

Unit-5

Hybrid Systems

- NeuroFuzzy Systems
- Adaptive Neuro-Fuzzy inference System
- Fuzzy Back propagation Network
- Genetic-Neuro Hybrid System
- Genetic Algorithm based Back propagation network
- Genetic Fuzzy Hybrid System.

Hybrid Systems

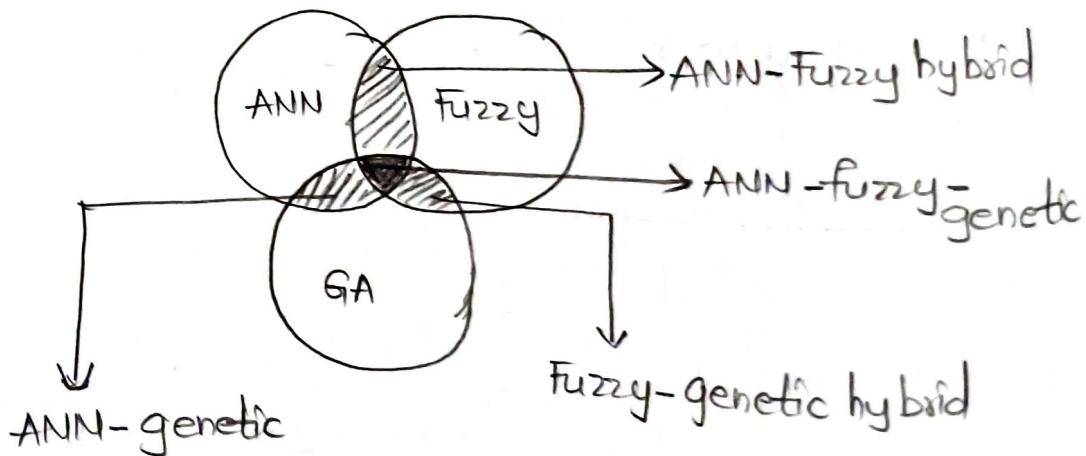
A Hybrid system is one which is the integration of (or) combination of various soft computing techniques (or) Artificial Intelligent techniques.

These hybrid systems are used to solve different complex real world problems where as individual soft computing techniques may not solve,

Different soft computing techniques are:

- 1) Artificial Neural Network
- 2) Fuzzy logic Controller
- 3) Genetic Algorithms

The following is the Venn Diagram which represents the various hybrid soft computing models.



The following are the different hybrid models

- 1) Neuro-Fuzzy hybrid model.
- 2) Fuzzy-Genetic hybrid model.
- 3) Genetic-Neural Network hybrid model.
- 4) ANN-Fuzzy-Genetic hybrid model.

1. Neuro-Fuzzy hybrid model

Neuro-fuzzy hybrid model is popular model for solving complex problems like face recognition, pattern recognition etc.

This method is the integration (or) combination of the artificial neural networks and fuzzy logic.

Artificial Neural network:

The concept of ANN given in 1st unit.

Fuzzy logic Controller:

The concept need to write from 1st unit-1.

The block diagram of the neuro-fuzzy hybrid model is as given in the below figure:

