United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

CT-I and CT-2 Exam Year: 2018, Trimester: Fall Program: MSCSE

Course: CSE 6025 Neural Network and Fuzzy Logic Systems

Marks: 25, Time Duration: 2 hours

There are THREE questions. Answer any TWO. Figures in the right-hand margin indicate full marks.

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1. a) Define fuzzy logic. Distinguish between crisp and fuzzy logic. 2.0

   b) Mention the importance of fuzzy based logic system in real life. 2.0

   c) Draw a diagram for fuzzy logic system. Explain its operation with an example. 8.5

2. a) Show the fuzzification of Good(x) and Bad(x) from the following 7.5

   Good: A student total mark greater than or equal to 80 is really good, but less than or equal to 60 is not considered as good.

   Also find the value of NOT ((Good(73) AND Bad(52))

   b) Show fuzzy $((a^3+b^3)/(a-b))$, where a=fuzzy 4 and b=fuzzy 5, where fuzzification is done using the triangular function. 3.0

   c) A pot may contain all apples or oranges. The pot may also contain a mixture of apples and oranges in the ratios 0:6, 1:5, 2:4, 3:3, 4:2, 5:1 and 6:0. If there is a question "how many apples in the pot?", what are the answers in crisp and fuzzy words and values? 2.0

3. a) Explain fuzzy and crisp set operations with the multi element set, A and B 4.0
   A={0.8 0.9 0.1} and B={0.9 0.5 0.8}

   b) If fuzzy 4 and 5 are defined as (3, 4, 5) and (4, 5, 6), respectively by using a triangular function, find membership function, μ for fuzzy 4 and fuzzy 5 using continuous functions. Also find $\mu(3.5) + \mu(5.5)$. 4.0

   c) Define fuzzy inference rule. What are the significances of it? 2.5

   d) Draw diagrams for the different fuzzification techniques. 2.0

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United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Final Exam Year: 2014 Trimester: Spring Program: MSCSE

Course: CSE 6019 Speech Recognition, Marks: 40, Time: 2 hours

There are FIVE questions. Answer any FOUR. Figures in the right-hand margin indicate full marks.

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1. a) Define fuzzy logic. Distinguish between crisp and fuzzy logic. 2
   b) Mention the importance of fuzzy based logic system in real life. 2
   c) Explain the steps of a fuzzy logic system with an example. 6

2. a) What are the necessities of the defuzzification technique? 1
   b) Write down the names of the different defuzzification techniques? 2
   c) Describe the area of bisector method in defuzzification with an example. 7

3. Show the fuzzification of Tall(x), Short(x) and Medium(x) from the following 10

   Tall: Student height greater than or equal to 1.8 meter is totally tall, but less than or equal to 1.6 meter is not considered as tall.

   Medium: Student height in-between 1.6 meter and 1.8 meter is considered as medium. It reaches at highest degree at 1.7 meter.

4. Estimate the weight of a student named John for his height 1.75 meter using the information given below and in Ques. (3). Use the centroid method in defuzzification stage for solving the problem. 10

   Inference Rule:

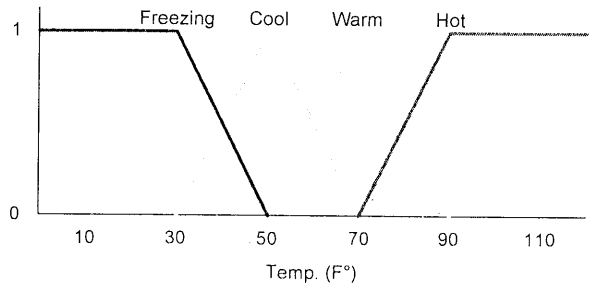
   If height is short, then weight is light. [Rule 1]
   If height is medium, then weight is medium. [Rule 2]
   If height is tall, then weight is heavy. [Rule 3]

   Membership function for light, medium and heavy are defined below:
   A student greater than or equal to 90kg is totally heavy weight, but less than or equal to 70kg is considered as completely light. At 80kg the medium weight reaches at highest degree and extends up to 70kg and 90kg. Beyond the 80kg the heaviness and lightness are assumed zero.

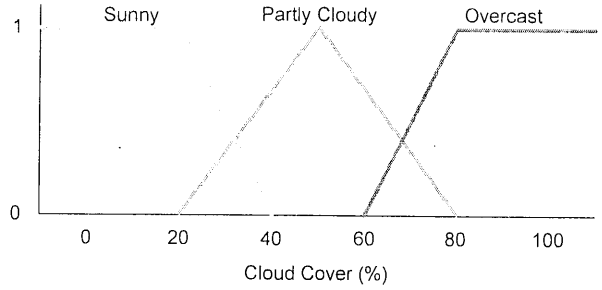
5. Membership functions for Temperature{Freezing, Cool, Warm, Hot}, Cloud Cover{Sunny, Partly, Overcast} and Speed{Slow, Fast}, and fuzzy rules are given below. How fast will I go if it is 65°F and 25% cloud cover? Use the center of sums method in defuzzification stage. Compare your answer with the defuzzified value obtained by the weighted average method. 10

Fuzzy rules:
If it is sunny and warm, drive fast. [Rule 1]
If it is cloudy and cool, drive slowly. [Rule 2]

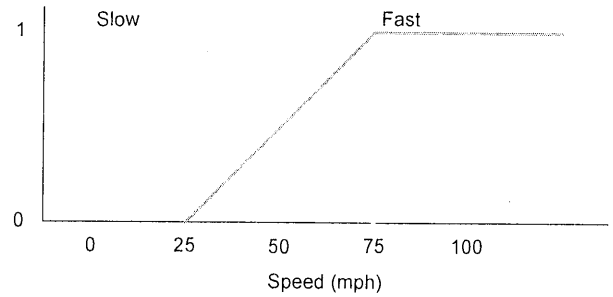
Membership function for Temperature{Freezing, Cool, Warm, Hot}:



Membership function for Cloud Cover{Sunny, Partly, Overcast}:



Membership function for Speed{Slow, Fast}:



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Assignment

Institute of Information and Communication Technology, BUET

Master of Science in Computer Science & Engineering (MSCSE)

Final Examination, Year: 2012, Course: ICT 6536 Neuro-Fuzzy Systems

Marks: 40, Time: 2 hours

There are FIVE questions. Answer any FOUR, Figures in the right-hand margin indicate full marks.

---

1. a) Define fuzzy logic. Distinguish between crisp and fuzzy logic. 2
   b) Mention the importance of fuzzy based logic system in real life. 2
   c) . Explain the steps of a fuzzy logic system with an example. 6

2. a) What are the necessities of the defuzzification technique? 1
   b) Write down the names of the different defuzzification techniques? 2
   c) Describe the area of bisector method in defuzzification with an example. 7

3. Show the fuzzification of Tall(x), Short(x) and Medium(x) from the following 10

   Tall: Student height greater than or equal to 1.8 meter is totally tall, but less than or equal to 1.6 meter is not considered as tall.

   Medium: Student height in-between 1.6 meter and 1.8 meter is considered as medium. It reaches at highest degree at 1.7 meter.

4. Estimate the weight of a student named John for his height 1.75 meter using the information given below and in Ques (3). Use the centroid method in defuzzification stage for solving the problem. 10

   Inference Rule:

   If height is short, then weight is light. [Rule 1]
   If height is medium, then weight is medium. [Rule 2]
   If height is tall, then weight is heavy. [Rule 3]

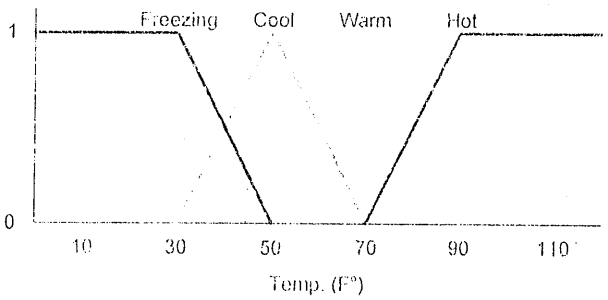
   Membership function for light, medium and heavy are defined below:
   A student greater than or equal to 90kg is totally heavy weight, but less than or equal to 70kg is considered as completely light. At 80kg the medium weight reaches at highest degree and extends up to 70kg and 90kg. Beyond the 80kg the heaviness and lightness are assumed zero.

