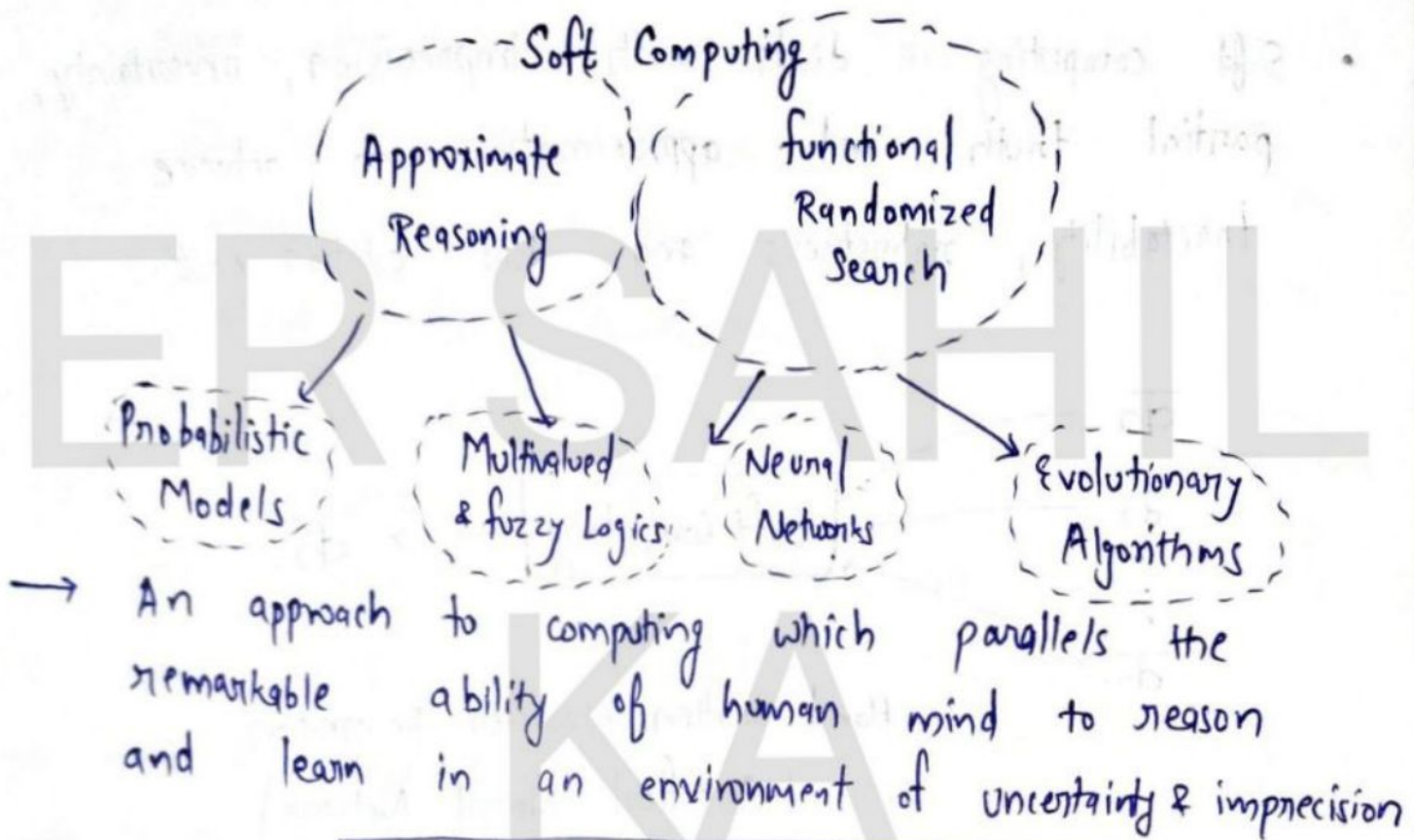


Soft Computing

Soft computing is a collection of artificial intelligence based computational techniques.



$$SC = \text{Fuzzy Logic} + \text{Neural Network} + \text{Genetic Algorithm}$$

For knowledge representation

For learning & Adaptation

For evaluation of computation evolutionary

Aims of Soft Computing :-

- It provides cost-effective solutions to the complex real-life problems for which hard computing solution does not exist.
- A. Zadeh coined the term of soft computing in 1992. The objective of soft computing is to provide precise approximation & quick solutions for complex real-life problems.

