A Review on the Study of Artificial Neural Network

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ABSTRACT: *Humans have been busy inventing machines that will directly interact with the actual environment since the invention of clever computers. Machine learning, for example, has proved to be a strong method over the last few decades. There are numerous algorithms in machine learning, but one of the most powerful is the Artificial Neural Network (ANN), which has been widely utilized in a variety of disciplines. Computers can also have intelligence thanks to Artificial Neural Networks. The introduction and principles of artificial neural networks are discussed in this review study. The advantages and uses of Artificial Neural Networks are also discussed in this study. Artificial neural networks have allowed us to make progress in areas like optical character recognition, financial forecasting, pattern identification, and even medical diagnosis. The ultimate objective of computer science and information technology is to enable computers to learn and make decisions on their own. As computer-based training and e-learning courses become more popular, there will be a greater chance and opportunity for ANNs to be useful in the future.*

KEYWORDS: *Algorithm, Artificial Neural Network (ANN), Brain, Layers, Pattern Recognition.*

1. INTRODUCTION

Artificial Neuron Networks (ANN) is a set of nodes or a network of neurons in the brain that are interconnected. ANNs are computational models that are capable of machine learning and pattern recognition and are inspired by animal central nervous systems (particularly the brain). As the name implies, an Artificial Neuron Network (ANN) is a network of neurons. It's a non-linear mapping structure, which is based on how biological nerve systems, such as the brain, process information. A neural network, sometimes known as a neural net, is a type of ANN[1]. They're effective modelling tools, particularly when the underlying data connection is unclear. The structure of the information processing system is a fundamental component of this paradigm. As in the human brain, it is made up of a vast number of highly linked processing units (neurons) that work together to solve specific issues. ANNs can learn by doing, much like humans. Through a learning process, an ANN is customized for a specific purpose, such as pattern recognition or data categorization. Learning in biological systems necessitates changes to the synaptic connections that connect neurons.

Neural networks are learnt or trained by processing instances, each of which has a known 'input' and 'result,' creating a probability-weighted connection between the two that is stored in the net. The difference between the network's processed output (typically a prediction) and a target output is generally determined while training a neural network from a given sample. This is the mistake. The network then changes its weighted associations using this error value and a learning algorithm. With each modification, the neural network will generate output that is more and more comparable to the intended output.

1.1 Neural Network:

The term "neural" comes from the fundamental functional unit of the human (animal) nervous system, the "neuron" or nerve cells found in the brain and other areas of the human (animal) body. A neural network is a collection of algorithms that verifies the underlying relationship in a piece of data in the same way as the human brain does. The neural network assists in changing the input so that the network can provide the optimal result without having to rewrite the output method[2].

1.2 Architecture of Artificial Neural Network:

Figure 1 states the architecture of Artificial Neuron Network with input, output and hidden layers[3]. Following layers are stated below:
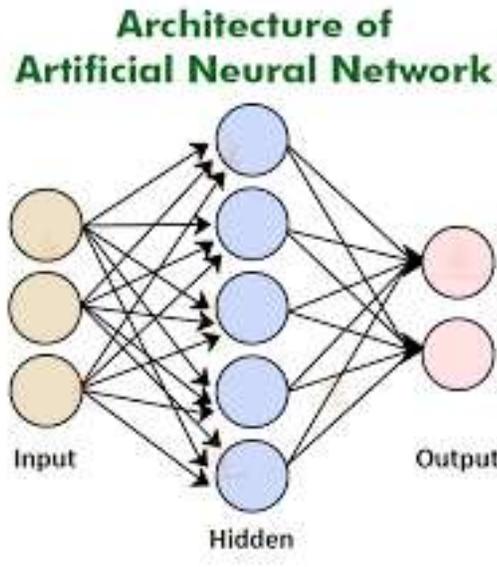

Figure 1: The above diagram shows the architecture of Artificial Neuron Network with input, output and hidden layers[4]

- *Input layer*: The input layer is made up of units that receive data from the outside world and that the network will learn, recognise, and process.
- *Hidden layer:* The units that sit between the input and output layers are known as hidden layers. The hidden layer's duty is to convert input into something that can be used by the output layer.
- *Output layer*: The units in the outer layer respond to the information sent by the hidden layer on how it learns any job or process.

