

The impact of Neural Network and Fuzzy Logic

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ABSTRACT

The neural network and fuzzy logic together provides strength to mathematical to capture the uncertainties which is associated with human cognitive process like thinking and reasoning. And with combination of the hybrid intelligent system to the fuzzy logic and neural network provides the effectiveness and solutions to the problems related to real world. In this paper, we will highlight about neural network and fuzzy system in details and there types, also look after its applications , advantages and disadvantages. Generically, when they are used in a combined manner, they are called Neuro-Fuzzy Systems. The main goals of this article is to explain the basic characteristics of fuzzy logic, neural networks, neuro-fuzzy systems and their different kinds; advantages, disadvantages and their applications

KEY-WORDS: *Neuro-fuzzy System, Fuzzy logic, Neural network, Cooperative Neuro-fuzzy System, Hybrid Neuro-fuzzy System, Concurrent Neuro-fuzzy System.*

1. INTRODUCTION

2. NEURAL NETWORK :

A neural network is a kind of network which learn from the human intelligence through combination set of data through a process that mimics the way the human brain operates. Thus, neural network refers to the neurons system in both biological and artificial way in nature.

As the biological neural network is made of a chemically connected group or of functionally associated neurons. We can get a extensive network with the connection in single neuron and other neurons same is with the neural network in computer system.

Artificial neural networks is a networks of mutually dependent natural or artificial neuron group that are used to solve mathematical or computational problems using the given information and it is much faster than many other techniques of computer science.

Neural network has ability to learn from computer program and it is based on human intelligence to learn from it. Neurons are there to connected and allow to send messages to everyone to solve the problem which attempts to do again and again every time by strengthening connections to bring the success and decline the failure attempts. There are output, input and hidden layers. The layers are made up of *nodes*. In the place of computation nodes are there to depend the patterned on a neuron in the human brain, which fires when it encounters sufficient stimuli. A nodes merge input to have the set of coefficients and increase that input by giving the importance to algorithm in relation to the task to learn.

Thus, these input weight products are added to pass through nodes which is called activation function afterwards to determine the extent to get signal progress to affect the final results to act as classification and if the signal passes successfully the neuron will be activated [1-10]. A neural network further classified in two steps:

- **Feedforward:** On a feedforward neural network, we have a set of input features and some random weights.
- **Backpropagation:** During backpropagation, we calculate the error between predicted output and target output and then use an algorithm (gradient descent) to update the weight values.

3. APPLICATIONS OF ARTIFICIAL NEURAL NETWORKS:

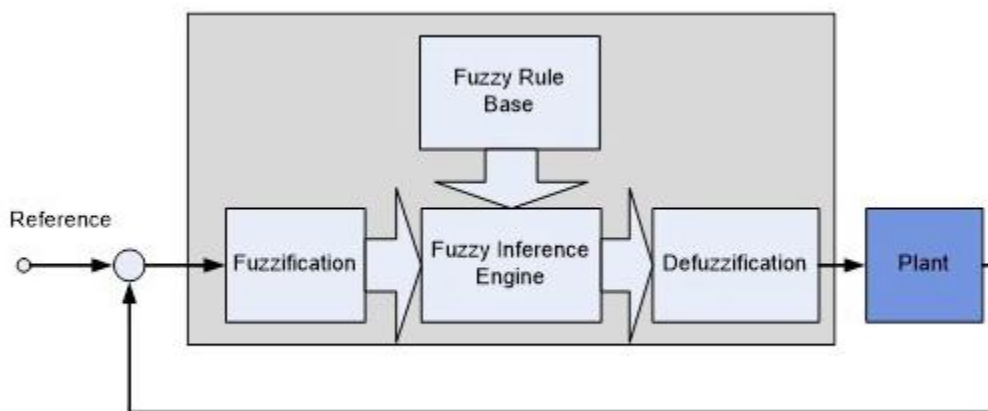
- Classification of data: Based on a set of data, our trained neural network predicts whether it is a dog or a cat?
- Discrepancy detection: Looking at the details about a person's transaction, it can say whether the

transaction is fraudulent or not.

- Speech recognition: We can train our neural network to recognize speech patterns. Example: Siri, Alexa, Google assistant.
- Audio generation: Looking at input as audio files, it can generate new music based on various factors such as style, singer, and more.
- Time series analysis: A well-trained neural network can estimate the price of a stock.
- Spell checking: We can train a neural network that detects misspellings and can also suggest a similar meaning to words. Example: Grammar
- Character recognition: A well trained neural network can detect handwritten characters.
- Machine translation: We can develop a neural network that translates one language into another language.
- Image processing: We can train a neural network to process an image and extract pieces of information from it.