Fuzzy Logic :- Fuzzy logic theory proposed in 1965 by A. Zadeh is a generalization of classical set theory.

In classical set theory, an element either belongs to or does not belong to the set & hence, such set are termed as crisp set. [0 & 1] Yes or No

But in fuzzy set, many degrees of membership (btw 0 & 1) are allowed.

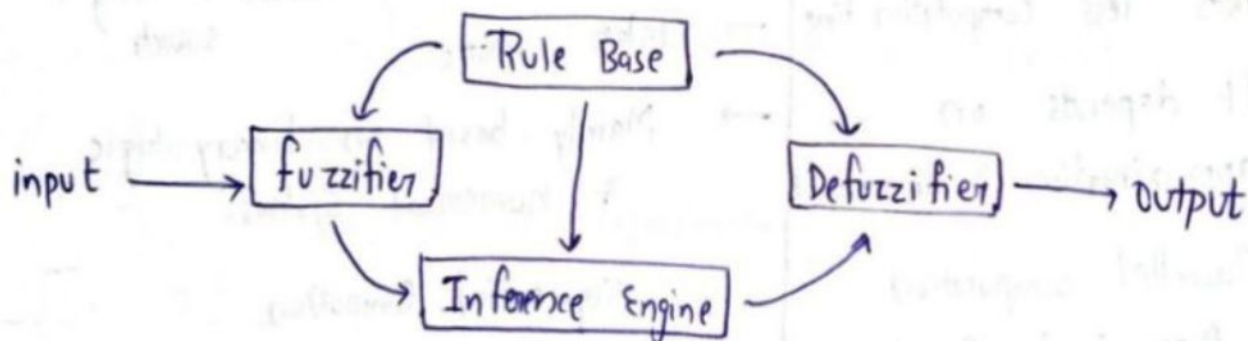
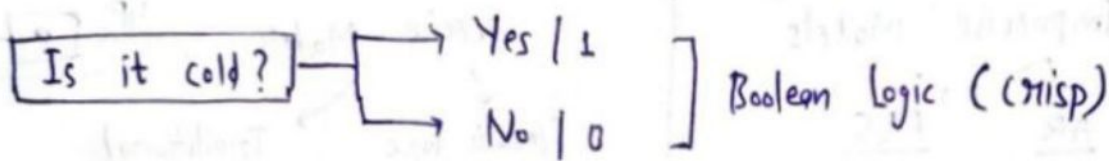
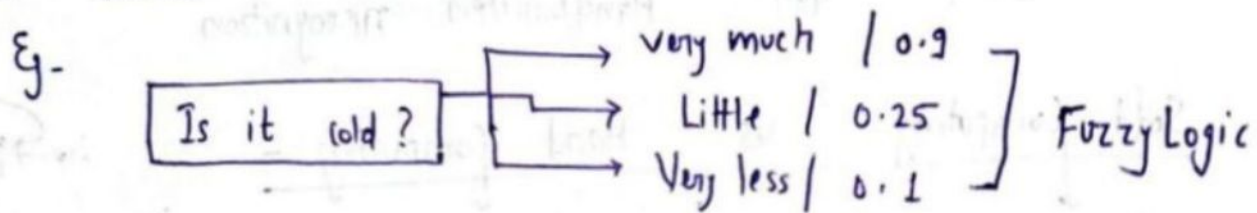


fig:- Fuzzy Logic Architecture

- The word "fuzzy" means vagueness. Fuzziness occurs when the boundary of a piece of information is not clear-cut.
- Fuzzy sets theory described with the aid of a membership function valued in the real unit interval [0, 1].

