

Fuzzification & its Methods

Fuzzification is the process of transforming a crisp set to a fuzzy set or a fuzzy set to a fuzzier set, i.e., crisp quantities are converted to fuzzy quantities. This operation translates accurate crisp input values into linguistic variables.

Methods of Membership Value Assignments

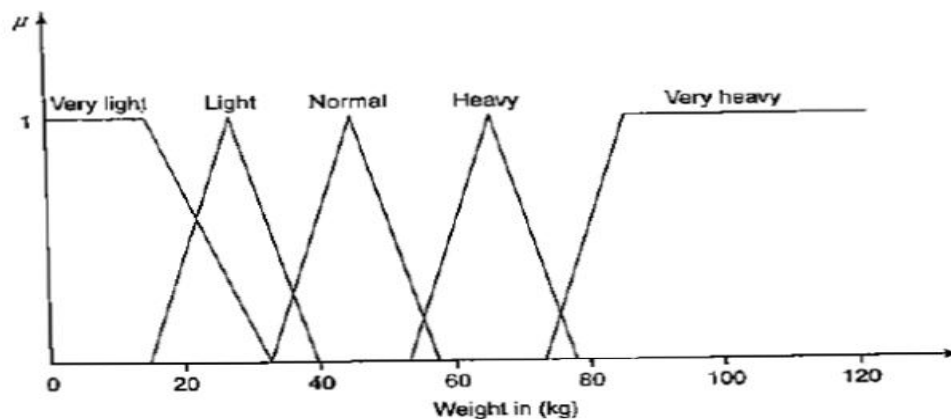
The method of assigning membership values are as follows:

1. Intuition
2. Inference
3. Rank Ordering
4. Angular Fuzzy Sets
5. Neural Networks
6. Genetic Algorithm
7. Inductive Reasoning

Intuition: Intuition method is based upon the common intelligence of human. It is the capacity of the human to develop membership functions on the basis of their own intelligence and understanding capacity.

The Figure below shows various shapes of weights of people measured in kilogram in the universe. Each curve is a membership function corresponding to various fuzzy (linguistic) variables; such as very light, light, normal, heavy and very heavy.

The main characteristics of these curves for their usage in fuzzy operations are based on their overlapping capacity. There must be an intersection point and this shows uncertainty.



Inference: The inference method uses knowledge to perform deductive reasoning. Here the knowledge of geometrical shapes and geometry is used for defining membership values. The membership functions may be defined by various shapes: triangular, trapezoidal, bell-shaped and so on. The inference method here is discussed via triangular shape.

Example

- Let u be the Universe of triangles.
- A, B and C are the inner angles of the triangles

$$A \geq B \geq C \geq 0$$

- Therefore the universe is given by

$$U = \{(A, B, C), A \geq B \geq C \geq 0, A + B + C = 180^\circ\}$$

- The types of triangles are

I is the appropriate Isosceles Triangle

R is the appropriate Right Angle Triangle

Membership Values

- Isosceles Triangle is

$$\mu_I(A, B, C) = 1 - \frac{1}{60^\circ} \min(A - B, B - C)$$

- Right Angle Triangle is

$$\mu_R(A, B, C) = 1 - \frac{1}{90^\circ} \min(A - 90^\circ)$$

If $X = 90^\circ$, the membership value of a right-angle triangle is 1, and if $X = 180^\circ$, the membership value becomes 0.

Rank Ordering: The formation of government is based on the polling concept; to identify a best student, ranking may be performed; to buy a car, one can ask for several opinions and so on. All the above mentioned activities are carried out on the basis of the preferences made by an individual, a committee, a poll and other opinion methods.

4. Angular Fuzzy Sets

- The angular fuzzy sets are different from the standard fuzzy sets in their coordinate description.
- These sets are defined on the universe of angles, hence are repeating shapes every 2π cycles.
- Angular fuzzy sets are applied in quantitative description of linguistic variables known truth-values.

