09.11.22

membership function - 295

Fuzzy logic.

Fuzzy means the things that are not clear or are vague. Sometimes in real life that the given problems or statement is either true or false. At that time this concept provides many value between the true and false and gives the flexibility to find the best solution to that problem.

fuzzy logic in comparison with boolean.

is it hot?

- yes - 1
- NO - 0

} boolean logic

every value will lie 0-1

is it hot?

- very much / 0.8
- little / 0.25
- very less / 0.1

} fuzzy logic

fuzzy logic contains the multiple logical values and these values are truth values of a variable or problem between 0 and 1.

As the complexity of the system increases it become more difficult and eventually impossible to make a precise statement about its behaviour, eventually arriving at a point of complexity where the fuzzy logic method born in human is only way

to get at a problem
— Lotfi A. Zadeh

Let see an example—
fuzzy logic representation—

slowest → 0.0 - 0.25
slow → 0.25 - 0.50
fast → 0.50 - 0.75
fastest → 0.75 - 1.0

by these we can make rules

if speed ≥ 0 && speed < 0.25
speed is slowest
elie if speed ≥ 0.25 && speed < 0.50
speed is slow
else if speed ≥ 0.50 && speed < 0.75
speed is fast
else speed ≥ 0.75 && speed < 1
speed is fastest

② fuzzy logic is proposed by Late Prof. Lotfi Askar Zadeh in 1965.
Also known as father of fuzzy logic

③ Professor Toshire Tereno in 1972 organised world first working group of fuzzy system

(*) FL smidth & Co. in 1980 first to market fuzzy expert system
A Danish company which used fuzzy logic in washing machine.

Membership Function

membership function defines fuzziness in a fuzzy logic set irrespective of the element in set, which are discrete or continuous.

The membership function is generally represented as graphical method

There exist certain limitation for the shapes which are used to represent graphical form of membership function.

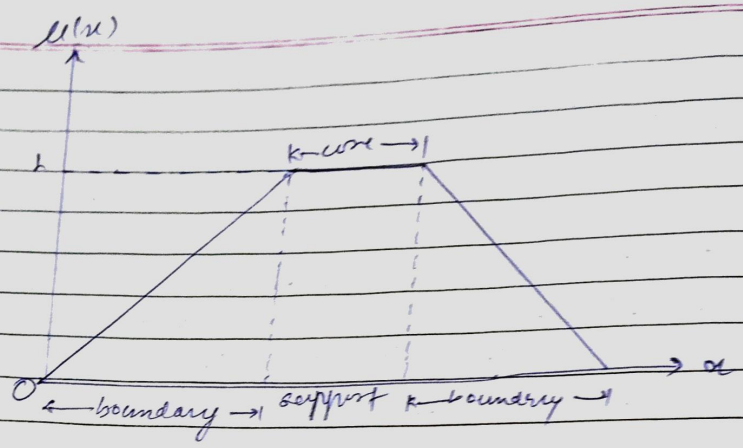
membership function defines all the information contained in fuzzy set.

various feature of ~~fuzzy~~ member function

A fuzzy set $\underset{\sim}{A}$ is universe discourse of X can be defined as a set of ordered pairs

$$\underset{\sim}{A} = \{(x, \mu_{\underset{\sim}{A}}(x)) | x \in X\}$$

where $\mu_{\underset{\sim}{A}}(\cdot)$ is called membership function of $\underset{\sim}{A}$.



1. core — the core is defined as region of universe that is defined as / characterise as complete membership in set $\underset{\sim}{A}$. The core has element x of the universe such as

$$\mu_{\underset{\sim}{A}}(x) = 1$$

the core of fuzzy set may be an empty set.

2. Support — the support is defined as the region of universe that is characterised as non zero membership in the set.

$$\mu_{\underset{\sim}{A}}(x) > 0$$

A fuzzy set whose support is single ele. in X. $\mu_{\underset{\sim}{A}}(x) = 1$ is referred as

fuzzy singleton

s) boundary — is the region of universe containing element that have a non zero but not complete membership.