(iii) Complement :-

$$\mu_{\bar{R}}(x,y) = 1 - \mu_R(x,y)$$

(iv) Containment :-

$$R \subset S \Rightarrow (\mu_R(x,y) \leq \mu_S(x,y))$$

• Fuzzy Composition :-

$$A \times B = R, \quad R \subset A \times B$$

$$\mu_R(x,y) = \mu_{A \times B}(x,y) = \min(\mu_A(x), \mu_B(y))$$

2 types of fuzzy composition techniques \Rightarrow

(i) Fuzzy max-min composition :- *Ege Sahil ka Gyan*

$$R = X \times Y$$

$$S = Y \times Z$$

max-min composition of R & S denoted by $T(x,z)$ as

$$\mu_{R \circ S}(x,z) = \max(\min(\mu_R(x,y), \mu_S(y,z))) \quad \checkmark$$

(ii) Fuzzy max-product composition :-

$$\mu_T(x,z) = \mu_{R \cdot S}(x,z)$$

$$= \max(\mu_R(x,y) \cdot \mu_S(y,z))$$

Q** Let R, S be defined on sets $\{1, 3, 5\} \times \{1, 3, 5\}$ and

$$R = \{(x,y) \mid y = x+2\}$$

$$S = \{(x,y) \mid x < y\}$$

Ans - $X \times X = \{(1,1) (1,3) (1,5) (3,1) (3,3) (3,5) (5,1) (5,3) (5,5)\}$

$$R = \{(1,3), (3,5)\}$$

$$S = \{(1,2) (1,5) (2,3) (2,5)\}$$

Architecture of fuzzy Logic Control:-

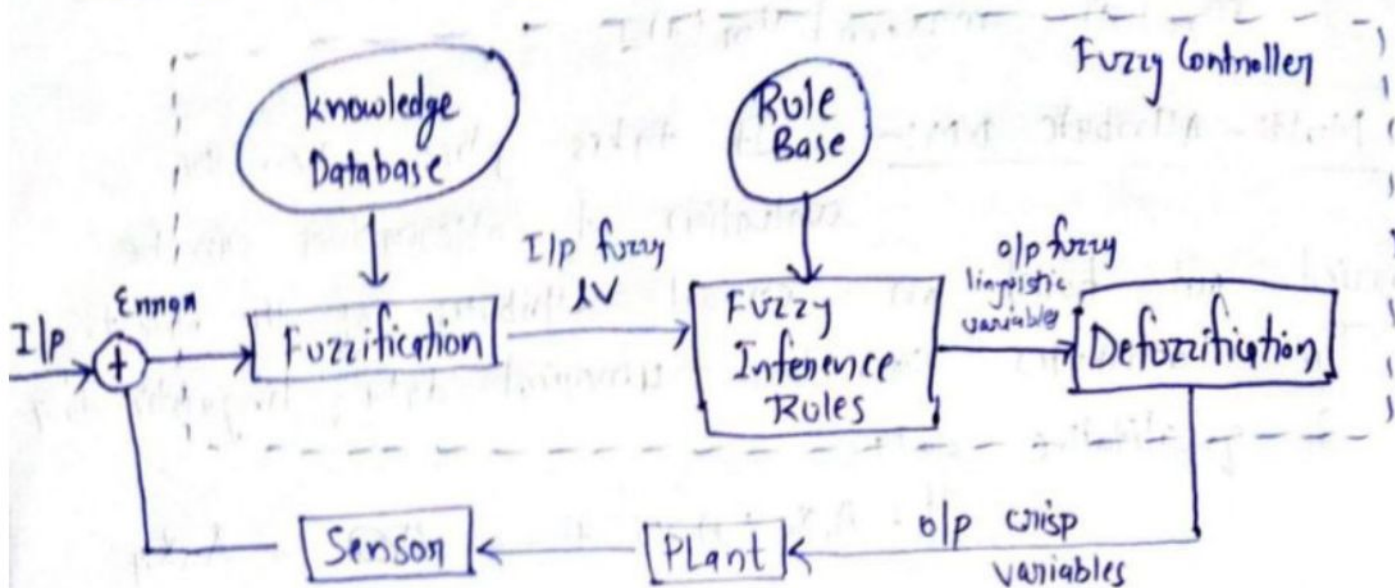


fig:- Architecture of FLC systems

Components of fuzzy logic control:

Ege Sahil Ka Gyan

Fuzzification:- It is to convert the crisp i/p values into fuzzy values.

Fuzzy Knowledge Base:- Normalization of parameters involved, partitioning of i/p & o/p spaces, selection of membership functions of a primary fuzzy set.

Fuzzy Rule Base:- selection of i/o variables;
types of fuzzy control rules;
completeness of fuzzy control rules;

Inference Engine:- It acts as kernel of any FLC. Basically it simulates human decisions by performing approximate reasoning.

Defuzzifier:- The role of defuzzifier is to convert the fuzzy values into crisp values getting from fuzzy inference engine.

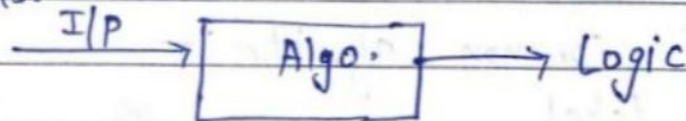
Machine learning is a subject of AI. The goal of ML generally is to understand the structure of data & fit that data into models that can be understood & utilized by people.