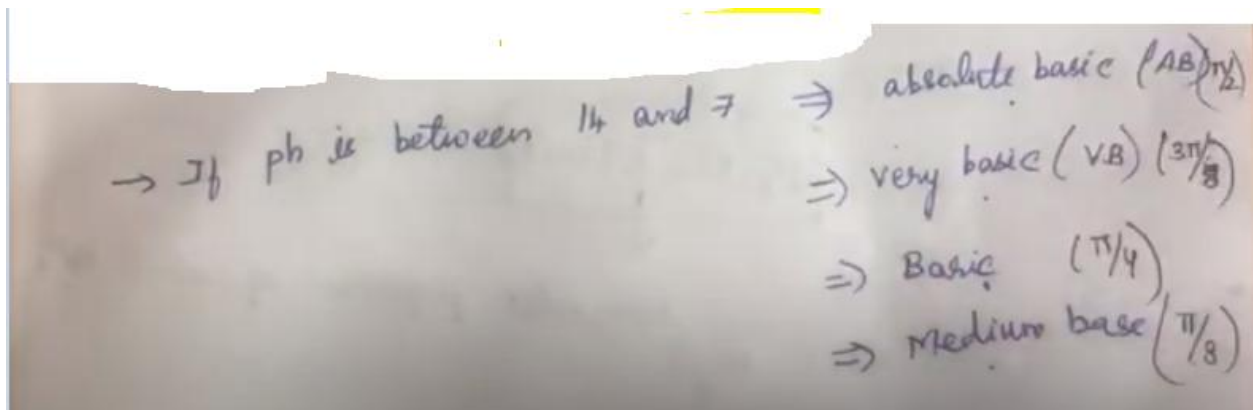
Example

ph values of water samples is taken from contaminated pond

ph = 7 (neutral solution)

ph is between 7 and 14

ph is between 0 and 7



Similarly for acidic values will be assigned

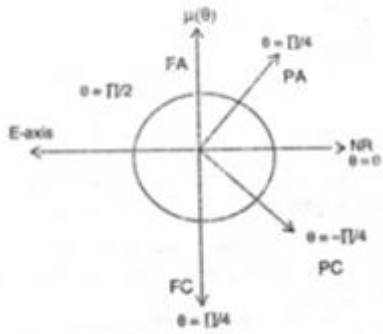
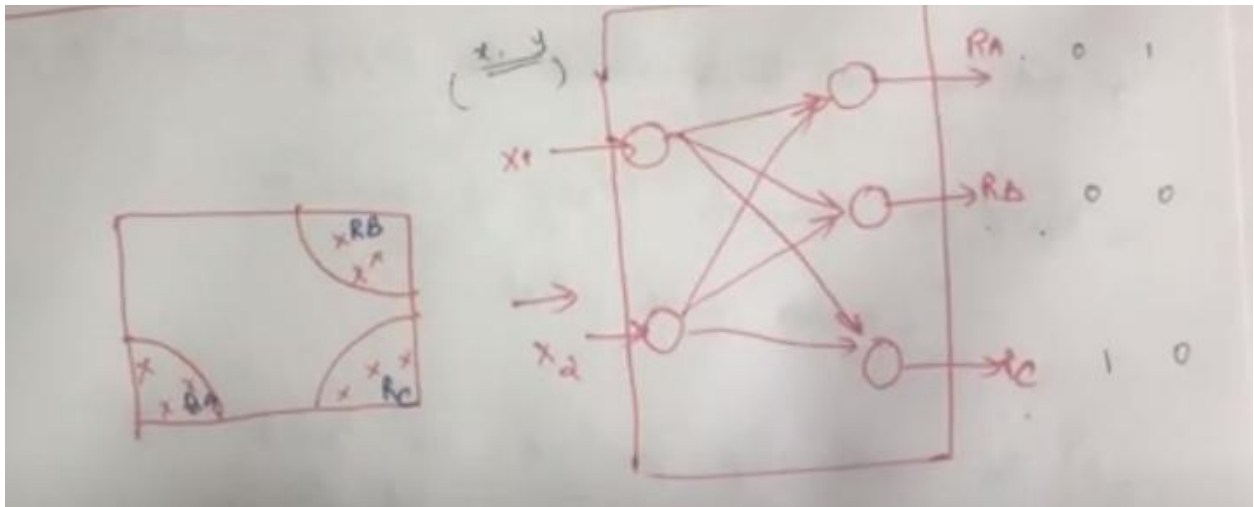


