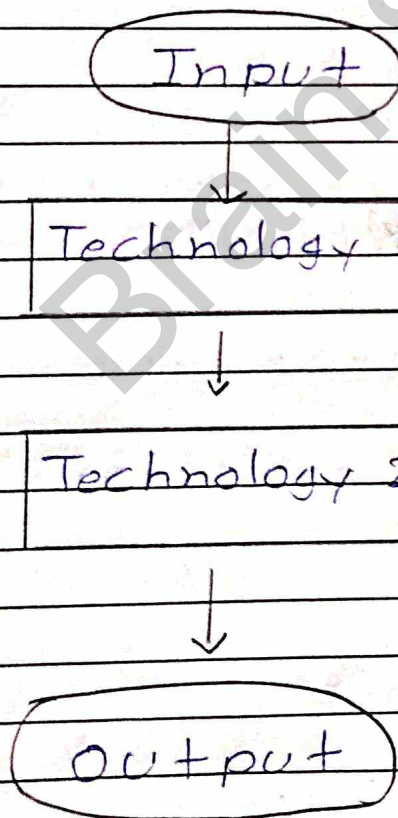


Hybrid Systems

* Explain Sequential Hybrid Systems.

⇒ Sequential Hybrid System is works likes pipe-like flow structure.

This Hybrid System is the weakest Hybrid system compare to other system.



The sequential Hybrid system is a straightforward structure.

In this system, One Technology output becomes another's Technology input.

=> Advantages:

- 1 The sequential approach allows systematic approach for different methods.
- 2 In this system, we can get step-by-step response.

=> Disadvantages:

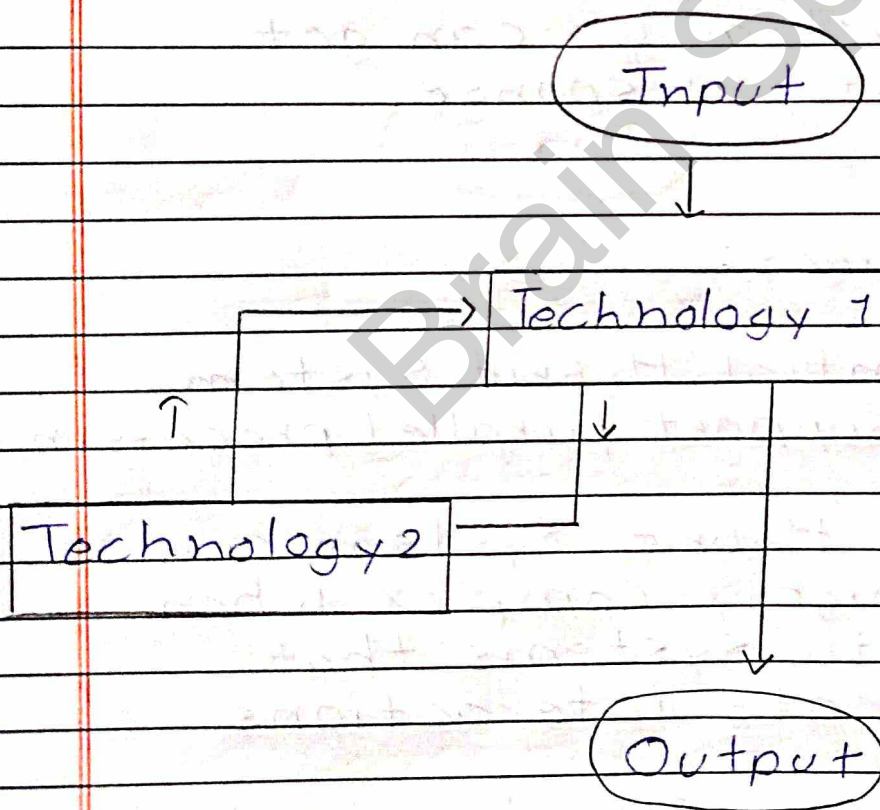
- 1 The Sequential Hybrid System does not support parallel processing.
- 2 Sequential Hybrid System can become highly complex when dealing with systems that have intricate interactions.
- 3 Implementing SHS-based solutions in real-world applications can be complex.