In traditional computing, algorithms are that of explicitly programmed instructions so used by computer to calculate or problem solve. ML algorithms instead allows for computer to trained on data inputs and used statistical analysis in order to output values that fall within specific

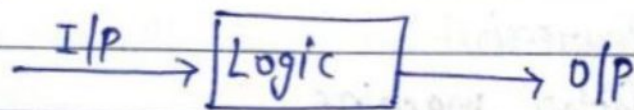
↳ range because of this

ML facilitates computers in building model from sample data in order to automate decision making process based on data input.

Training phase:-



Testing phase:-



Type of ML Algorithm: ⇒ There are variations of how to define ML algorithm but commonly they can be divided into categories according to their purpose & main category are following:-

1. Supervised
2. Unsupervised
3. Semi-supervised
4. Reinforcement

6-3439 0-1183

-03295

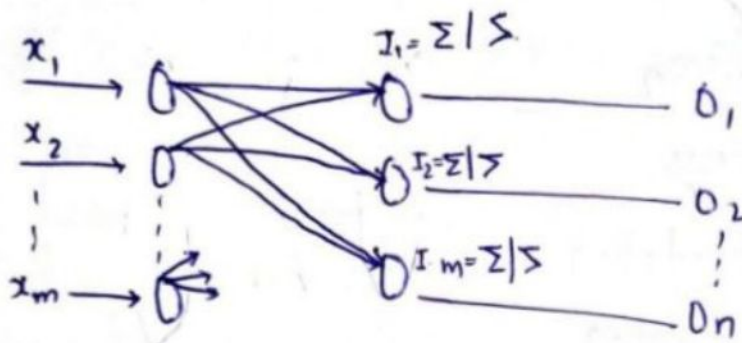
(i) SLFFN:- There is only one computational layer (of layers) so it is single layer FFN.

→ The input x_1, x_2, \dots, x_m are connected to layers of neurons through weight matrix

$$W = \begin{bmatrix} w_{11} & w_{12} & w_{13} & \dots & w_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ w_{m1} & w_{m2} & w_{m3} & \dots & w_{mn} \end{bmatrix}_{m \times n}$$

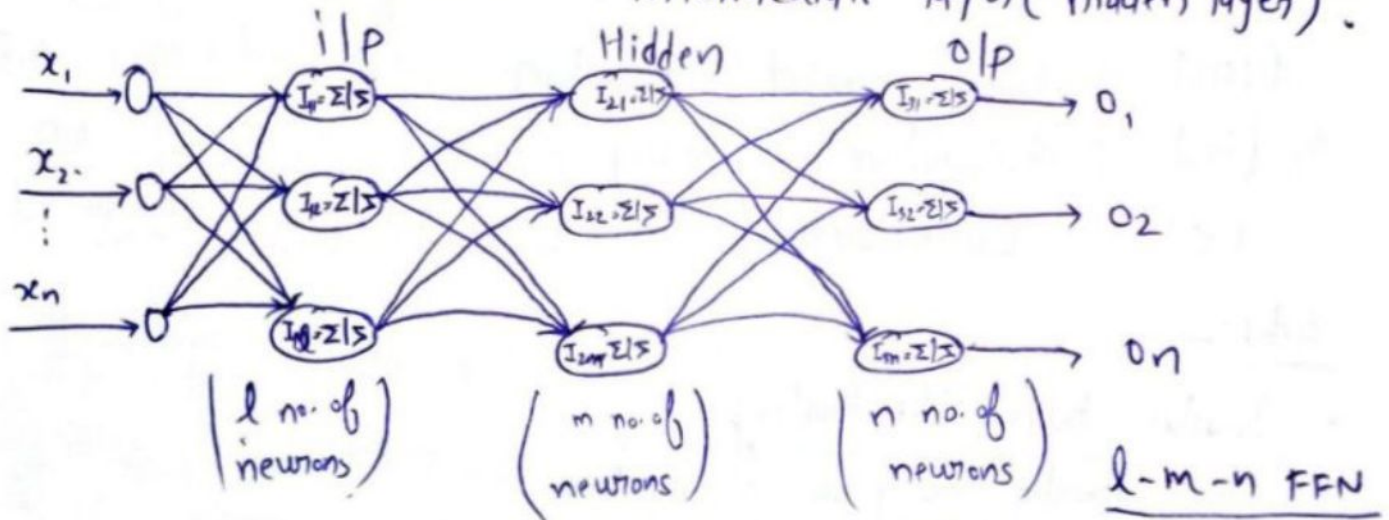
o/p of k^{th} neuron $O_k = f_k \left(\sum_{i=1}^m (w_{ik} \cdot x_i) + \theta_k \right)$