1.3 Types of Artificial Neuron Network:

1.3.1 Feed-forward Neural Network: One of the most basic artificial neural networks is the feed-forward neural network. As a result, the input supplied moves in the appropriate direction. It enters the ANN via the input layer and exits via the output layer, with hidden layers present or absent. In a feed-forward neural network, as illustrated in Figure 2, there is no loop, which implies that the output of one layer does not impact the output of another layer. Pattern recognition is where they're most useful. Bottom-up or top-down networks are terms used to describe this sort of network.
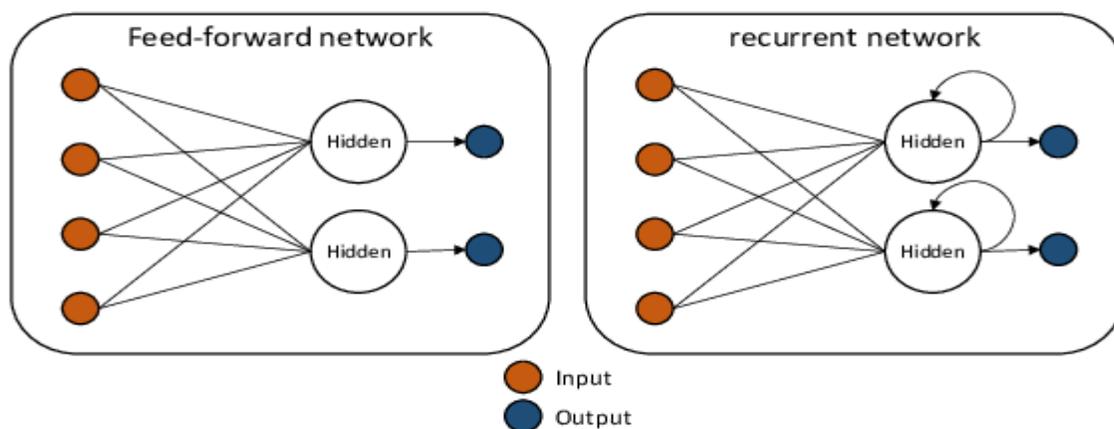

Figure 2: The above diagram shows the structure of feed-forward network and recurrent network[5]

1.3.2 Recurrent Neural Network: The Recurrent Neural Network (RNN) is a type of neural network that allows signals to go in both directions by creating loops in the network, as shown in Figure 2. Between the input and output layers, there lies a hidden layer.

1.3.3 Convolutional Neural Network: A feed-forward neural network is similar to a convolutional neural network in that the connections between networks contain weights that affect the effect of one network on another. CNN has one or more convolutional layers, each of which performs a convolutional operation on the input and passes the result to the next layer. Speech and picture recognition are two of the most common CNN applications in computer vision.

1.3.4 Modular Neural Network: A modular neural network is made up of a number of distinct networks that operate together to produce an output without interacting with one another. Distinct neural networks execute different sub-tasks by getting unique inputs in comparison to other networks. This modular neural network has the advantage of breaking down a huge and complex process into smaller parts. As a result, reducing its complexity by obtaining the outcome is fantastic.

1.3.5 Radial basis function Neural Network: Radial basis functions are functions that take into account a point's distance from the centre. There are two levels to RBF functions. The input is mapped into all of the Radial basis functions in the hidden layer in the first layer, and the output is computed in the following step by the output layer.