* Explain Auxiliary Hybrid System.

⇒ In this system, a particular technology includes the other technology as subroutine.

One Technology includes other technology as a subroutine.

The second technology processes the information which is provided by the first technology.



This system offer flexibility in modeling system with which allows smooth transitions.

The Auxiliary Hybrid System support real-time adaptation and decision-making.

=> Advantages:

- 1 This System allows for a holistic representation of system behaviors and interactions.
- 2 AHS allows for hybrid optimization method that optimize system performance.

=> Disadvantages:

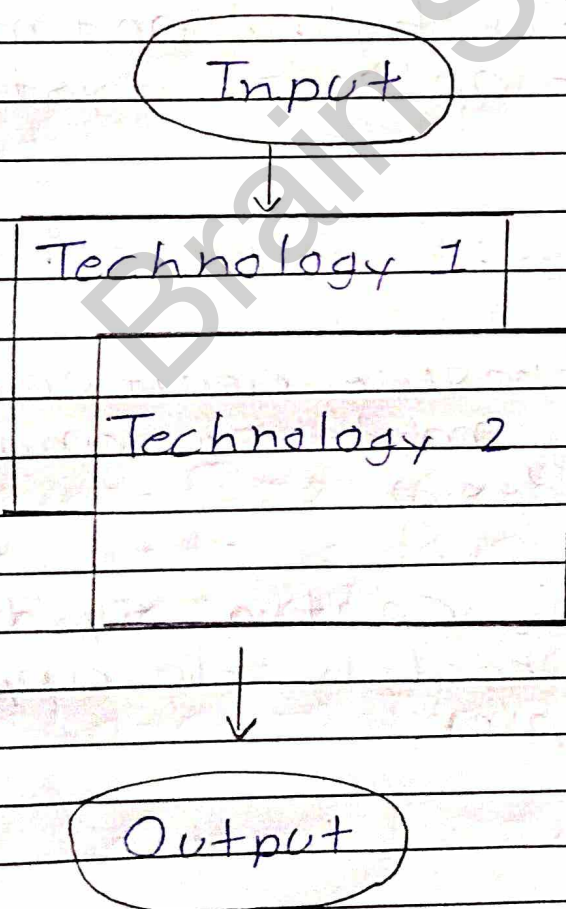
- 1 AHS can introduce additional complexity in modeling, analysis and control design.
- 2 Implementing control system for AHS in real-world application can be complex.

* Explain Embedded Hybrid System.

⇒ In Embedded Hybrid System, the technologies participating are integrated in such manner that they appear intertwined.

One Technology is integrated with other technology in EHS.

This systems are commonly found in applications such as Automotive System.



In this type of system no technology can be used without the involvement of other Hybrid technologies.

In this system, Different technology can be work together in one system.

⇒ Advantages :

1 All the types of technologies can be work together for get powerful solution.

2 This system can adjust different types of problem very easily with using different methods.

⇒ Disadvantages :