5. Membership functions for Temperature{Freezing, Cool, Warm, Hot}, Cloud Cover{Sunny, Partly, Overcast} and Speed{Slow, Fast}, and fuzzy rules are given below. How fast will I go if it is 65°F and 25% cloud cover? Use the center of sums method in defuzzification stage. Compare your answer with the defuzzified value obtained by the weighted average method. 10

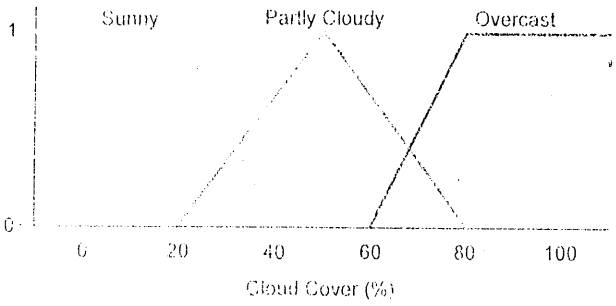
634 = sum of centroid
57.95 = Weighted

Fuzzy rules:
If it is sunny and warm, drive fast. [Rule 1]
If it is cloudy and cool, drive slowly. [Rule 2]

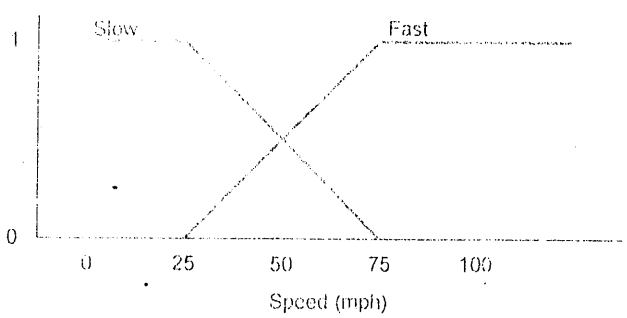
Membership function for Temperature{Freezing, Cool, Warm, Hot}:



Membership function for Cloud Cover{Sunny, Partly, Overcast}:



Membership function for Speed{Slow, Fast}:



7

Assignment

United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Class Test Year: 2014 Trimester: Fall Program: MSCSE

Course: CSE 6025 Neural Network and Fuzzy logic, Marks:25, Time: 1.5 hours

There are THREE questions. Answer all of them. Figures in the right-hand margin indicate full marks.

---

1. a) Draw crisp 5 and fuzzy 5. Also show the membership value of both. [2]
   b) Write the crisp and fuzzy logic to represent the short and tall characteristics of a man or woman. [2.33]
   c) Show fuzzy arithmetic operation, (A*B)-(A/B) where [4]
   A=(-2, 3, 8)

   B=(-1, 2,7)

2. a) Show Crisp and Fuzzy set operations [4]
   i) Disjunction
   ii) Conjunction
   iii) Complement
   iv) Difference
   [Note: Use circle for crisp set and hexagon for fuzzy set]

   b)Find the following fuzzy operation [2.33]
   $0.9 \wedge 0.8,\ 0.4 \vee 0.6,\ \sim 0.7,\ 0.9 \Rightarrow 0.7$

   c) Show the following fuzzy set operations [2]
   i) $A \cup B$
   ii) $A \cap B$
   iii) $B \setminus A$
   iv) A^c
   v) A is subset of B $\Rightarrow A \subset B$

   A=(0.9 0.6 0.9)
   B=(1.0 0.8 0.5)
3. a) Show Fuzzy A AND B, A OR B, NOT(A) [4]
   A=(0, 0.25, 0.5, 0.75, 1.0)
   B=(0, 0.25, 0.5, 0.75, 1.0)
   b) Construct membership function for Heavy(x), Light(x), Heavy(x) V Light(x). [2.33]
   Heavy: Student weight greater than 90kg is totally heavy, but less than 70kg is not considered as heavy.
   c) Also find Heavy(80) $\wedge$ Light (80) from Ques. 3(b) [1]

Assignment

United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Midterm Exam Year: 2016, Trimester: Fall Program: MSCSE

Course: CSE 6025 Neural Network and Fuzzy Logic Systems

Marks: 30, Time Duration: 1 hour 30 minutes

There are FOUR questions. Answer any THREE including Question no. 3. Figures in the right-hand margin indicate full marks.

---

1. a) Define fuzzy logic. Distinguish between crisp and fuzzy logic. 2
   b) Mention the importance of fuzzy based logic system in real life. 2
   c) Draw a diagram for fuzzy logic system. Explain its operation with an example. 6
2. a) Show the fuzzification of Good(x) and Bad(x) from the following 5

   Good: A student total mark greater than or equal to 80 is really good, but less than or equal to 60 is not considered as good.

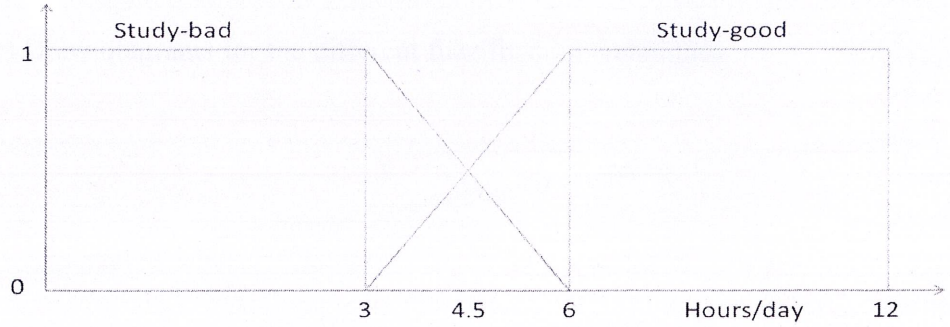
   Also find the value of NOT ((Good(73) AND Bad(52))
   b) Draw a diagram that shows Maximum and Mean of maximum defuzzification with an example. 2
   c) A pot may contain all apples or oranges. The pot may also contain a mixture of apples and oranges in the ratios 0:6, 1:5, 2:4, 3:3, 4:2, 5:1 and 6:0. If there is a question "how many apples in the pot?", what are the answers in crisp and fuzzy words and values? 3
3. Membership functions for STUDY_HOUR {Study-bad, Study-good}, SLEEPING_HOUR {Under-sleep, Well-sleep, Over-sleep} and STUDENT {Good, Bad}, and fuzzy rules are given below. Find the obtained mark of a student who studies 4.5 hours and sleeps 7.5 hours in a day using the centroid defuzzification method. 10

   Fuzzy rules:

   If a student studies and sleeps well, he will be good student.

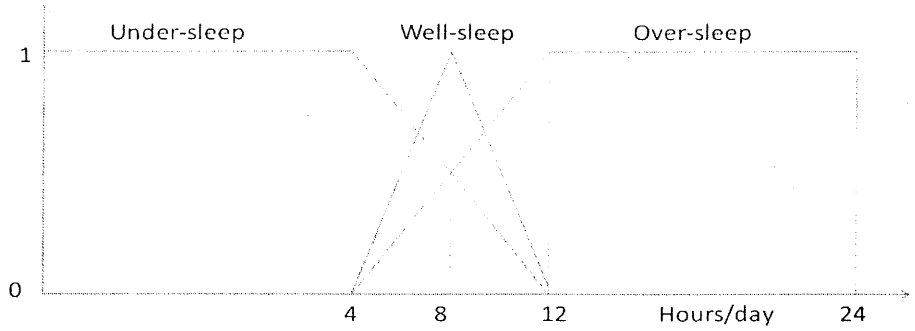
   If a student studies bad, and sleeps bad or over, he will be bad student.