1.4 Human and Artificial Neurons:

Figure 3 depicts the structure of human neurons and a model of artificial neurons. Soma, Axon, Dendrites, and Synapse are the parts of a human neuron, whereas nodes, input, weight, and output are the parts of an artificial neuron. Human neurons learn from their prior experiences and modify their synaptic connections to increase their own performance levels[6]. Artificial neurons also alter various algorithms and applications based on their previous experiences in order to enhance their own performance. Table 1 lists a few of the features.

Table 1: List of Characteristics involved with Artificial and human neurons

Characteristics	Artificial Neurons	Humans Neurons
Speed	Faster	Slower
Processing	In a sequential mode	Parallel Operations
Size and Complexity	Small size and less complex	high size and more complex, non linear
Fault Tolerance	Not fault tolerance	Tolerant
Mechanism	Control unit monitors all the activities	There is no central control for processing information in the brain

Human eyesight, for example, is an information-processing activity. It is a visual system function that offers a representation of the world as well as information when interacting with it. Perceptual identification tasks (such as identifying a similar face buried in an unexpected environment) take the human brain 100-200 milliseconds to complete.
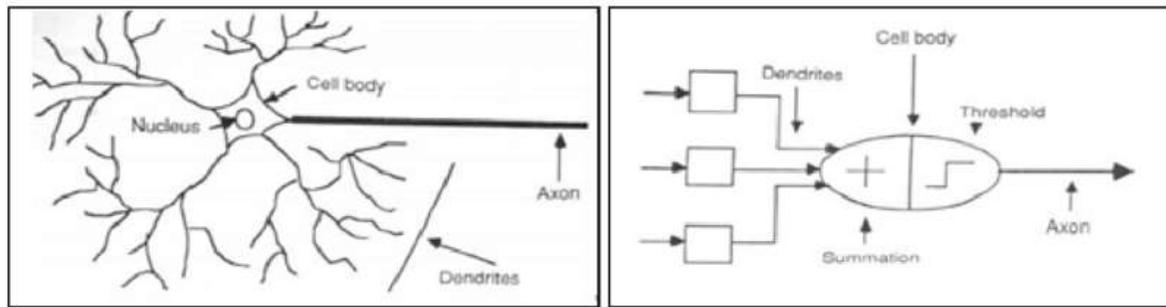
Figure 3: The above diagram shows the structure of neuron and artificial neuron model[7]

1.5   Learning techniques in Artificial Neural Networks:

1.5.1   Marketing and Sales: When you visit e-commerce sites such as Amazon or Flipkart, they will suggest goods for you to buy based on your prior browsing history. Similarly, if you enjoy pasta, Zomato, Swiggy, and other similar apps will provide restaurant recommendations based on your preferences and previous order history. This is true across all new-age marketing categories, such as book sites, movie services, hospitality websites, and so on, and it is accomplished through the use of customised marketing. Artificial Neural Networks are used to determine a customer's preferences, dislikes, prior purchase history, and so on, and then customise marketing efforts appropriately.

1.5.2   Healthcare: In Oncology, Artificial Neural Networks are used to develop algorithms that can detect malignant tissue at the microscopic level with the same accuracy as professional clinicians. Various uncommon diseases might express themselves in physical features that can be detected early on applying Facial Analysis on patient pictures. As a result, using Artificial Neural Networks on a large scale in the healthcare environment would only increase medical professionals' diagnostic abilities and, in turn, improve the general quality of medical treatment throughout the world.

1.5.3   Personal Assistant: We've all heard of Siri, Alexa, and other voice assistants, as well as their corresponding phones. These are personal assistants and an example of speech recognition that interact with users and create responses based on Natural Language Processing. Natural Language Processing makes use of artificial neural networks to handle a variety of duties for these personal assistants, including managing language grammar, semantics, proper pronunciation, the current discussion, and so on.