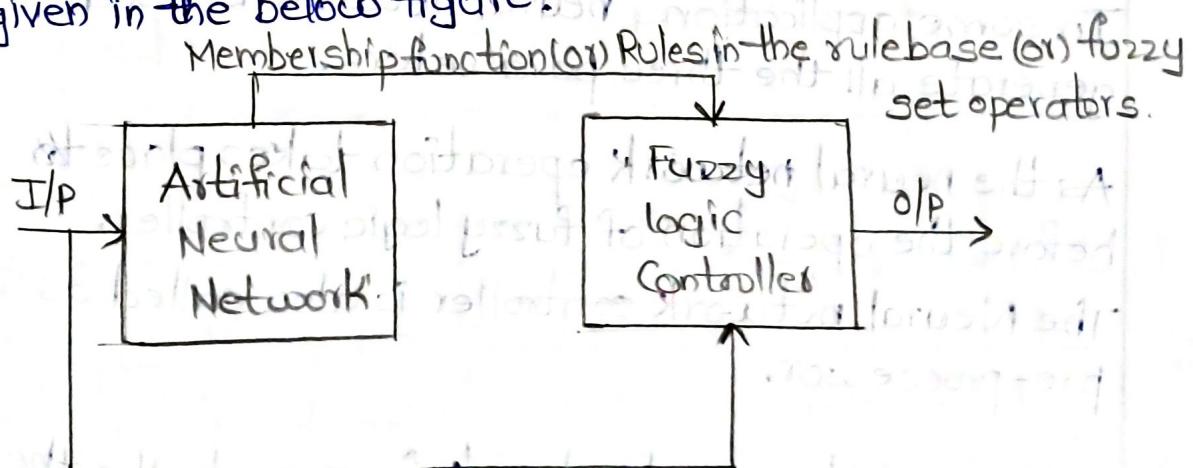


fig: Neuro-fuzzy hybrid System

*** The advantages of Neural Network is adaptive to changing environments once the neural network is trained if any input parameters change in the environment instantly the output can be generated in neural network.

The main advantages of fuzzy logic controller is it can deal with uncertain (or) vague (or) incomplete data.

In a neuro-hybrid model the advantages of both the controllers can be achieved.

There are several neuro-fuzzy hybrid models are given below

- 1) Co-operative neuro-fuzzy controller
- 2) Concurrent neuro-fuzzy controller
- 3) Fused neuro-fuzzy controller.

In Cooperative neuro-fuzzy System, the neural networks are used to find the fuzzy membership functions are rules in the rulebase are to perform some 'fuzzy' set operations.

In some applications neural network is used to generate all the three parameters.

As the neural network operation takes place before the operation of fuzzy logic controller.

The Neural network controller is also called as pre-processor.

In Concurrent neural network fuzzy controller the neural network is used to assist the parameters of fuzzy logic controller.

For example it is used to convert the fuzzy membership functions at the output of fuzzy logic

controllers into crisp value means it is performing defuzzification action.

In this model, the operation of neural networks comes after operation of fuzzy logic controller. so it is called as post-processor.

In fused neuro-fuzzy system the neural network is fused into the fuzzy logic controller. The neural network used to find the parameters of fuzzy inference system. (Mamadani FIS, Sugeno FIS).

2. Adaptive Neuro-Fuzzy Inference System (ANFIS)

It is the integration of ANN and Fuzzy logic used to either generate membership functions (or) rule base based on the given application.

Artificial Neural Network:

Fuzzy logic:

ANFIS is a fuzzy system which will make use of trained neural network using an algorithm to produce membership function (or) fuzzy logic controller.

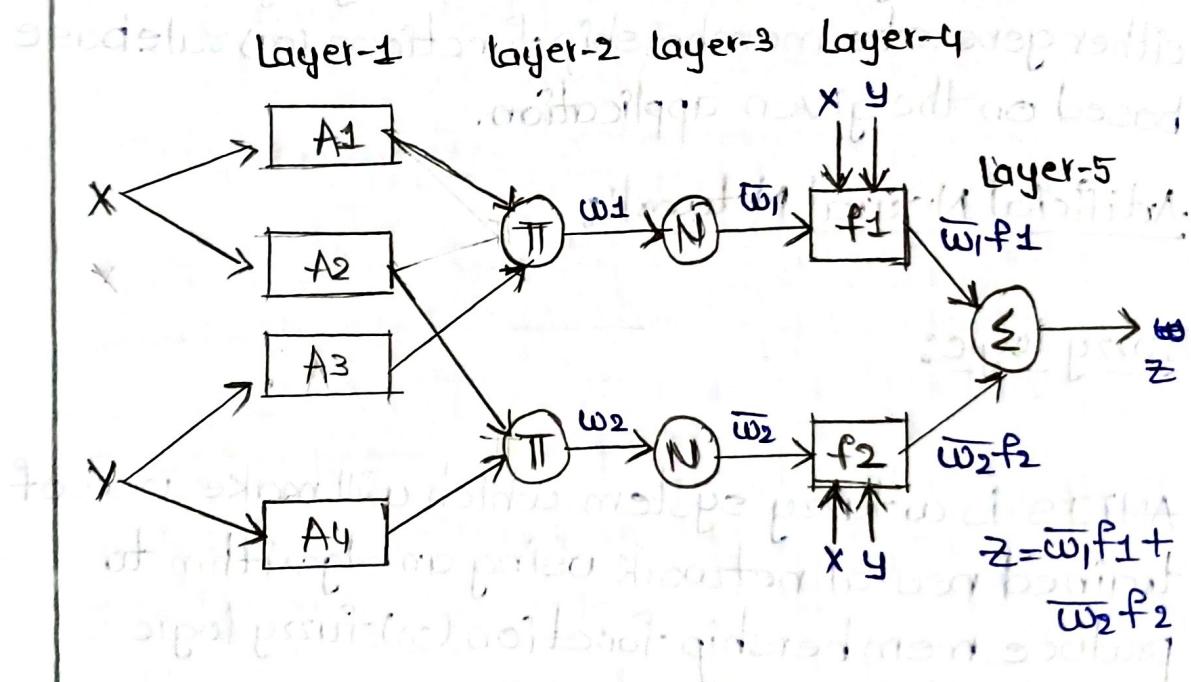
The ANFIS will get both the advantages of ANN and (adaptability to real world time environment, learning capability) and fuzzy logic controller (deal with uncertain data, excellent knowledge representation & inferencing).