Threshold value



Ege Sahil ka Gyan

(ii) MLFFN:- There is an input layer, and one or more intermediate layers (hidden layers).



$$O_i^l = f_i^l \left(\sum x_j w^l + \theta_i^l \right)$$

(iii) RNN:- The network differs from feed back network architecture in the sense that there is at least one "feedback loop".

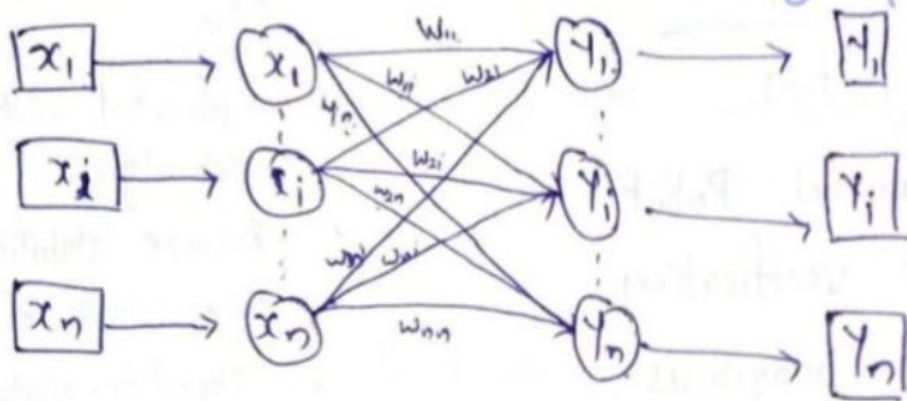
So there could exist one layer with feedback connection.

(1) Auto-Associate Memory: - This is a single layer neural n/w in which the i/p training vectors and the o/p target vectors are the same, the weights are determined so that the network stores a set of patterns.

→ It is capable of retrieving a piece of data upon presentation of only partial information from that place of data.

→ Neural n/w using autoassociative memory are called associative network.

Ege Sahil ka Gyan



weight matrix
calculation

$$W_{\text{new}} = W_{\text{old}} + x_i y_j$$

$$W_{\text{new}} = [s] [e]^T$$

Training Algorithm: -

S₁: - Initialize all weights to zero as

$$w_{ij} = 0, \quad i = 1 \text{ to } n, \quad j = 1 \text{ to } n$$

S₂: - Perform step-3&4 for each i/p vector

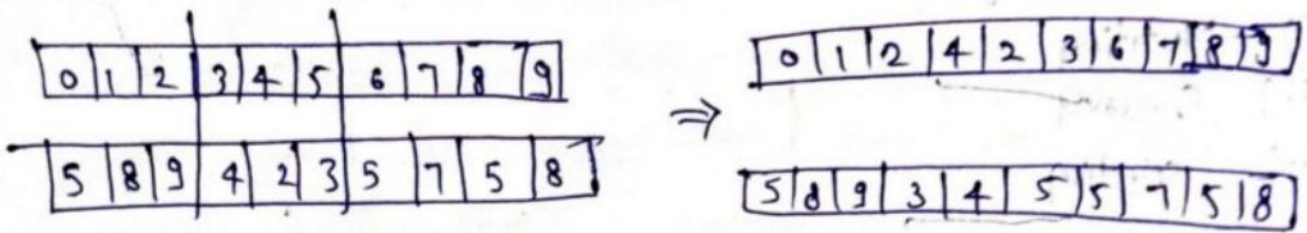
S₃: - Activate each i/p unit as follows $x_i = s_i$ ($i = 1 \text{ to } n$)

S₄: - Activate each o/p unit as follows $y_j = s_j$ ($j = 1 \text{ to } n$)