4. FUZZY SYSTEM :

Things which are not clear and vague is called fuzzy. Most of the time we comes under situation that we cannot decide what is true or false and in that type of cases fuzzy system show the valuable flexibility for logic. We can see below the configuration of fuzzy system -



A fuzzy system can be divided into four main parts and it as follows:-

- **Fuzzification** is the process which assign the numerical input of a system to fuzzy sets with some degree of membership and this degree can show anywhere between the interval of 0,1.If the value comes to 0 then it means it's not belong to fuzzy set and if the value is 1 then it's completely belong to fuzzy set. Any value between 0 and 1 indicates the degree of uncertainty that the value is in the set. These fuzzy sets are usually described by words, and so by assigning the system input to fuzzy sets, we can interpret it in a linguistically natural way.
- The **knowledge base** consists of knowledge of the application domain and the attendant control goals. It is further divided into definitions database which use to express language control rules in the controller and the knowledge is describe in a rule base by the experts of the domain. Intuitively, the knowledge base is the core element of a fuzzy controller as it will contain all the information necessary to carry out its execution tasks.
- **Inference engine** identify the degree to match current fuzzy input with respect to each rule to decides which rules need to be removed according to the input field. Subsequently, the fired rules are combined to form the control actions.

- The **Defuzzification** process converts fuzzy value into crisp value and it links a single point to a fuzzy set, given that the point belongs to the support of the fuzzy set. There are several defuzzification techniques, the most famous of which is centre-of-area or centre-of-gravity.

I. ADVANTAGES OF FUZZY LOGIC SYSTEM

- This system can work with any type of inputs whether it is impermeable, distorted or noisy input information.
- The approach of Fuzzy Logic Systems is easy and understandable.
- Fuzzy logic comes with mathematical concepts of set theory and it's logic is quite simple.
- It provides a very organized solution to difficult problems in all steps of life as it resembles human reasoning and decision making.
- The algorithms can be described with little data, so little memory is required.

II. DISADVANTAGES OF FUZZY LOGIC SYSTEMS

- Different researchers showed many ways to solve a given problem through fuzzy logic which lead to ambiguity. There is no systematic approach to solve any problem through fuzzy logic.
- Evidence of its characteristics is difficult or impossible in most cases because every time we do not get mathematical description of our approach.
- As fuzzy logic works on accurate as well as inaccurate data and due to which most of time accuracy is compromised.

5. APPLICATIONS OF FUZZY LOGIC SYSTEMS

- It is used in the aerospace field for altitude control of spacecraft and satellite.
- It has used in the automotive system for speed control, traffic control.
- It is used for decision making support systems and personal assessment in the large company business.
- It has application in chemical industry for controlling the pH, drying, chemical distillation process.
- Fuzzy logic is used in various intensive applications such as natural language processing and artificial intelligence.
- Fuzzy logic used more in modern control systems like in experts system.
- Fuzzy Logic is used with the combination of neural Networks because as it copy the human in making decision and only in much faster.

6. FUZZY NEURAL NETWORK :

A fuzzy neural network is a machine learning that use to find parameters of a fuzzy system by taking advantages of neural network techniques. Following are some of the reasons for using fuzzy logic in neural networks -

- Fuzzy logic is used to define weights in neural networks, largely from fuzzy sets.
- When it is not possible to apply crisp values, fuzzy values are used.
- We have already studied how neural networks perform better in unexpected situations in training and learning. At that time fuzzy values will be more applicable than crisp values.
- Values not so crisp and processing is done in parallel when we use fuzzy logic in neural networks.

We can normally say for the fuzzy neural network that -

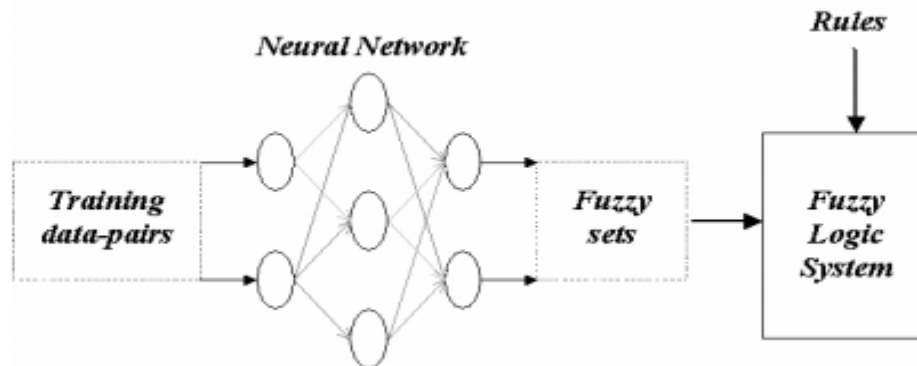
- Neural networks and fuzzy logic systems are parameters of computational nonlinear algorithms for numerical processing of data (signals, images, stimuli).
- Knowledge is acquired by the network/system through a learning process.
- The obtained knowledge is stored in internal parameters (weights).

