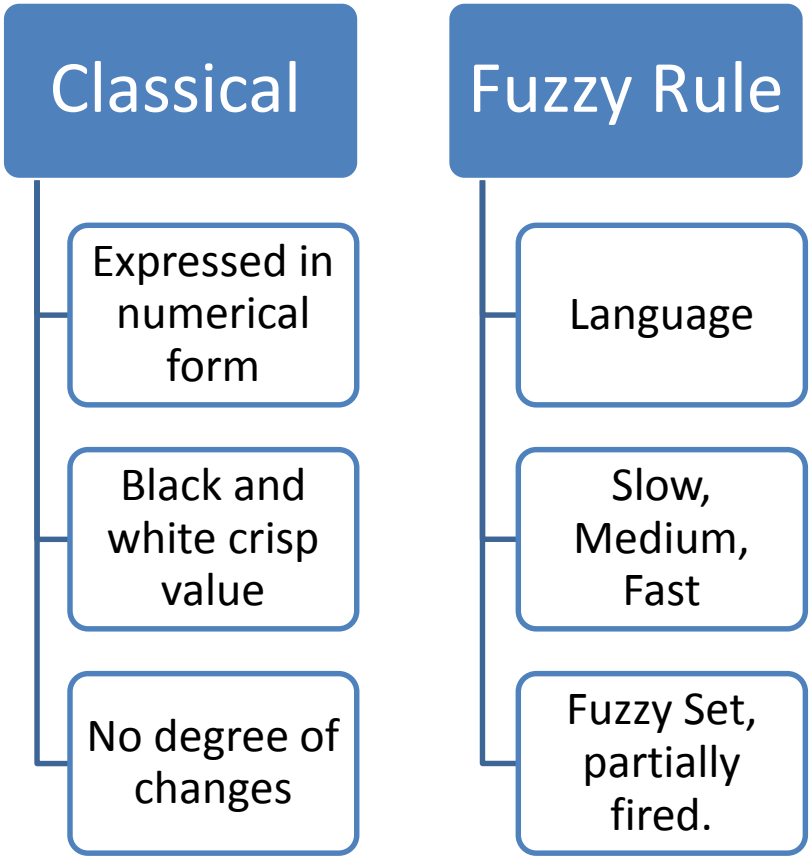
http://www.cs.Berkeley.edu/~zadeh

A fuzzy rule can be defined as a conditional statement in the form:

IF x is A
THEN y is B

where x and y are linguistic variables; and A and B are linguistic values determined by fuzzy sets on the universe of discourses X and Y, respectively.

http://slideplayer.com



Dr. Nor Maniha Abdul Ghani

Faculty of Electrical and Electronics Engineering
Universiti Malaysia Pahang,
26600, Pekan, Pahang, Malaysia
Phone: +609-424-6087
Fax: +609-424-6000

http://fkee.ump.edu.my/index.php/en/staff-menu/articles-staff/1034-niha-main-profile