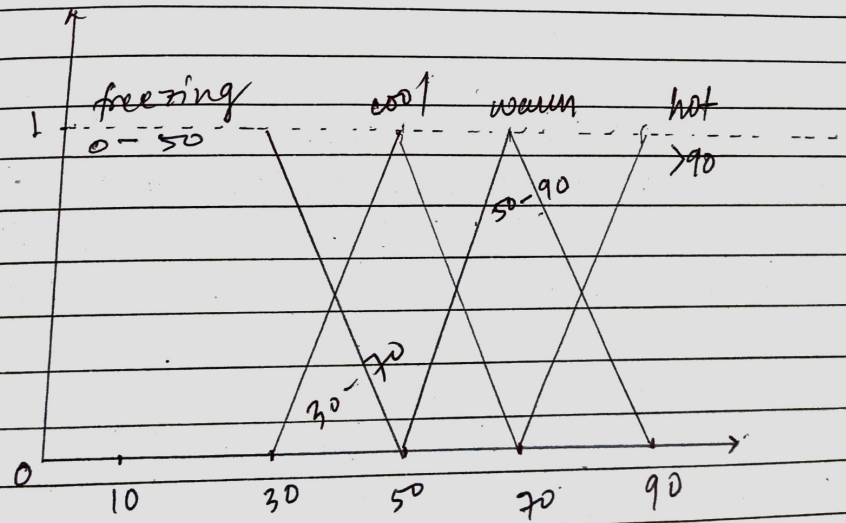
$$0 < \mu_{\tilde{A}}(x) < 1$$

this posses partial relationship in fuzzy set $\tilde{A}$.

example —

for temperature

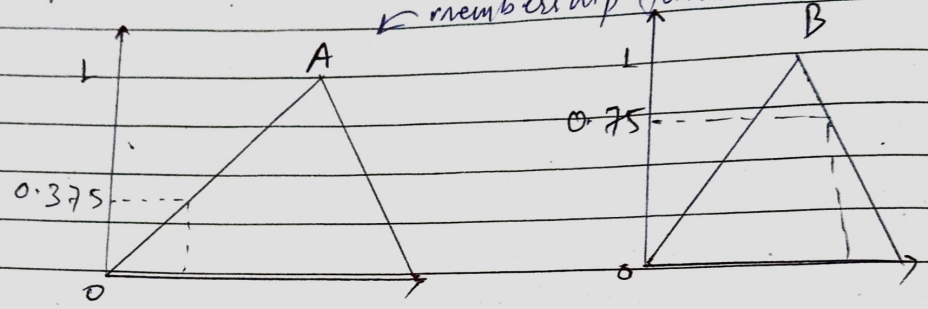
temp (freezing, cool, warm, hot)



⊛ fuzzy disjunction

represented as $A \vee B = \max(A, B)$

membership function



fuzzy disjunction :-

$$A \vee B = \max(A, B)$$
$$= \max(0.375, 0.75)$$
$$= 0.75$$

⊛ fuzzy conjuction

represented as $A \wedge B = \min(A, B)$

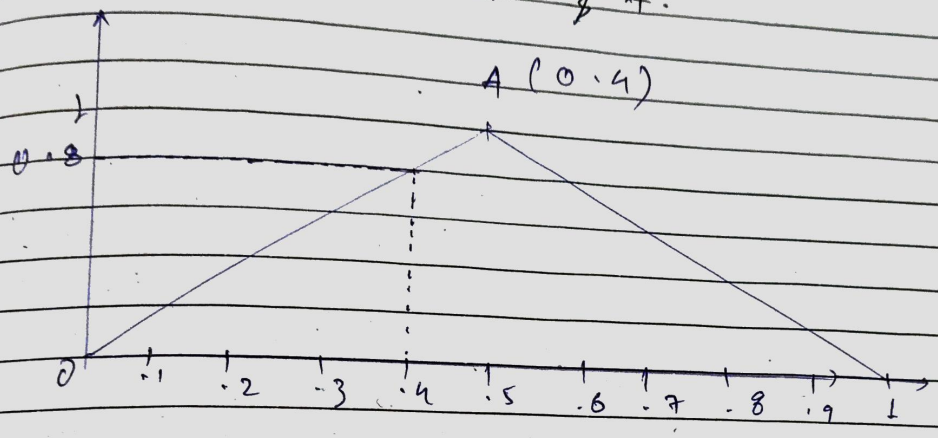
for same graph as above.