1 This system can mixed different technologies, So this system can be complex.

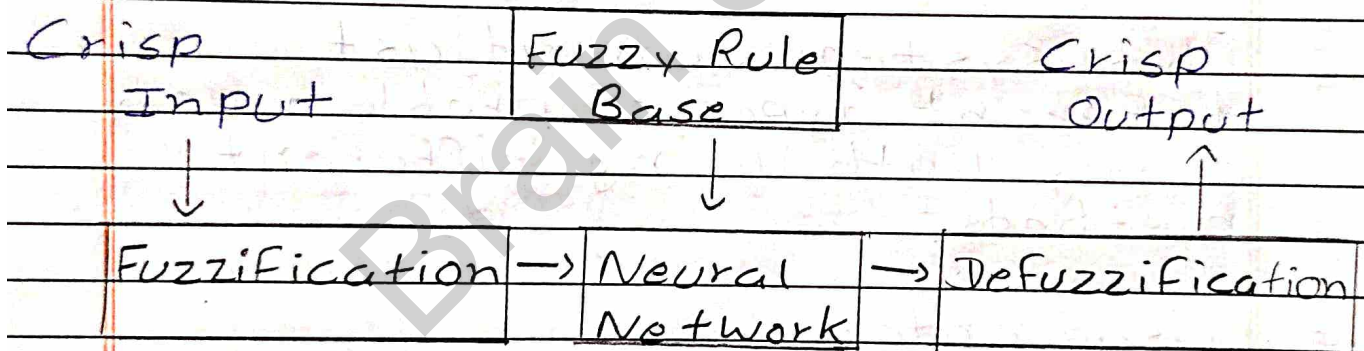
2 Sometimes all the mixed method can create different problem.

* Explain Neuro-Fuzzy Hybrid System

=> Neural Network and Fuzzy Logic represent two distinct methods to deal with complex problem.

A Neuro-Fuzzy Hybrid system is combination of Neural Network and Fuzzy Logic.

Neural Network is used to model complex nonlinear relationships and Fuzzy Logic system handles imprecision of input and output.



A Neuro-Fuzzy System can be divided into 3-layer feedforward neural network.

First Layer → Input Variables

Middle Layer → Fuzzy Rules

Third Layer → Output Variables

Input Layer transmits crisp input in the Fuzzification and Find out the input data Fuzzy set.

Fuzzy rule layer receives neurons that represent Fuzzy sets.

An Output neuron combines all inputs using Fuzzy operation.

=> Advantages:

- 1 FGHs can handles Uncertainty and imprecision data
- 2 FGHs can capture nonlinear mapping between input and output variables.
- 3 In FGHs, Fuzzy rules offers human-readable explanations of the system's behavior.

=> Disadvantages:

- 1 FGHs can be complex to design and implement due to Neural Network and Fuzzy Logic