   Membership function for STUDY_HOUR:

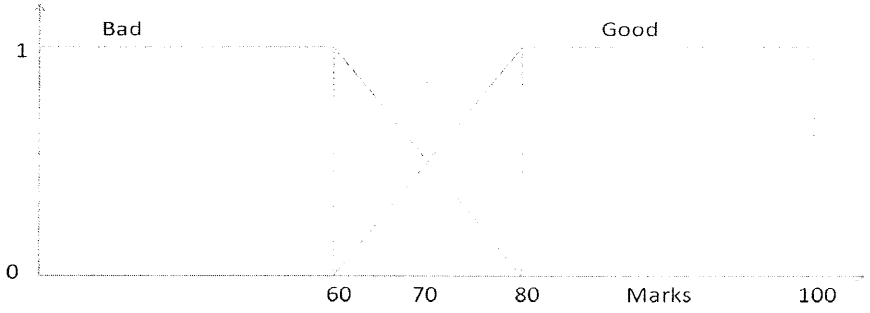


Please Turn Over

Membership function for SLEEPING_HOUR:



Membership function for a STUDENT:



4. a) Explain fuzzy and crisp set operation with the multi element set, A and B 2
A={0.8 0.9 0.1} and B={0.9 0.5 0.8}

b)Show fuzzy $((a^3+b^3)/(a-b))$, where a=fuzzy 4 and b=fuzzy 5, where fuzzification is done using the triangular function. 3

c) If fuzzy 4 and 5 are defined as (3, 4, 5) and (4, 5, 6), respectively by using a triangular function, find membership function, μ for fuzzy 4 and fuzzy 5 using continuous functions. Also find $\mu(3.5) + \mu(5.5)$. 2

d) Define fuzzy inference rule. What are the significances of it? 2

e) Draw diagrams for the different fuzzification techniques. 1

Ques:

Given

i) Membership functions for

a) short, medium-height, tall

b) Light, medium-weight, heavy

ii) Inference rule (Fuzzy rules)

If height is short then weight is light [Rule1]

If height is medium then weight is medium [Rule2]

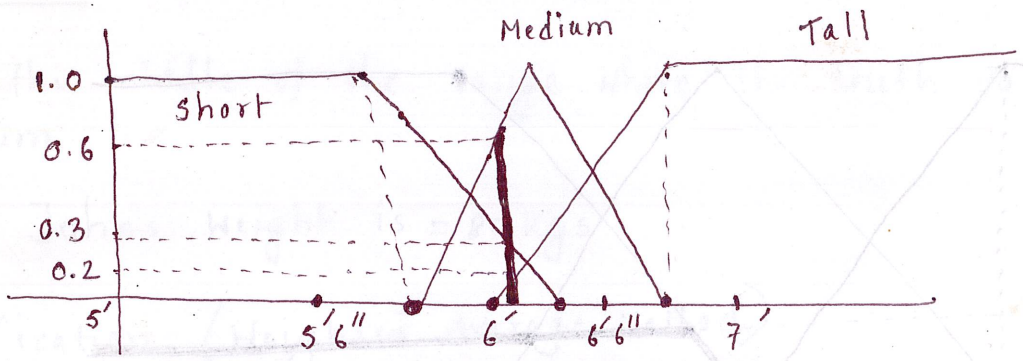
If height is tall then weight is heavy [Rule3]

iii) The fact that John's height is 6'1"

Estimate John's weight.

Solution:

i) Membership function for short, medium-height, tall



From John's height we know that

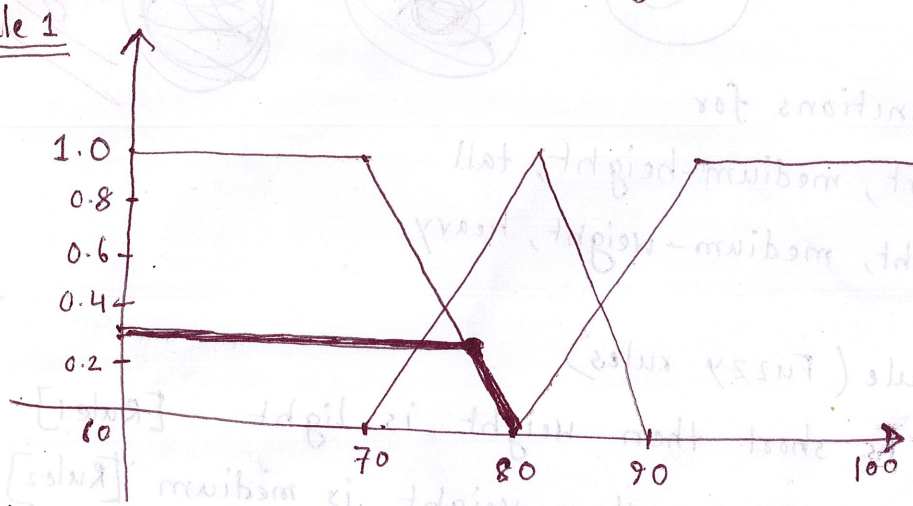
John is short (degree 0.3)