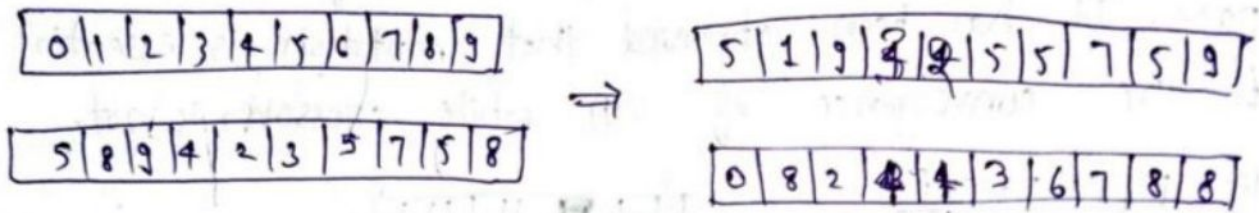
S₅: - Adjust the weights:

$$w_{ij}(\text{new}) = w_{ij}(\text{old}) + x_i y_j$$

Multi-point crossover :- It is a generalization of the one-point crossover where m alternating segments are swapped to get new off-springs.

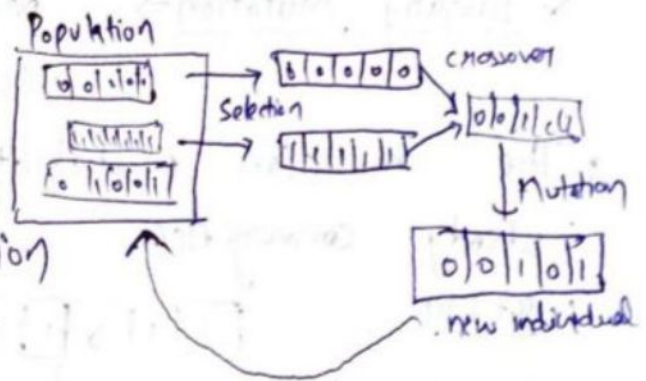


Uniform crossover :-



(iii) Selection :-

- Roulette-wheel selection
- Elitist selection
- Fitness-proportionate selection
- Stochastic selection
- Rank selection



Optimization of GA :-

Optimization is a process that find a best or optimal solⁿ for problem. It is centered around 3 factors.

- An objective function.
- A set of unknowns or variables.
- A set of constraints.

fuzzy, Neural Network

→ It is a learning machine that finds the parameters of a fuzzy system (sets, rules) by exploiting approximation techniques from neural networks

fuzzy sets / Logic

80% very cold
70% less
[0, 2]
0.5 0.6 0.7
0.8 60%

Er Sahil ka Gyan

→ Used for solving a problem (pattern recognition, regression or destiny estimation)

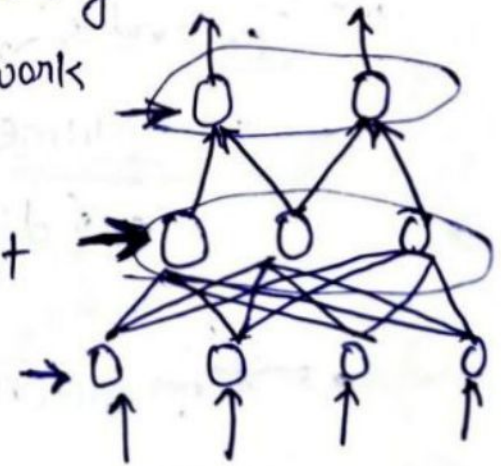
→ Neuro-fuzzy system based on underlying fuzzy system is trained by means of data-driven learning method derived from neural networks theory.

→ first layer corresponds to input variables

→ 2nd - fuzzy rules

→ 3rd → output variables

→ fuzzy sets are converted as connected weights.