Fig. 4.9. Angular fuzzy set

$$M_F(\theta) = t \cdot \tan(\theta)$$

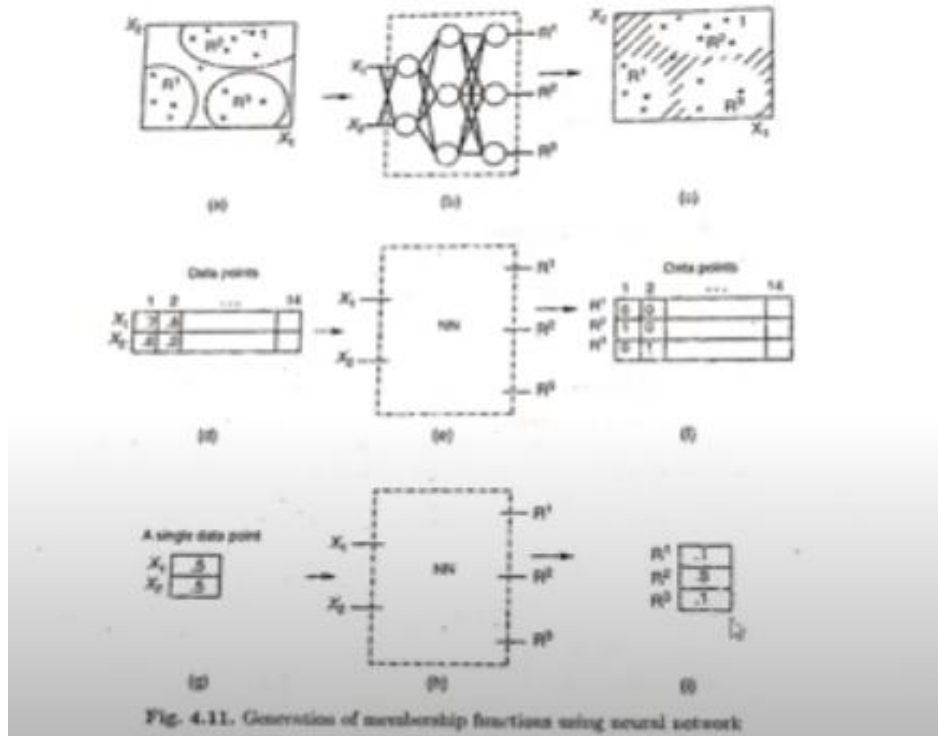
t = horizontal projection of vector

NEURAL NETWORKS



Then the neural network is trained and tested and membership value is found.

5. Neural Networks

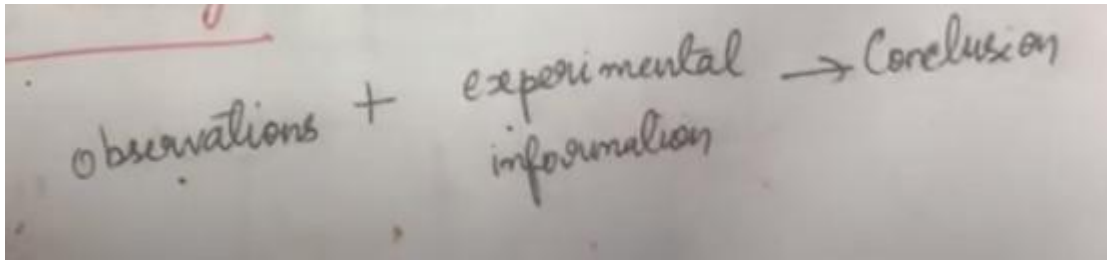


Genetic Algorithm

6. Genetic Algorithm

- For the given functional mapping of a system, some membership functions and their shapes are assumed for various fuzzy variables to be defined.
- These membership functions are then coded as bit strings.
- These bit strings are then concatenated (joined).
- Similar to activation function in neural networks, GA has a fitness function.
- This fitness function is used to evaluate the fitness of each set of membership functions.

INDUCTION REASONING



Method of logical reasoning that combines observations and experimental information to derive conclusion.

Example: If sky looks sunny, you do not need any umbrella. (Information obtained from past experiences).