John is medium height degree 0.6

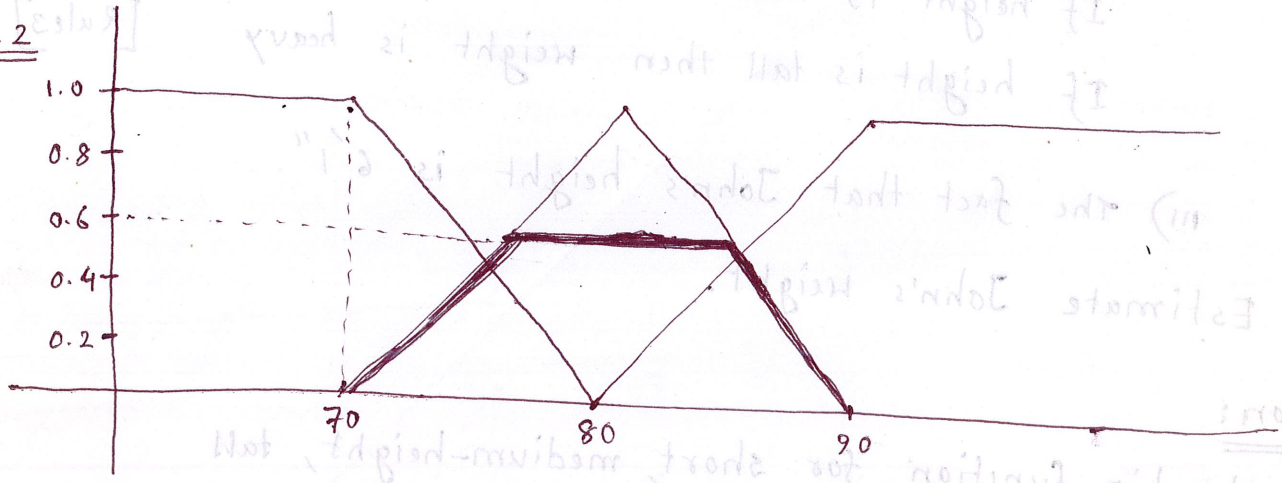
John is tall degree 0.2

11) Membership function for Light, medium-weight, heavy

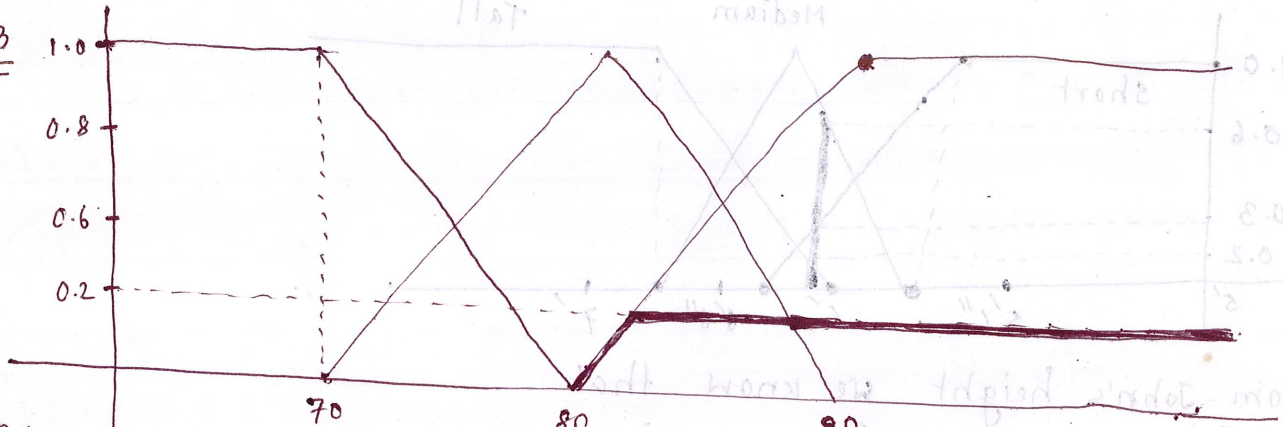
Rule 1



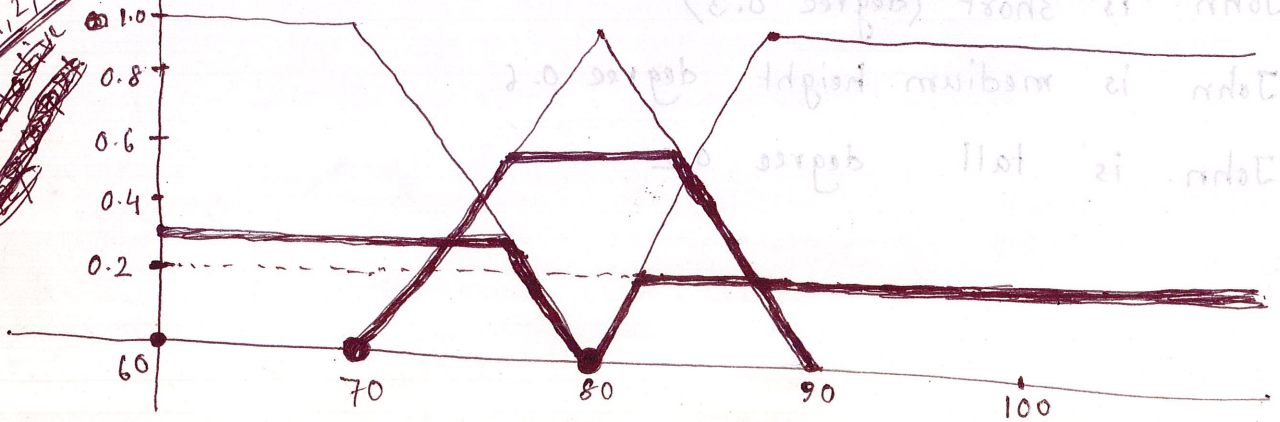
Rule 2



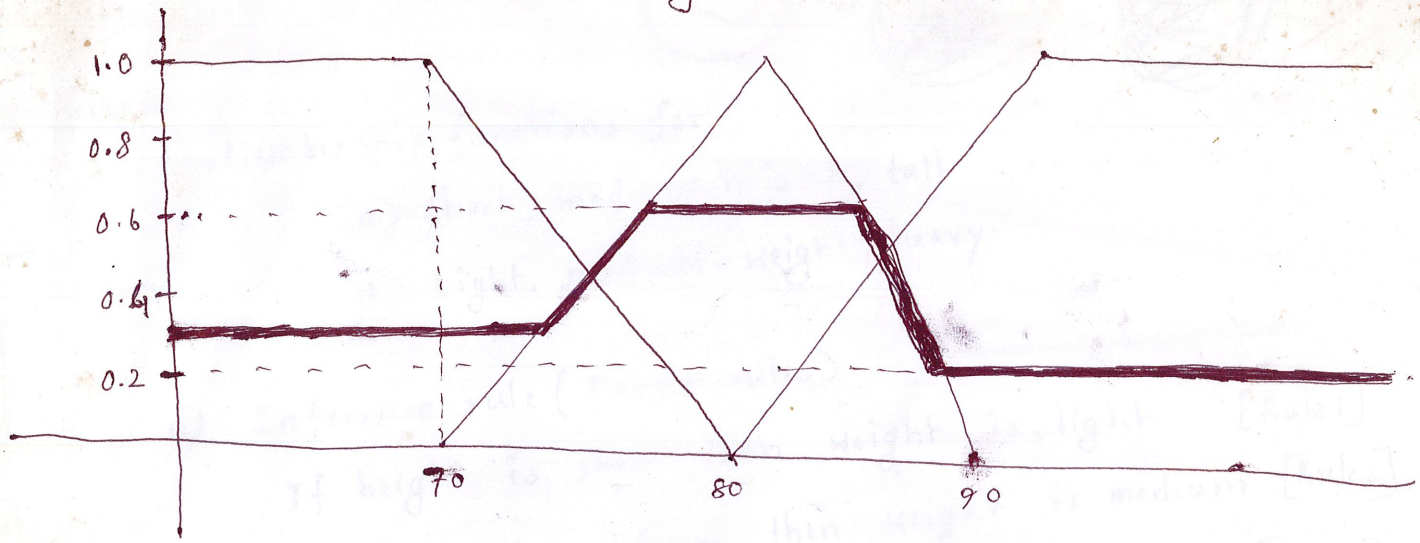
Rule 3

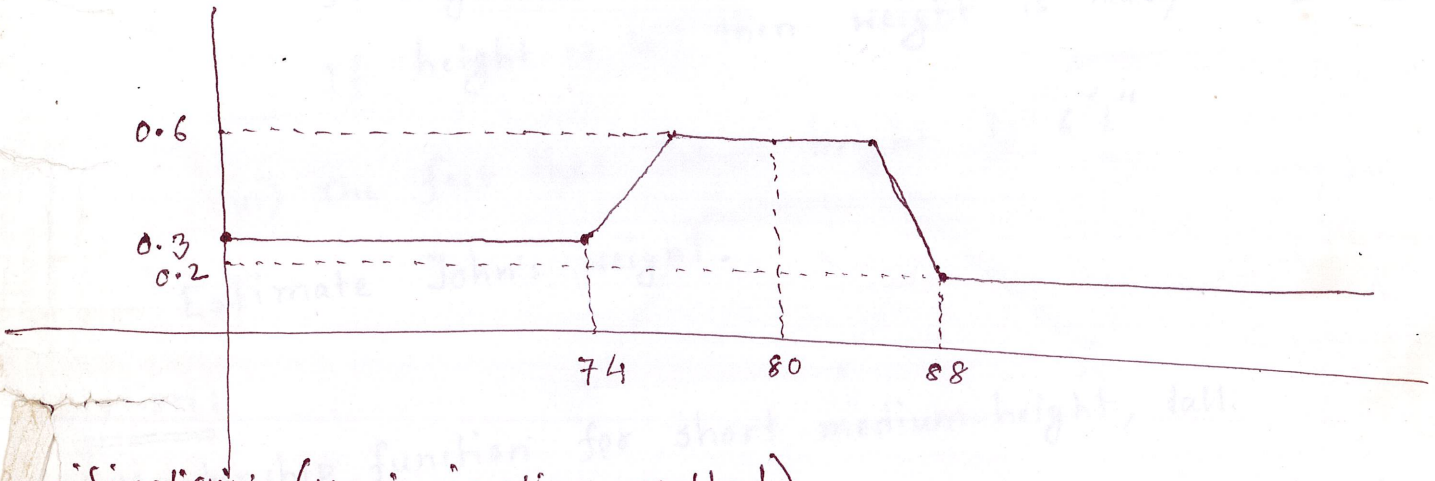


1,2,3



Cumulative fuzzy output by ORing the output from each rule:





Defuzification: (Maximization Method)

Choose the middle of the range where the truth value is maximum

John's weight is = 80 kgs

Defuzzification: (Weighted Average Method)

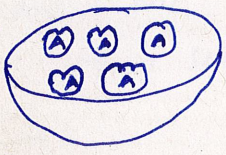
Fuzzy logic

Dr. Mohammad Nurul Huda
M.Sc. in CSE Program
Neural Network and Fuzzy logic
Sheet-6

uzzy logic:

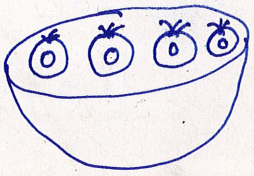
- A way to represent variation or imprecision in logic
- Fuzzy in the real-word sense "partly cloudy" - the distinctions that people use in decision-making all the time, but that computers and other advanced technology haven't been able to handle.