7. TYPES OF NEURO FUZZY SYSTEM

Neuro Fuzzy system can be categorized into three types as follows-

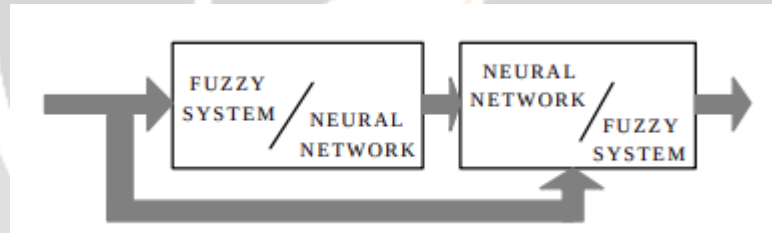
I. COOPERATIVE NEURO-FUZZY SYSTEMS :

In this case both neural and fuzzy system work independently with each other. The artificial neural network learn from the fuzzy system and can perform in both the cases whether its offline or online. On the parameters of fuzzy system neural network is used to tune with. Below we can see the figure how it works-



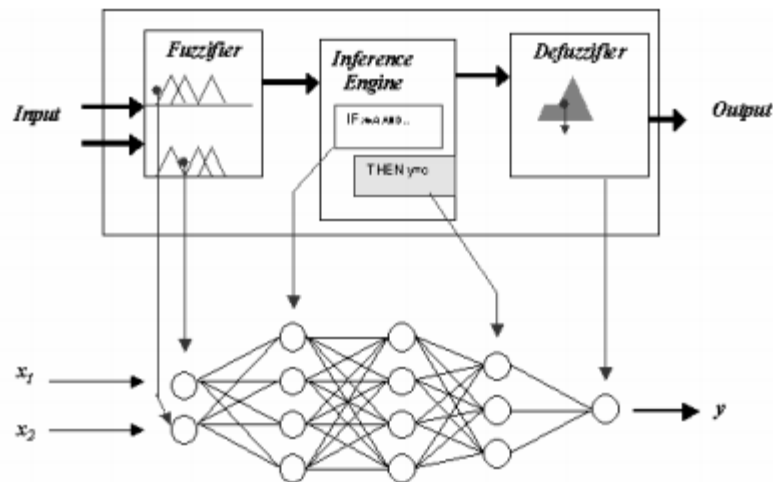
II. CONCURRENT NEURO-FUZZY SYSTEMS :

In this system, inputs enter in the fuzzy system as a processed earlier so that it can process the neural network to get the output of the concurrent system in a reverse way. This system can be considered as disadvantage as it doesn't interpret the results of the concurrent neuro-fuzzy system. Below we can see the figure how it works-



III. HYBRID NEURO-FUZZY SYSTEM :

These are the systems which are categorized in the same group and much resemble to neural network. In this fuzzy system is identified as special kind of neural network and the benefit of this system is that both fuzzy and neural did not have to communicate with each other and work independently. They are one fully interconnected entity. These systems can learn online and offline. In hybrid neural fuzzy networks, the neural network and fuzzy logic system are used in parallel. Below we can see the figure how it works by considering five layer of neural network [10-13]



Computer science is a department which world in sector of science, mathematics ,psychology, linguistics and many others with the help of artificial intelligence. So as the technology is increasing day by day as it have the capability of solving tough problem in a little span of time. Since computer is developed to increase the speed of the solution and decrease the time of solving it. The technique that we have discussed above are together used to solve the heavy science problem and issues in few seconds. Those problems includes pattern recognition, regression or density elimination. There are few disadvantages and advantages which almost solved and get disappear once both the concepts are combines Neural network comes only into process and work when they see the problems and expressed in a sufficient amount through observed examples which is used to train the black box.

Fuzzy system generally need set of rules and pre details of problem to solve it sooner. It can solve any problem no matter how tough it is but just the need is to know some details of the problem to solve it quicker than the expected time. Fuzzy system will be tuned if the knowledge is not completed and as there is no formal approach which make tuning to be performed in heuristic way and which is very time consuming . We can say that neural network concepts used to emulate the human brain operation and concentrate on the human brain structure to emulate basic functions on the hardware. Whereas, fuzzy logic system focused on emulating fuzzy and symbolic reasoning of software ad it is as good and useful technique but the basic need of it to solve the problem and correct the basic requirement of the problems in details. These principles aids in developing new concepts in artificial intelligence which are gaining popularities in the emerging world [14-16]

8. CONCLUSION

The neural network has greatly influenced on solving the world's problems and uplifting the problems. Hence the present study describes its basic concept and applications.

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