There are five main processing stages in ANFIS operation.

- 1) Fuzzification
- 2) Applications of fuzzy operation.
- 3) Application method.
- 4) Fuzzy output Aggregation.
- 5) Defuzzification.

ANFIS utilizes ANN to find the effective (or) optimum membership functions and the fuzzy controller to represent the knowledge in an effective way and for better inferencing.

ANFIS is a multilayer feed forward network having five different layers as given below.



In the above ANFIS network the inputs are x and y , which are crisp values. The output is membership function which is represented with Σ .

* Layer-1 receives crisp information and converting into membership functions as it is performing defuzzification action. This layer is also called as defuzzification layer.

At the second layer multiplication of membership functions which are coming from layer 1 takes place to increase the firing strength.

The layers 3 is used to normalize the signal between certain limits based on the problem and the layer 4 is used to transfer the signal to the consequent layers.

At layer 5 summation of the signals takes place and you will have outputs in the form of membership functions.

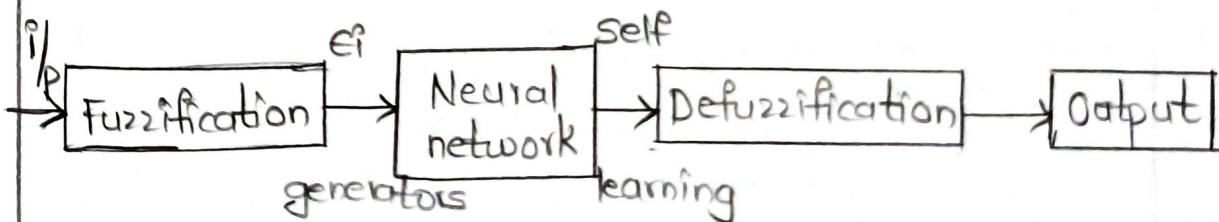
3. Fuzzy Back propagation Hybrid System

It is the combination of fuzzy logic controller and Back propagation algorithm.

Fuzzy logic Controller:

Back propagation algorithm:

The block diagram of the fuzzy Back propagation hybrid system is as given below.



In the above block diagram, fuzzification module will convert crisp values into fuzzy membership values. The fuzzy membership values are given as input to the artificial neural network module.

The neural network acts as a fuzzy inference system in this hybrid model, it applies rules on the input membership function and produces the output.

The output of the neural network is again member ship function. To convert these membership functions again into the crisp value defuzzification module will be used.

4. Genetic-Neuro Hybrid model

In this hybrid model, Genetic algorithm is integrated with ANN to solve the complex real world problems.