Architecture of NFS

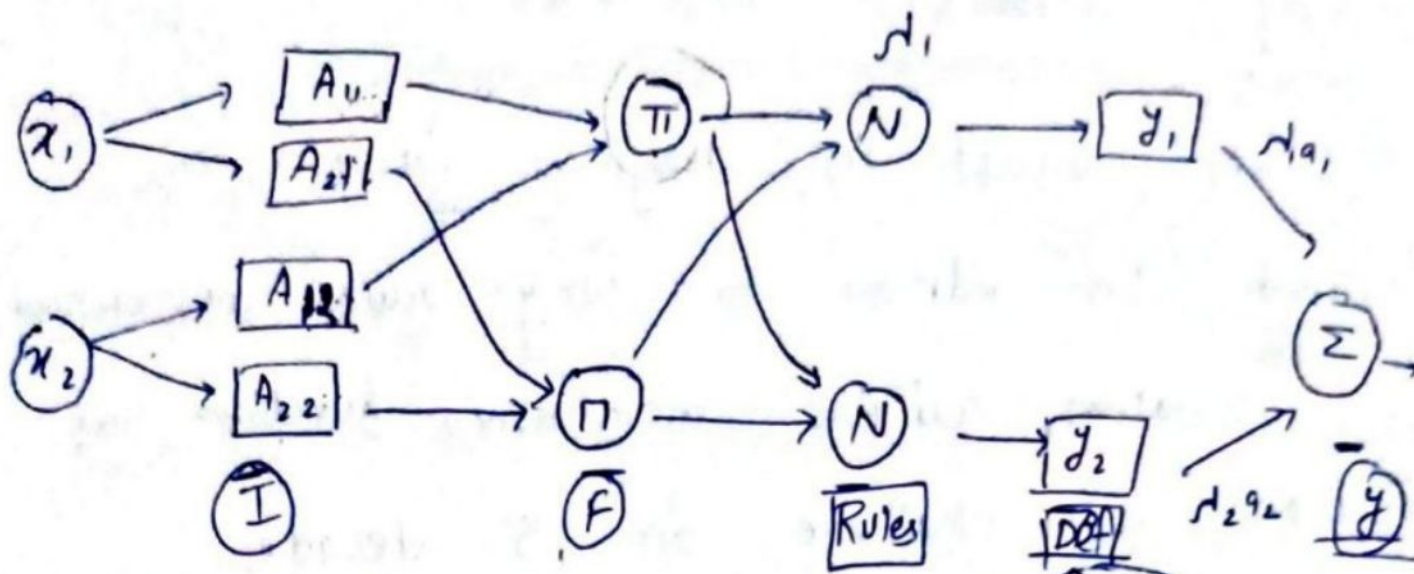
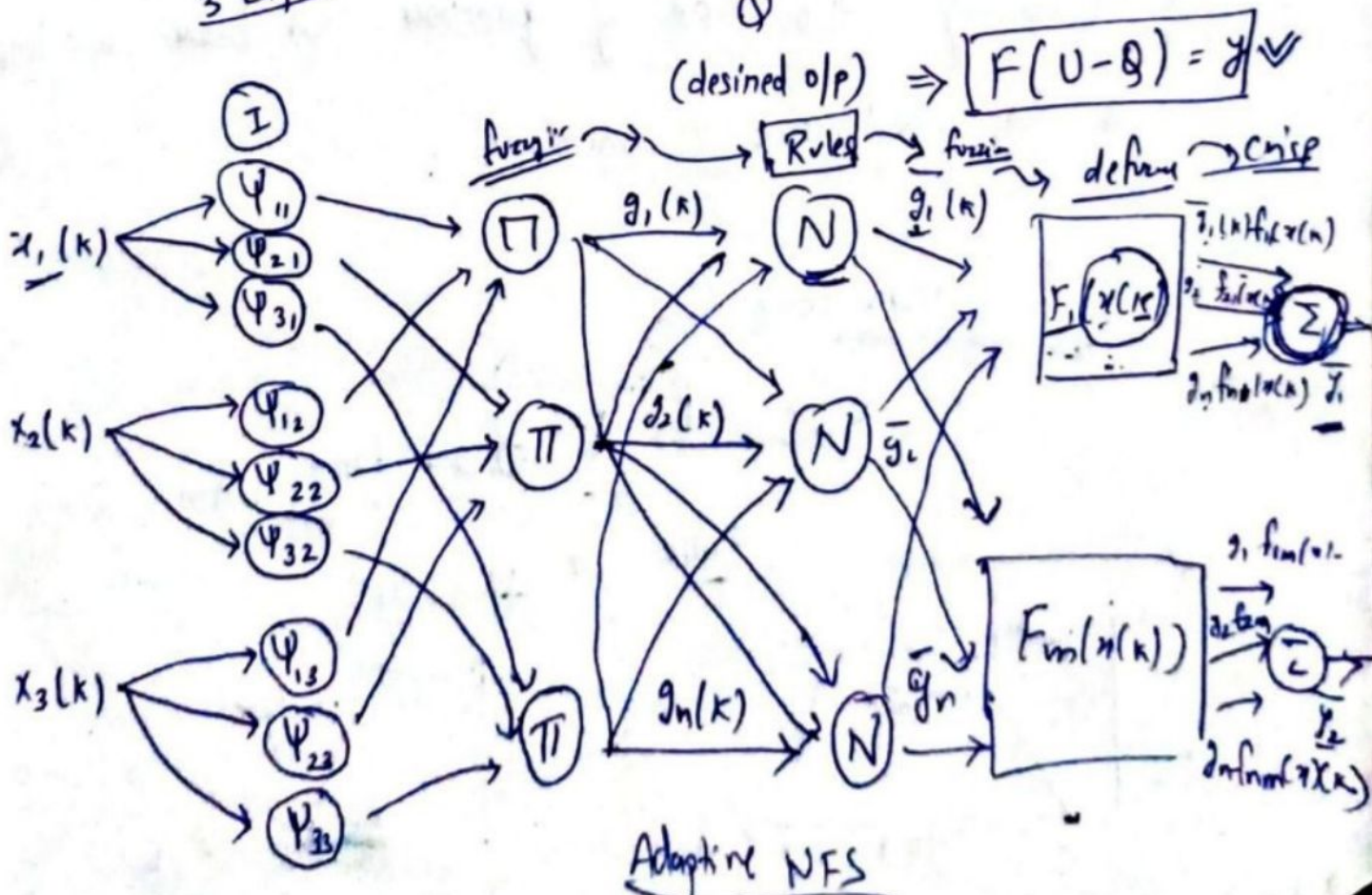
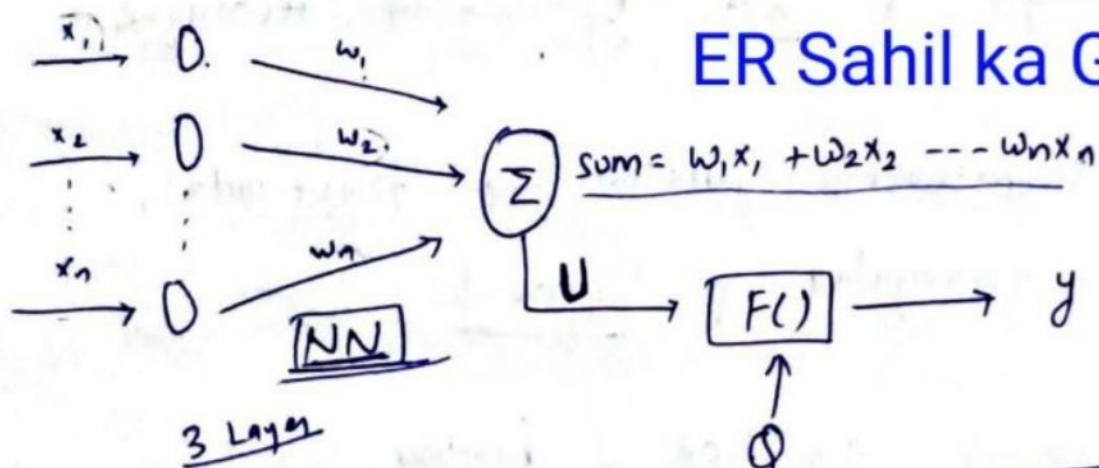