Crisp logic:



Is this a bowl of oranges?

Ans: NO



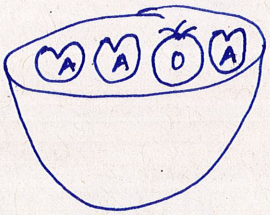
Is this a bowl of oranges?

Ans: YES

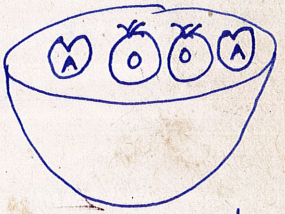
Answer: {NO, YES}
: {0, 1}

Thinking Fuzzy logic:

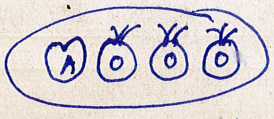
"Thinking fuzzy" about a bowl of oranges.



Fuzzy bowl of apples



Fuzzy bowl of apples (continued)



Fuzzy bowl of apples (continued)

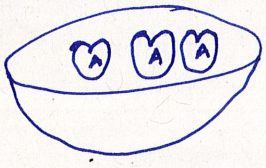
...ties of fuzziness:

...ord based, not number based. For instance, hot; not 85°

Analog (ambiguous), not digital (YES/NO)

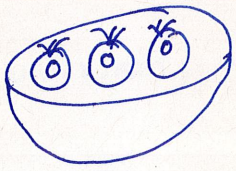
Nonlinear changeable.

Crisp Values:



Orangle ??

Ans: NO

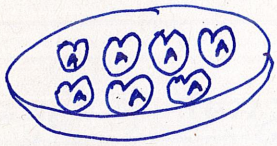


Orange??

Ans: YES

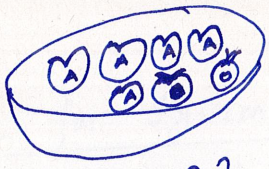
Crisp set ≡ {NO, YES} ≡ {0, 1}

Fuzzy Values:



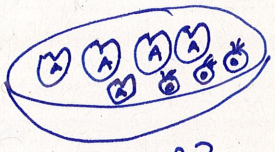
orange ??

Ans: NO



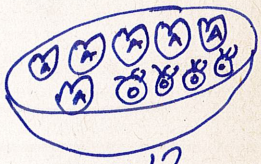
orange ??

slightly



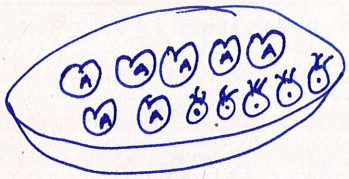
orange??

somewhat



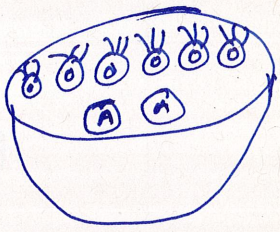
orange??

sort of

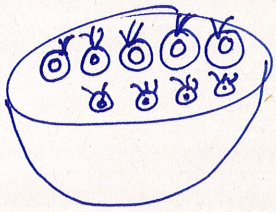


orange??

few



Mostly



YES, Absolutely.

Fuzzy set ≡ {NO, slightly, somewhat, sort of, few, mostly, absolutely}

Words:

- Quantification:
  all, most, many, ~~half~~ about half, few and no.

- Usuality:
  Always, frequently, often, occasionally, seldom and never

- Likely hood:
  certain, likely, uncertain, unlikely, and certainly not.

Fuzzy words are called linguistic variable.

Inventor of fuzzy logic:

Lotfi Zadeh in 1965.

Advantage of fuzzy logic for System Control

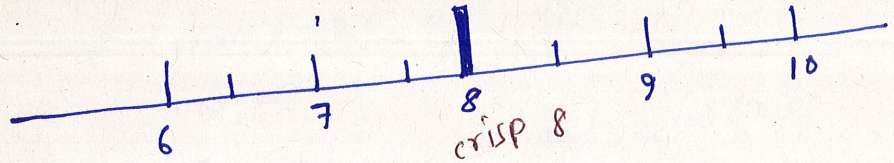
- Fewer rules, values and decisions.
- Linguistic variables are used.
- Relation of input and output.
- Simplicity.
- Rapid prototyping.
- Easier to design.
- Increased Robustness.
- Simple knowledge representation.
- Few rules for great complexity.

Drawbacks:

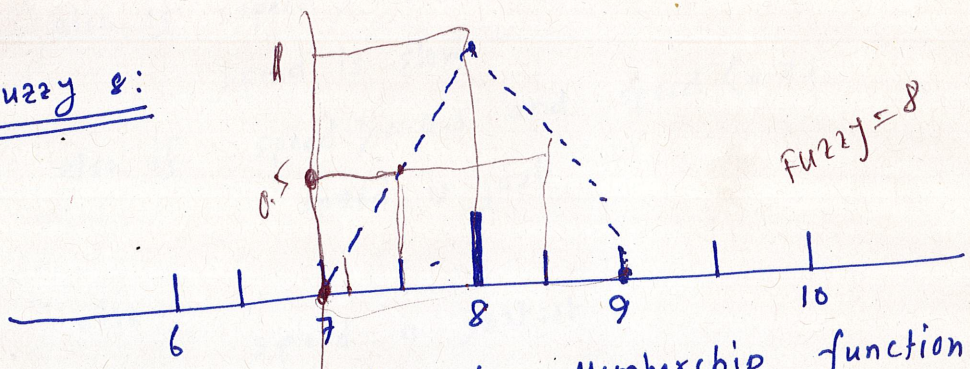
- Tunning of membership functions.
- May not scale well to large or complex problems.
- Deals with imprecision and vagueness, but not uncertainty.

Numbers:

A crisp 8:



A fuzzy 8:



Eightness with a triangular Membership function:

Member	Degree of Membership
7	0
7.5	0.5
8	1
8.5	0.5
9	0

Traditional Representation of logic (Crisp logic):

```
boolean speed
get the speed
if speed = 0
        speed is slow
else    speed is fast
```

logic Representation:

```
float speed
get the speed
if   speed >= 0.0  and  speed < 0.25
        speed is slowest
else if  speed >= 0.25  and  speed < 0.5
        speed is slow
else if  speed >= 0.5  and  speed < 0.75
        speed is fast

else
        speed is fastest
```

Crisp and Fuzzy arithmetic Operations:

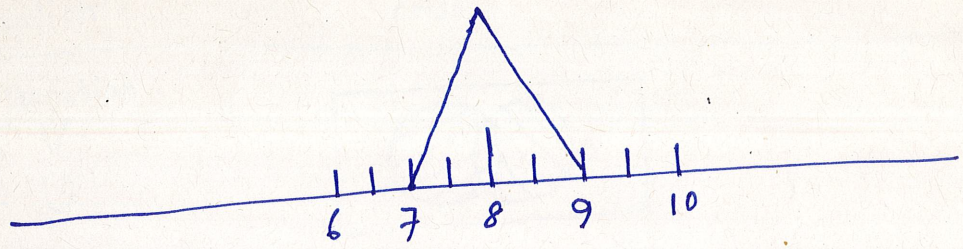
Crisp	Fuzzy
$a = 3 \quad b = 2$	$a = (-2, 3, 8)$ $b = (-1, 2, 7)$
Addition: $a+b$ $3+2=5$	$(-2,3,8) + (-1,2,7)$ $= (5-9, 5, 5+9)$ $= (-4, 5, 14)$
subtraction: $a-b$ $3-2=1$	$(-2,3,8) - (-1,2,7)$ $= (1-9, 1, 1+9)$ $= (-8, 1, 10)$
Multiplication: $a \times b$ $3 \times 2 = 6$	$(-2,3,8) \times (-1,2,7)$ $= (6-9, 6, 6+9)$ $= (-3, 6, 15)$
Division: ~~a/b~~ a/b $3/2 = 1.5$	$(-2,3,8) / (-1,2,7)$ $= (1.5-9, 1.5, 1.5+9)$ $= (-7.5, 1.5, 10.5)$