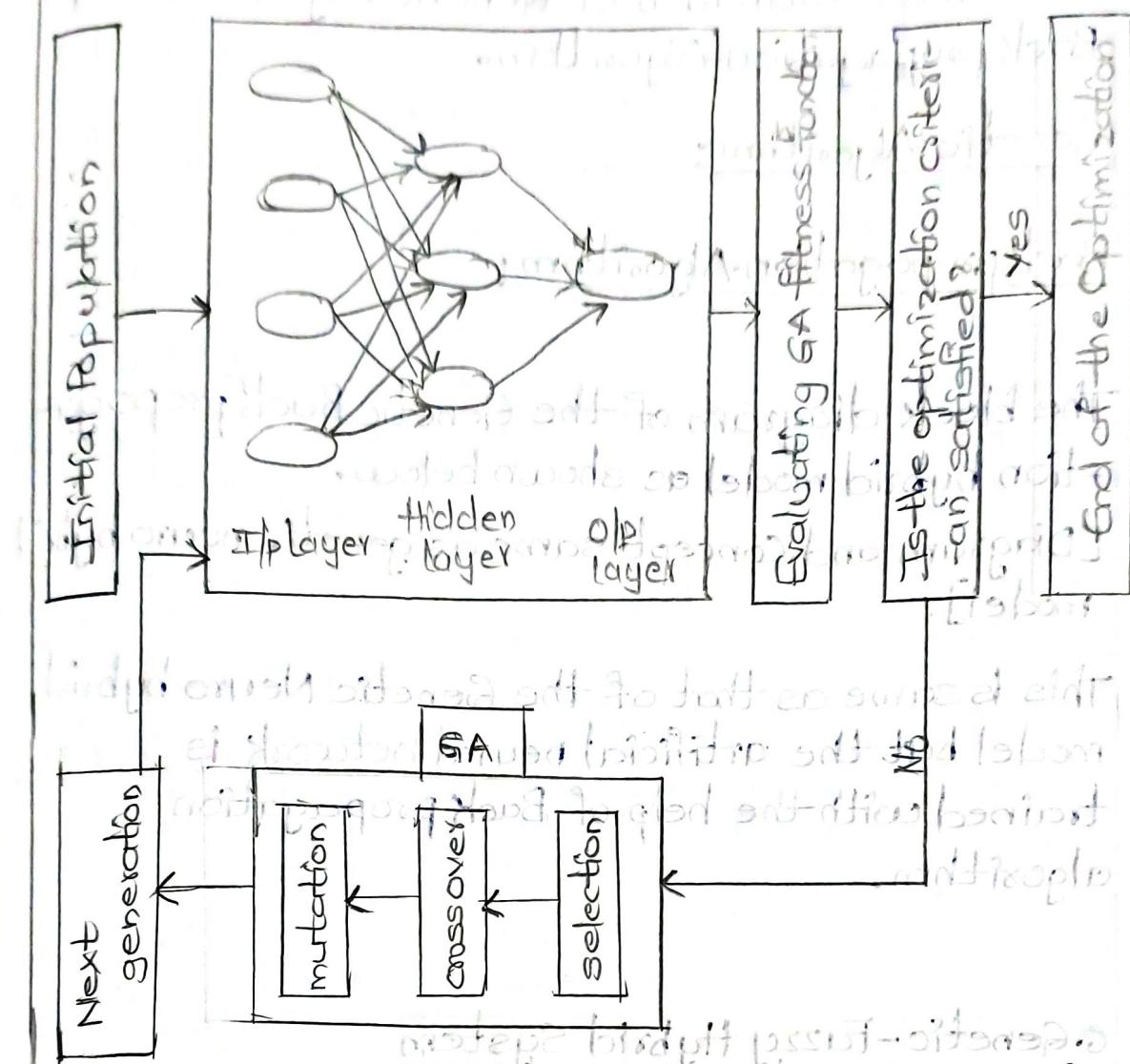
Genetic Algorithm:

Artificial Neural Network:

The block diagram of the Genetic-neuro hybrid model is as given below.



The solution is difficult to implement as it involves a set of rules and a genetic algorithm which needs to handle a large number of parameters at a time.



The Genetic Neuro hybrid model is used the genetic algorithm to find the best weights of the neural network.

Initially weights will be randomly generated and the output of the neural network is calculated.

The output is compared with target value and the error is determined. If the error is high, the genetic algorithm again find out the weights using selection, crossover and mutation steps.

The process will be continued in a iterated manner until the error reached to below a tolerance value 0.001.

5. Genetic Backpropagation hybrid model

It is the combination of Genetic Algorithm and Back propagation Algorithm.

Genetic Algorithm:

Back propagation Algorithm:

The block diagram of the Genetic Back propagation hybrid model as shown below.
[Diagram and concept same as genetic neuro hybrid model].

This is same as that of the Genetic Neuro hybrid model but the artificial neural network is trained with the help of Back propagation algorithm.