Fig: - Architecture of Neural Network (5-Layers) 3 Layers

ER Sahil ka Gyan



- You must first write an M-file that computes function you want to optimize

~~ER~~ ER Sahil ka Gyan

1. Install DS toolBox
2. Define fitness function
3. Configure Genetic Algorithm
4. Run Genetic Algorithm (using 'ga' fⁿ)
5. Access the Best Solution
6. Post-Processing & Analysis.

Thank you for being through this 🙏

⇒ Using fuzzy Logic ToolBox

1. Define fuzzy Inference System (FIS)
[use 'newfis' fⁿ]
2. Define fuzzy sets & membership fⁿ
[use 'addvar' & 'addmf' fⁿ]
3. Define Fuzzy Rules
4. Set Input Values & Perform fuzzy Inference
5. Defuzzify Output
6. Analyze & Validate Results

Purchase the Notes

100₹

**Per semester
(All subjects)**

Notes (Hand written) ✓
Most Questions ✓

All Branches

**Min 100%
amount will go
into charity ✨**

**For specific
Subject - 50₹**

**UPI ID -
sahilkagyan337@ybl**

Er Sahil ka Gyan



Steps for getting NOTES and Most Questions -

👉 Do payment using UPI ID -

sahilkagyan337@ybl

👉 Take screenshot of transaction
and send me on Email -

ersahildrive@gmail.com

Then finally access all Notes and
most questions 🔥

Scan & Pay Using PhonePe App



SAHIL KHAN