10 → −2, 3, 8 ← 8 ; −1, 2, 7

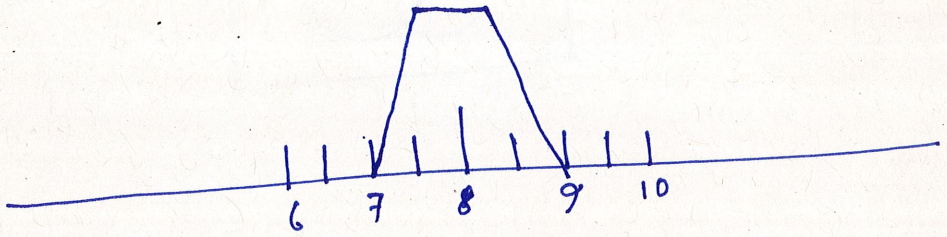
$\frac{10+8}{2} = 9$

types of membership function:

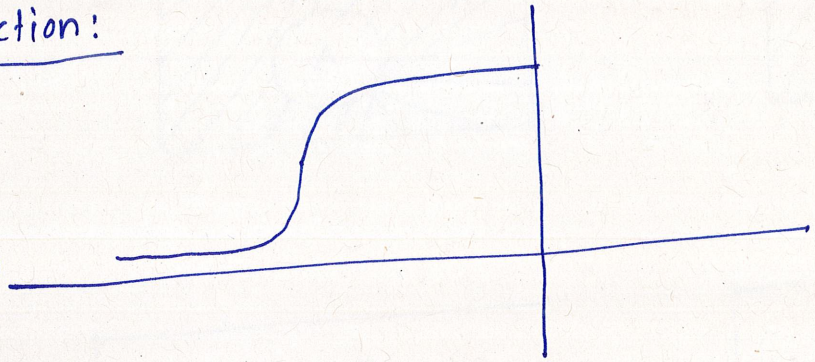
riangular:



Trapezoid:

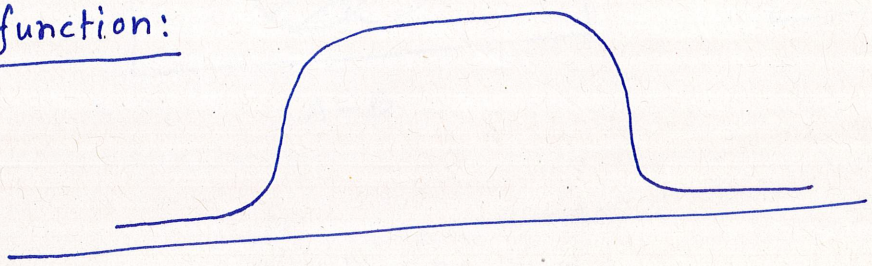


S-function:

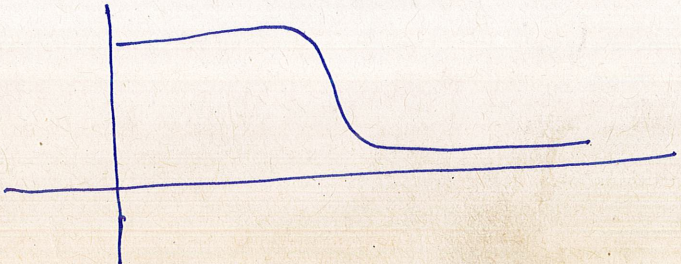


s function

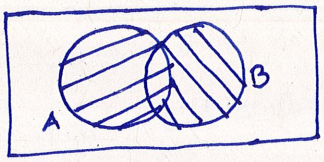
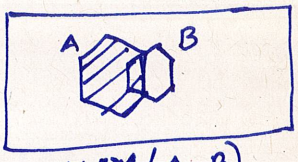
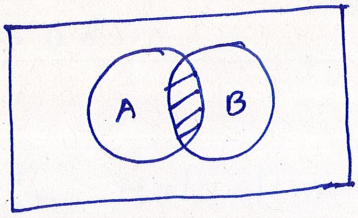
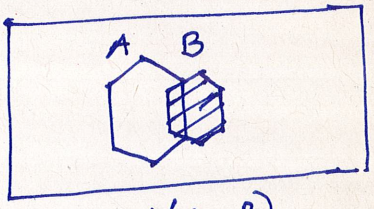
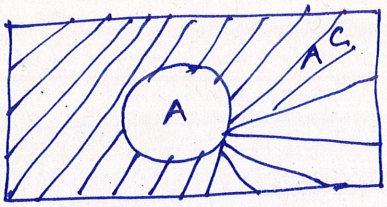
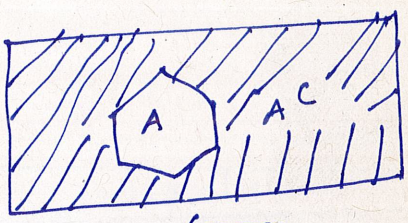
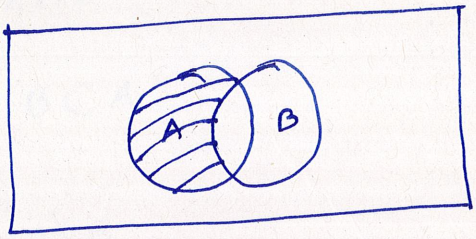
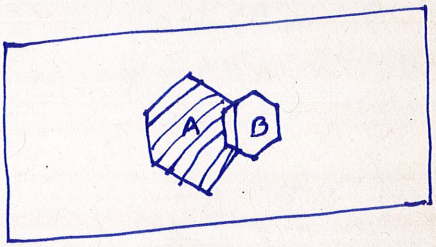
pi- function:



z- function:



heory

peration	crisp	Fuzzy
Disjunction or V or U		 MAX(A, B)
Conjunction or intersection		 MIN(A, B)
Complement		 1−A
ffference	 A−B	 A−B
mplication	A implies B or, A → B	A → B

zzy logic calculator:

$0.3 \wedge .8 = MIN(0.3, 0.8) = 0.3$

$0.2 \vee .0.6 = MAX(0.2, 0.6) = 0.6$

$\neg 0.9 = 1.0 - 0.9 = 0.1$

$\neg 0.6 = 1.0 - 0.6 = 0.4$

$0.8 \Longrightarrow 0.7$ $\quad 0.8 >= 0.7$ YES

$0.7 \Longrightarrow 0.8$ $\quad 0.7 >= 0.8$ NO

Fuzzy logic in Multielement sets :

$A \equiv (0.8 \quad 0.2 \quad 0.7)$

$B \equiv (1 \quad 0.3 \quad 0.4)$

Operation	Fuzzy logic
$A \cup B$	$(1.0 \quad 0.3 \quad 0.7)$
$A \cap B$	$(0.8 \quad 0.2 \quad 0.4)$
$B \subset A$	(NO NO YES)
	$(0 \quad 0 \quad 3)$
$A \setminus B$	$(0.2 \quad 0.8 \quad 0.3)$
A^C	

Crisp set:

$A \equiv (0.8 \quad 0.2 \quad 0.7)$

$B \equiv (1 \quad 0.3 \quad 0.4)$

fuzzy set

$\Rightarrow$

$A \equiv (1 \quad 0 \quad 1)$

$B \equiv (1 \quad 0 \quad 0)$

crisp set

and Fuzzy logic (Rules of inference)

Set theory is closely related to the truth-finding logical statements called the rules of inference.