2 Training and optimizing FGHS models can be computationally expensive.

3 FGHS may require a significant amount of data for training and optimization.

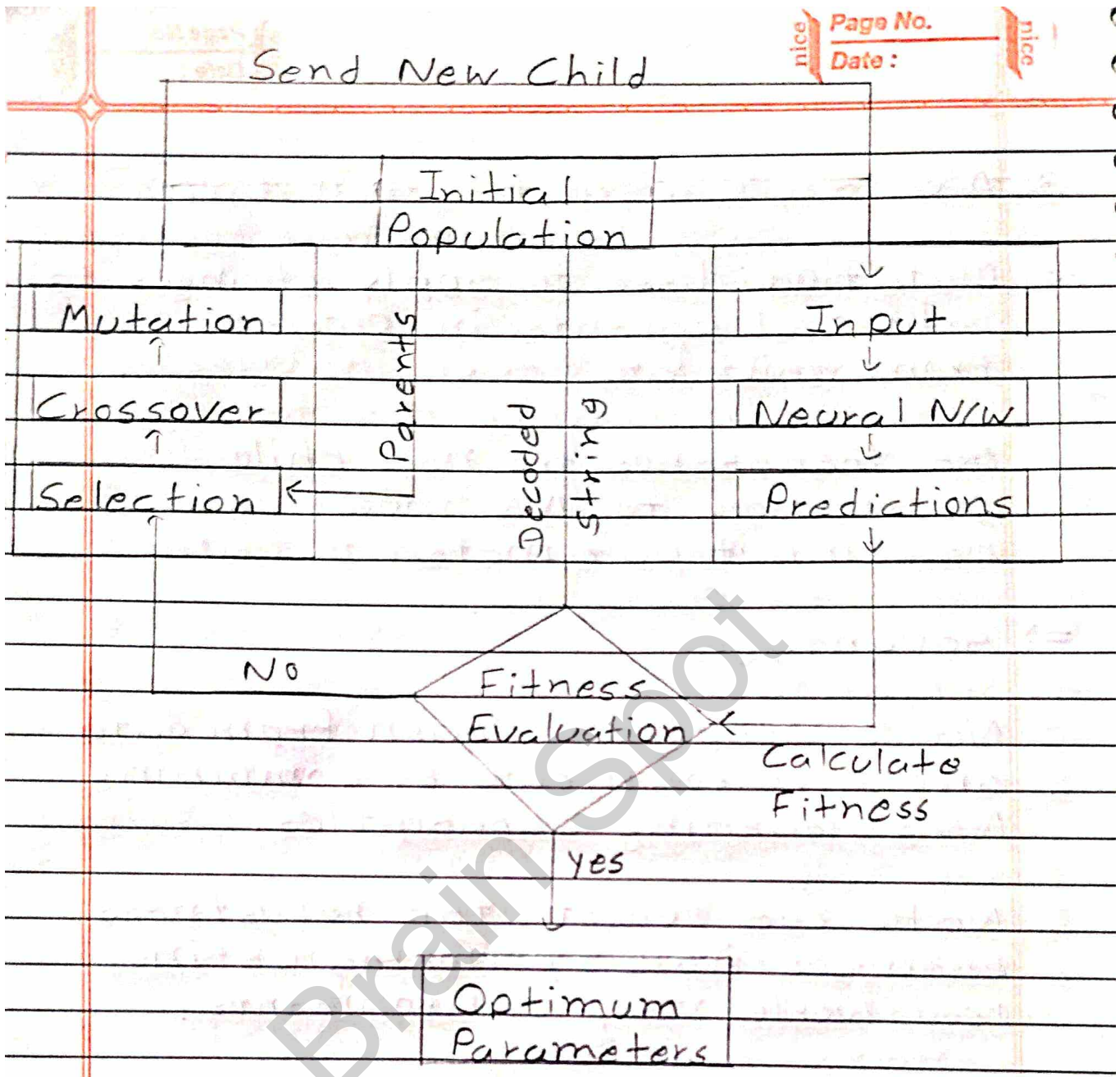
* Explain Neuro - Genetic Hybrid System.

=> Neuro - Genetic Hybrid is combination of Neural Network with Genetic Algorithms.

This hybrid approach combines Neural Network's ability to model complex relationships and Genetic Algorithm provides global search and optimization capabilities.

In this system, GA repeatedly modifies a population of every solution.

GA uses three types of step to create next generation from the current generation.



- 1 Selection: Used to select the individuals called parents that contribute to the population at the next generation
- 2 Crossover: Used to combine two parents to form children for the next generation

3- NN

3 Mutation: Used to apply changes to individual parents in order to form children.

GA then sends the new child generation to NN model as a new input parameter.

=> Advantages:

1 NGHS adaptively learn from data and environments by combining NN's learning capabilities.

2 NGHS are robust, this robustness enhances NGHS's performance in real-world noisy environments.

=> Disadvantages:

1 NGHS can be complex to design and implement due to the NN and GA.

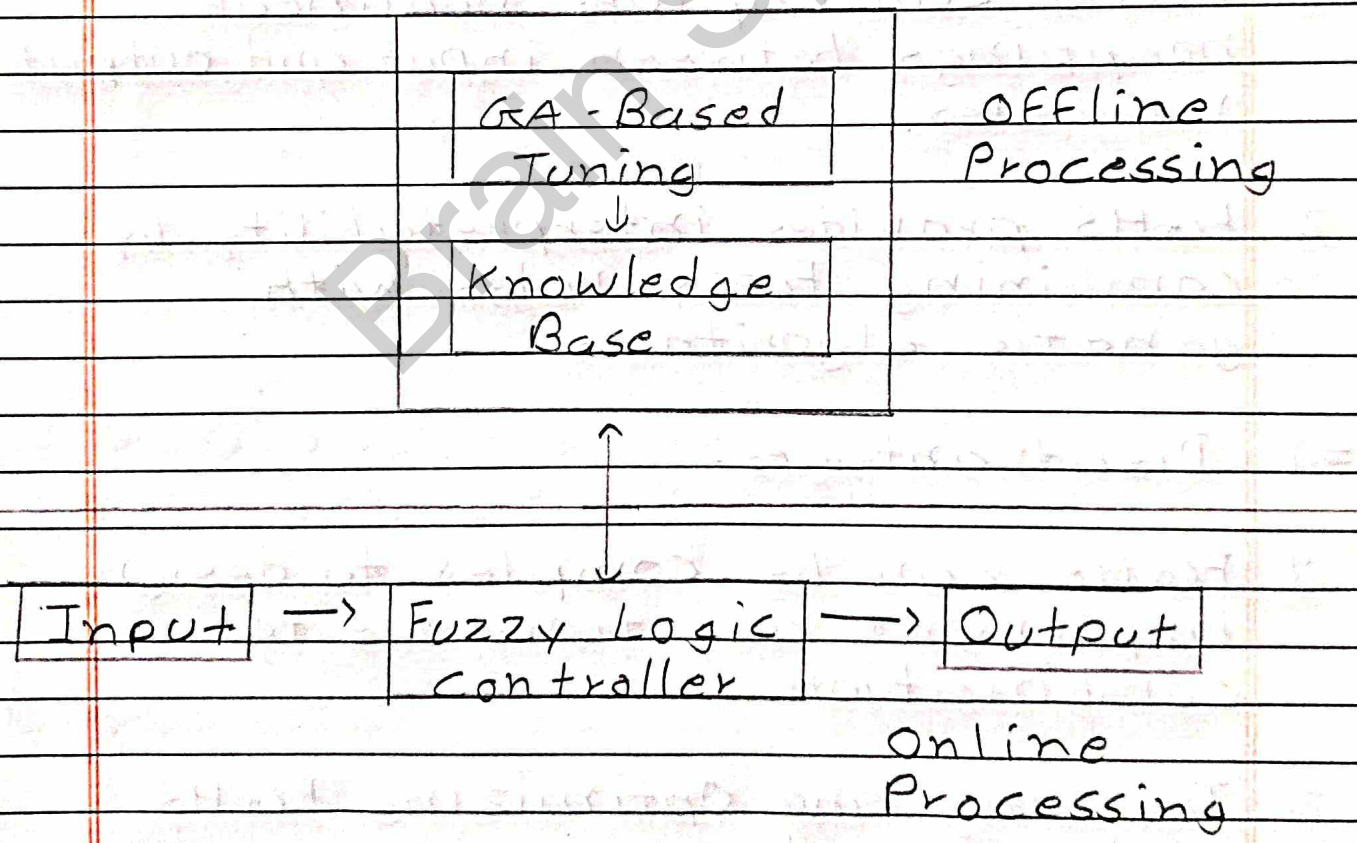
2 Training NGHS models can be expensive and required large dataset.

* Explain Fuzzy Genetic Hybrid System

=> Fuzzy Genetic Hybrid System is combination of Fuzzy Logic-based system and Genetic Algorithm

Fuzzy Logic-based system provides the membership function to define the Fuzzy system.

Genetic Algorithm provides capable of handle complexity and uncertainty in environments.



This system start with initial population of solution that represent the first generation.

After that feed each individuals from the population into the Fuzzy logic controller.

Create a new generation using evolution operators.

=> Advantages:

- 1 FGHS can capture nonlinear mappings between input and output variables.
- 2 FGHS provides interpretability by combining Fuzzy rules with genetic algorithms.

=> Disadvantages:

- 1 FGHS can be complex to design, implement and tune due to combination.
- 2 Training and optimizing FGHS models can be expensive.