fuzzy conjuction = $\min(0.375, 0.75)$
$= 0.375$

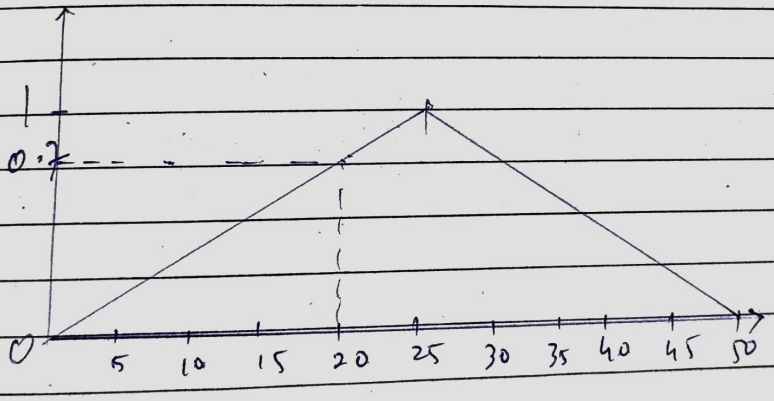
conjuction

Calculate $A \wedge B$ given that $A = 0.4$ & $B = 20$.

membership function for A.



membership function for B



now $A \wedge B = \min(A, B)$

$= \min(0.8, 0.7)$

$= 0.7$

⑧ fuzzy control :-

This combines the fuzzy linguistic variables with fuzzy logic.