⇒ Use rules of implication ($A \Rightarrow B$)

Modus ponens: (Affirmative mode)

If the apple is red
AND a red apple is a ripe apple
Then the apple is ripe

Modus tollens: (Denial mode)

If the apple is not ripe
AND a red apple is a ripe apple
Then the apple is not red

Fuzzy Rule 1: (Modus ponens)

As the apple is very red
And a red apple is a ripe apple
Then the apple is very ripe

Fuzzy Rule 2: (compositional rule of inference)

As Apple #1 is very ripe
And Apple #2 is not quite as ripe as Apple #1
Then Apple #2 is more or less ripe.

logical statements

Existential quantifier

sp: $(\exists x)[\text{ripe}(\text{apple})]$

There exists one example of a ripe apple.

Fuzzy:

- There exists
- Few

Universal quantifier

crisp: $(\forall x)[\text{apple}(x) \longrightarrow \text{ripeness}(x)]$

All apples are ripe

Fuzzy

- For all
- Most

Traditional or Crisp Rule:

Ex: If the room temperature is less than 62 degrees
Then set the thermostat for 68 degrees

* Crisp rule gives precise terms.

Fuzzy logic

If-Then-style rules expressed by As-Then (general form) or As-Do (control form).

Ex: As the room temperature is cool
Do turn on the heater to High

zzy logic NOT

A	Not(A)
0	1
0.25	0.75
0.5	0.5
0.75	0.25
1	0

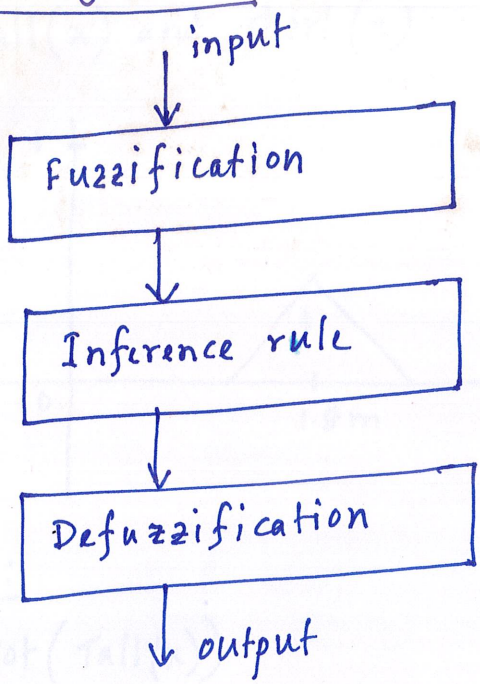
Fuzzy logic AND

A \ B	0	0.25	0.5	0.75	1.0
0	0	0	0	0	0
0.25	0	0.25	0.25	0.25	0.25
0.5	0	0.25	0.5	0.5	0.5
0.75	0	0.25	0.5	0.75	0.75
1.0	0	0.25	0.5	0.75	1.0

Fuzzy logic OR

A \ B	0	0.25	0.5	0.75	1.0
0	0	0.25	0.5	0.75	1.0
0.25	0.25	0.25	0.5	0.75	1.0
0.5	0.5	0.5	0.5	0.75	1.0
0.75	0.75	0.75	0.75	0.75	1.0
1.0	1.0	1.0	1.0	1.0	1.0

zzy logic systems:

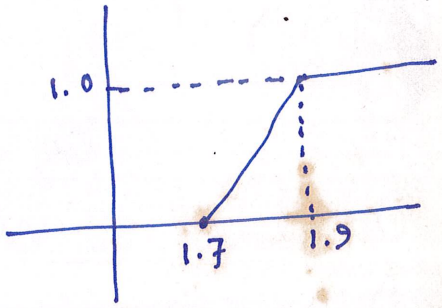


Membership Functions:

Better than listing membership values.

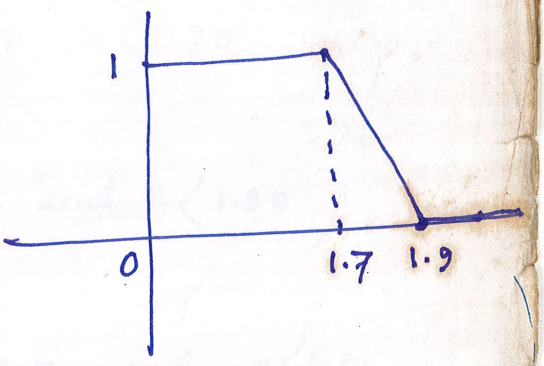
xample: Fuzzy tall

$$Tall(x) = \begin{cases} 1 & \text{if } x >= 1.9\,m \\ 0 & \text{if } x <= 1.7\,m \\ \frac{x-1.7}{0.2} & \text{otherwise} \end{cases}$$



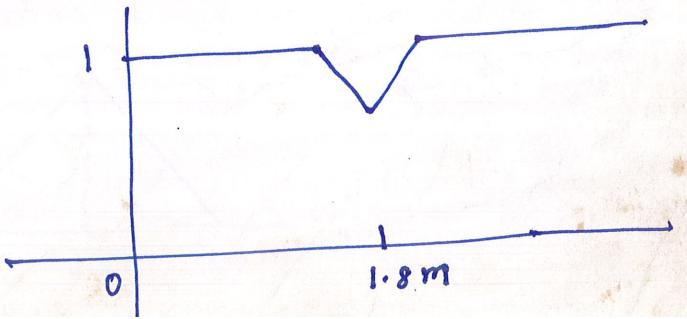
xample: Fuzzy short

$$short(x) = \begin{cases} 0 & \text{if } x >= 1.9\,m \\ 1 & \text{if } x <= 1.7\,m \\ \frac{1.9-x}{0.2} & \text{otherwise} \end{cases}$$



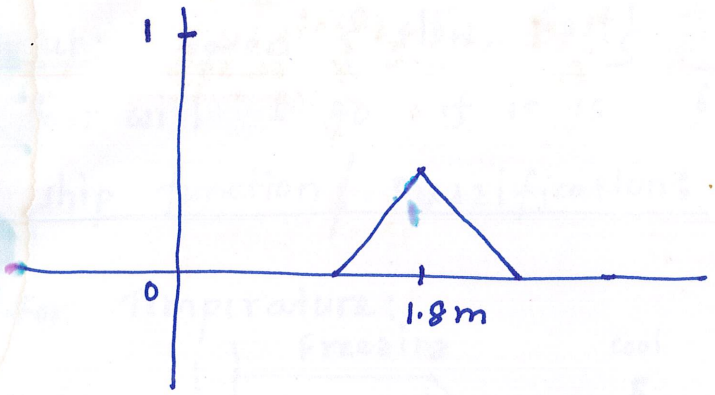
Union:

Tall (x) ∪ short (x):



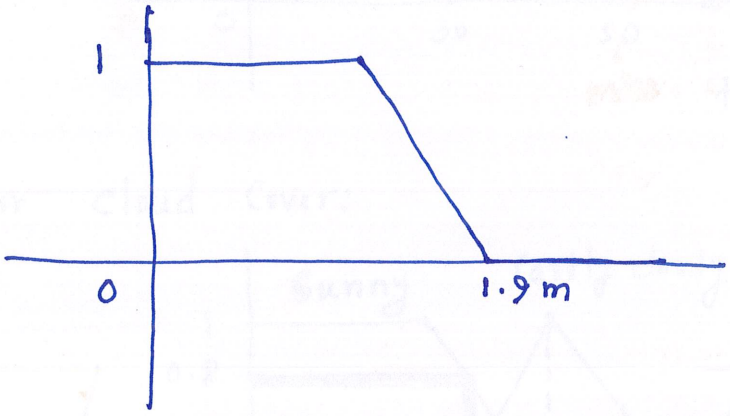
section:

Tall(x) and short(x)



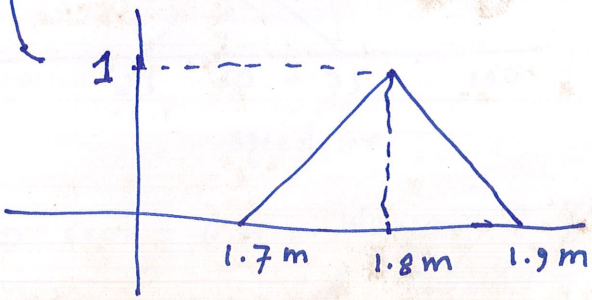
mplement:

Not(Tall(x))



xample:

$$\text{Medium}(x) = \begin{cases} 0 & \text{if } x >= 1.90 \text{ or } x < 1.70 \\ \frac{1.9 - x}{0.1} & \text{if } x >= 1.80 \text{ and } x < 1.90 \\ \frac{x - 1.70}{0.1} & \text{if } x >= 1.70 \text{ and } x < 1.80 \end{cases}$$



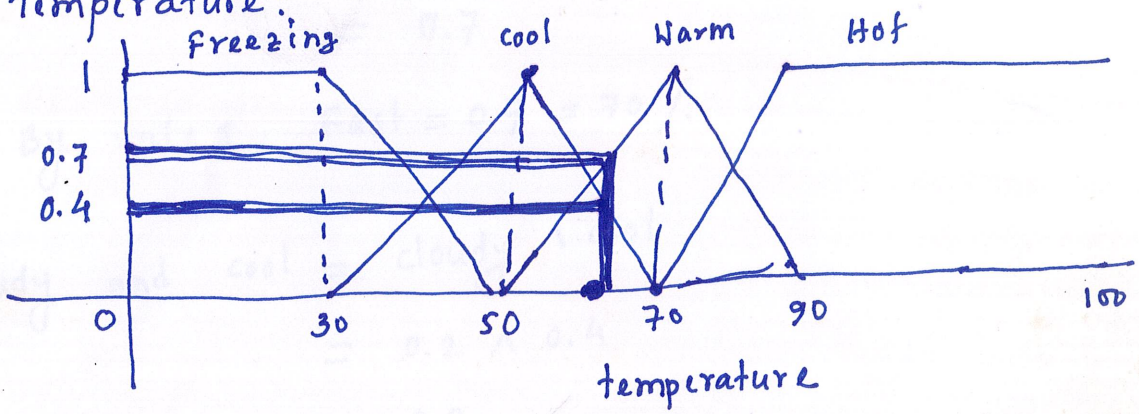
Input: Temperature { Freezing, Cool, Warm, Hot }
Cloud Cover { Sunny, [illegible], Partly, Overcast }

Output: Speed { slow, Fast }

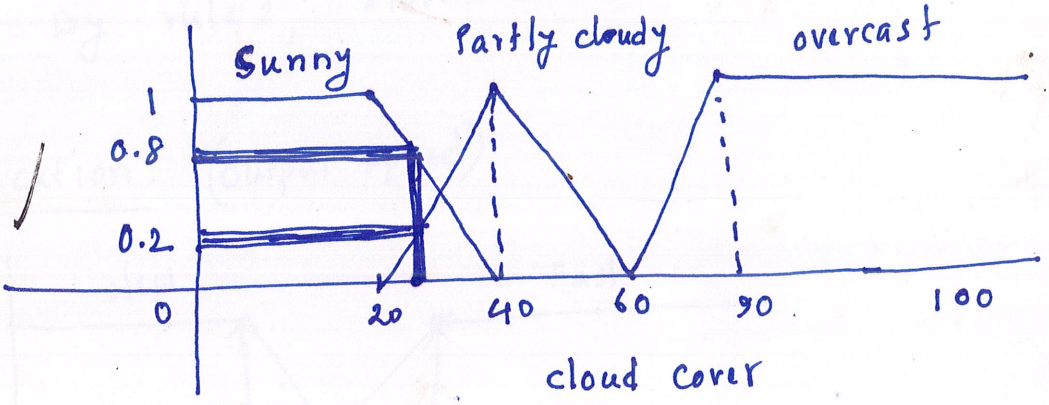
How fast will I go if it is 65 F° and 25% cloud cover?

Membership function / Fuzzification:

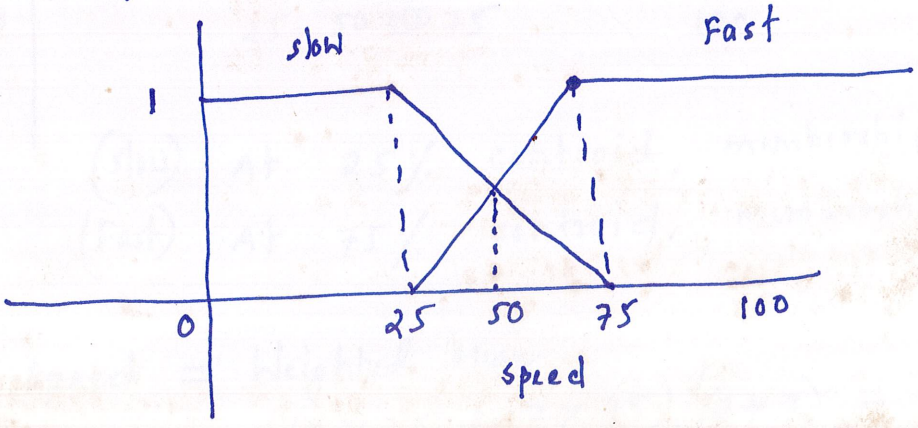
For Temperature:



For cloud Cover:



For output speed:



65°F ⇒ cool = 0.4, Warm = 0.7
25% Cover ⇒ Sunny = 0.8, cloudy = 0.2

rules :

If it is sunny and warm, drive fast

If it is cloudy and cool, drive slow

sunny and warm = sunny $\wedge$ warm

$= 0.8 \wedge 0.7$

$= 0.7$

By rule 1, Fast $= 0.7 = 70\%$

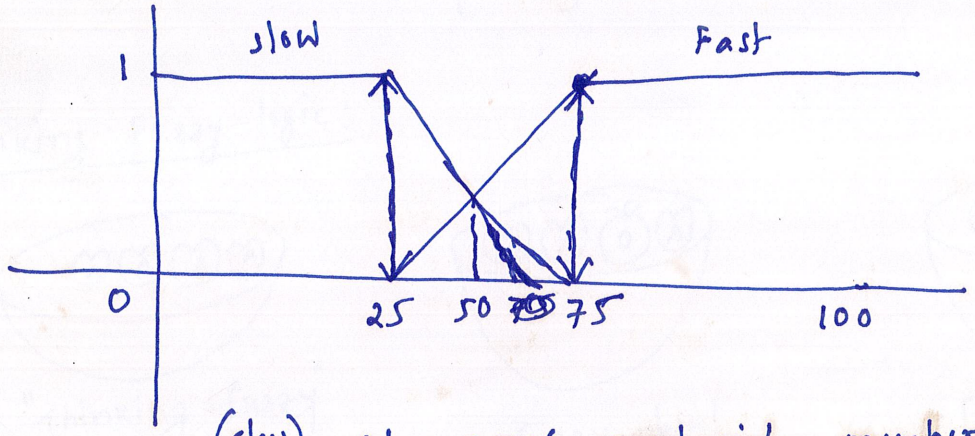
cloudy and cool = cloudy $\wedge$ cool

$= 0.2 \wedge 0.4$

$= 0.2$

By rule 2, slow $= 0.2 = 20\%$

Defuzzification: (output speed)



(slow) At 25% centroid, membership is 100%.

(Fast) At 75% centroid, membership is 100%.

Generated speed = Weighted Mean

$= (2 \times 25 + 7 \times 75)/(2+7) = 63.8$ mph Ans!

apples (continued)