1.5.4   Social Media: In social media, Artificial Neural Networks have been employed. For example, everyone is familiar with Facebook's 'Individuals you may know' function, which recommends people we may know in real life so that you may send them friend invitations quickly. This effect is achieved by utilising Artificial Neural Networks to compute the individuals you could know based on your profile, hobbies, existing friends, and their friends, as well as a variety of other criteria. Facial recognition is another popular use of machine learning in social media.

2.   LITERATURE REVIEW

Mitali S Mhatre et al. discussed a review on Artificial Neural Network[8]. This paper provides a quick overview of the Artificial Neural Network (ANN) prediction approach (ANN). It is used to increase the model's prediction accuracy while reducing the requirement on experimental data. The fundamental MATLAB procedures are described, as well as several ANN trainings. The goal of the training is to reduce mean square error as much as possible. The ANN model may be readily used to forecast output parameters, which aids in the optimal selection of machining parameters for the purposes of process planning and machining parameter optimization.

Engin Pekel et al. discussed a review on Artificial Neural Network Application to Public Transportation[9]. Since 2000, a broad overview of research papers on the use of artificial neural networks (ANNs) to public transportation (PT) has been presented in this study. ANN-based PT applications are quite popular since they allow for prediction, comparison, and assessment in PT. To help new readers, the study includes a brief

introduction to applied research in public transportation based on NN, as well as a thorough review table. There have been over a thousand papers seen, however only 72 PT studies are connected to ANN. Multi-layer feed forward networks with gradient descent training have been popular in recent years. In contrast, lesser-known approaches, on the other hand, are likely to grow in popularity. The methodologies to be used in PT for input determination are presented in this study, which will influence future research paths.

Oludare Isaac Abiodun et al. discussed a survey on the applications of artificial neural network[10]. This study presents taxonomy of artificial neural networks (ANNs) and informs the reader about current and emerging trends in ANN applications research as well as research areas of interest. In addition, the research discusses ANN application problems, contributions, performance comparisons, and technique critiques. The research includes a wide range of ANN applications in fields such as computers, science, engineering, medical, environmental, agricultural, mining, technology, climate, business, the arts, and nanotechnology, among others. The research evaluates ANN contributions, compares results, and criticises approaches. The researchers discovered that neural-network types like feedforward and feedback propagation artificial neural networks perform better when applied to human situations. As a result, based on data analysis parameters such as accuracy, processing speed, latency, fault tolerance, volume, scalability, convergence, and performance, we suggested feedforward and feedback propagation ANN models for study emphasis. Furthermore, rather than focusing on a single technique, future research should concentrate on integrating ANN models into a single network-wide application.

3. DISCUSSION

As previously stated, an Artificial Neuron Network is essentially an information processing paradigm designed to stimulate human brain activity. Fingerprint recognition, Character recognition, Speech recognition, and Face recognition are all examples of pattern recognition that employ artificial neural networks. Data gathering and preprocessing, Data representation, and Decision making are the three main components of pattern recognition systems.

Artificial Neuron Networks (ANN) is now frequently employed in the medical field, particularly in cardiology. Diagnoses, medical picture analysis, electronic signal analysis as well as radiography have all benefited from the usage of ANNs. In medical and clinical research, several authors had utilised ANN for modelling. Unexplained network behaviors, Hardware dependencies, and so on are some of the problems that ANNs face. ANN will be highly useful in decision making, computer intelligence, and many other areas if these difficulties can be solved in the future.

4. CONCLUSION

In order to provide current computational intelligence, artificial neuron networks play a vital role. Artificial neuron networks are now employed mostly in pattern recognition applications such as face identification, fingerprint recognition, character recognition, and audio recognition, among others. Artificial neuron networks are extremely essential in the medical profession, particularly in cardiology. In this paper, the author analyses how human neurons vary from artificial neural networks, as well as providing an overview of how the ANN concept developed and functions. Author also discusses about the architecture of artificial neural network, types of artificial neural network as well as the applications of artificial neuron networks. As computer-based training and e-learning courses become more widely used, there is a good chance that ANN will be useful in future employment.

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