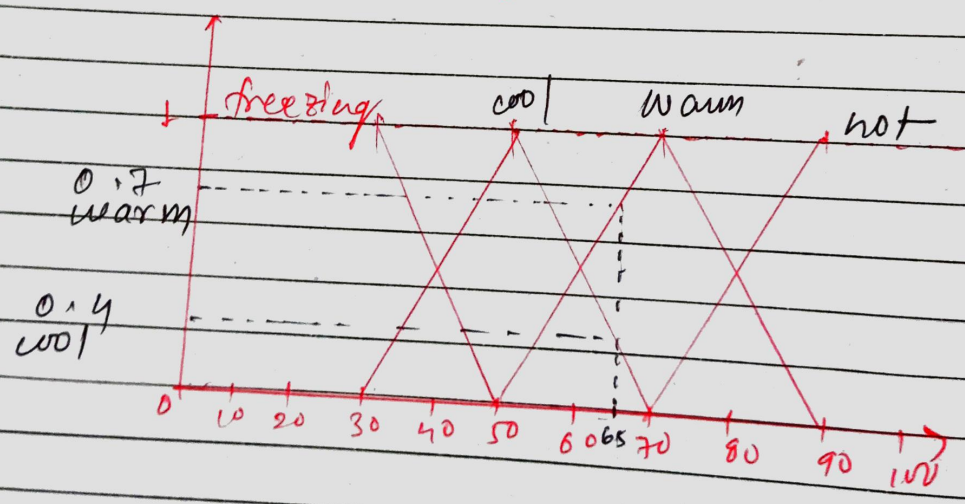
example - speed control

Q. How fast am I going to drive today?

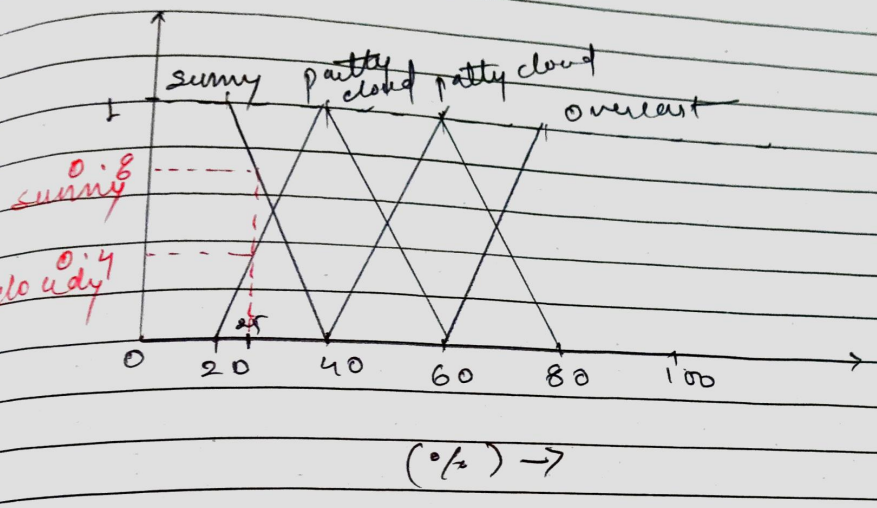
Soln. Inputs are - temperature and cloud cover
output - speed.

Drawing membership function

#fuzzification,
for temp (freezing, cool, warm, hot)

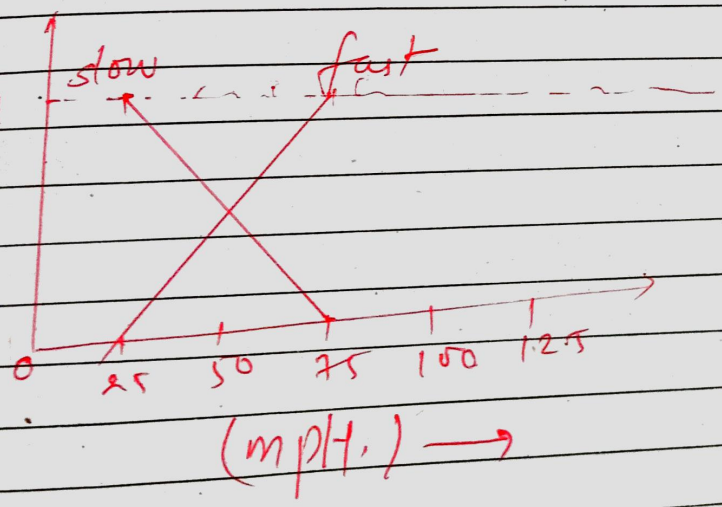


for cloud cover



for output :-

speed (slow , fast)



rules –

1. if sunny and warm drive fast

sunny (cover) ∧ warm (temp)
⇒ fast (speed)

2. if it is cloudy & cool

cloudy (cover) ∧ cool (temp)
⇒ slow (speed)

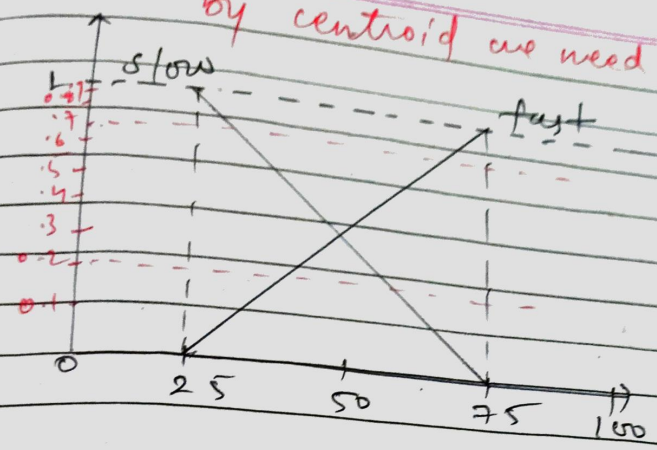
Q. How fast I can drive with temp 65°F, with cloudy whether of 25%

by rules 1 (0.8) ∧ (0.7) ⇒ 0.7
fast (speed)

2 (0.2) ∧ (0.4) ⇒ 0.2
slow (speed)

Defuzzification.

by centroid we need to draw perpendicular.



$$\text{speed} = \frac{2 \times 25 + 7 \times 75}{9}$$

$$= 63.8 \text{ mph}$$

$(.2 \times 25 + .7 \times 75) \times 9$

$= 49.725.$