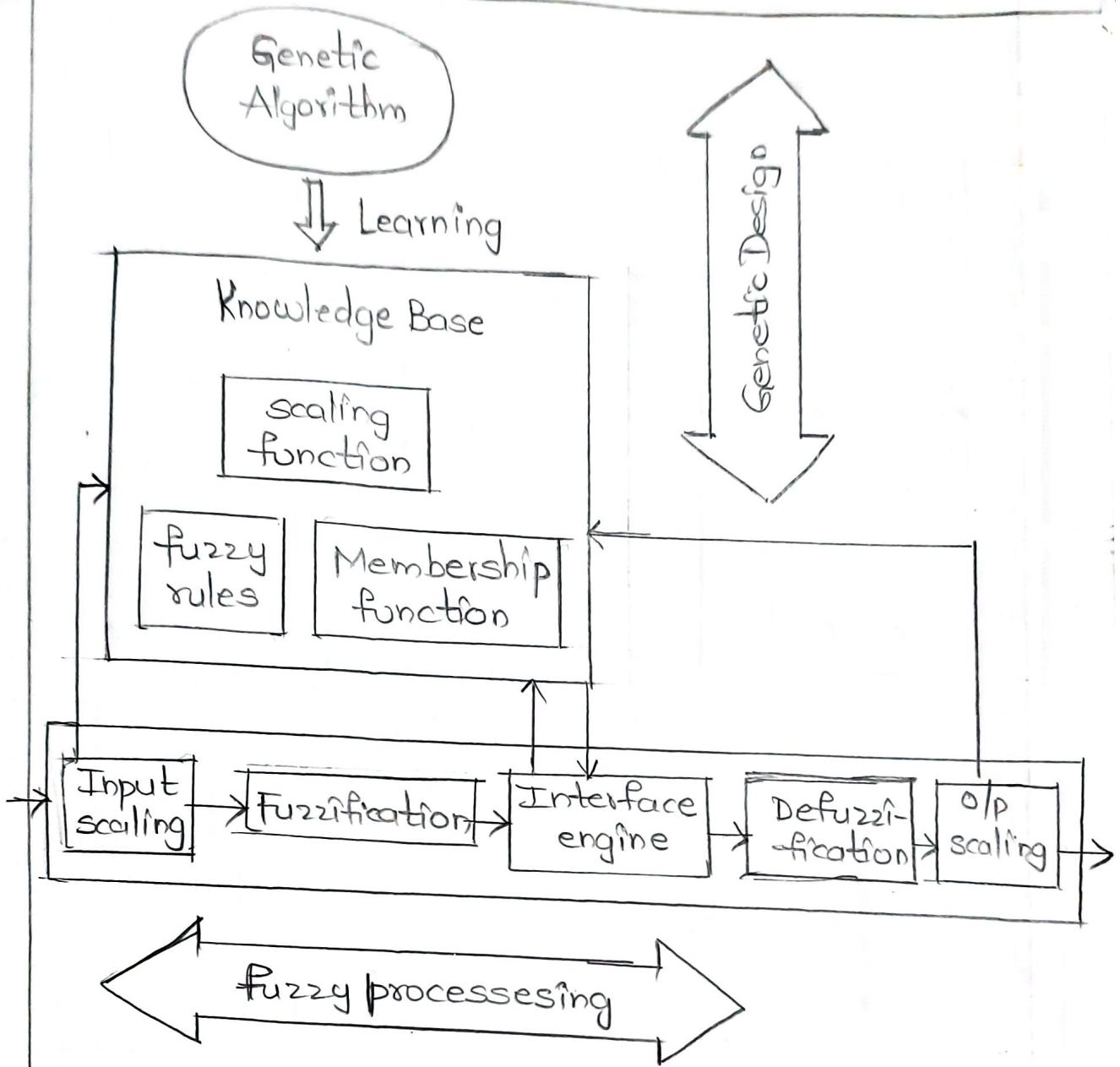
6. Genetic-Fuzzy hybrid System

The Genetic Fuzzy Hybrid system is the combination of genetic algorithm and fuzzy logic controller.

Genetic Algorithms:

Fuzzy logic Controller:

The block diagram of the genetic fuzzy hybrid system is as shown in the below figure.



A genetic-fuzzy hybrid system is a fuzzy system which takes the help of genetic algorithm to find different parameters.

The genetic algorithm will provide scaling function, fuzzy rules and membership function to the fuzzy logic controller.

The fuzzy logic controller will perform fuzzification, fuzzy inferencing, Defuzzification tasks to provide the outputs.

The effective operation of fuzzy logic controller is pure depends upon effective operation of Genetic algorithm.