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Review on Artificial Neural Network

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ABSTRACT: Neural networks are those systems of information processing which are designed and implemented to build human brain. Neural network research's main objective is to create a computational tool to represent the brain to perform different evaluation tasks at a faster rate than traditional systems. Neural networks are the new form of computer programming. Neural networks have been successfully applied to a wide variety of fields including economics, data mining, medicine, engineering, geology, physics, and biology. Neural networks are used in finance for stock market prediction, credit score, prediction of recession and statistical measure forecasting. Neural networks have been widely used in medicine to identify, track and assess medical conditions and estimate the cost of treatment. Such tasks are very challenging for conventional methods; high-speed digital computers are used for the implementation of artificial neural networks, which makes simulation possible of neural processes. The paper gives a detailed review of the wide range of artificial neural networks, many of the most popular network architecture, and various learning processes currently used in study. It also explains many technologies in a concise way.

KEYWORDS*:* Activation Function, Artificial Neuron, Biological Neuron, Learning Process, Neural Network Architecture.

I. INTRODUCTION

Artificial neural network is actually influenced by biological neural networks which are massively parallel computing systems composed of an extensively huge number of common computing elements with many interconnections, called nodes or neurons, which are designed in standard architecture. Every neuron is connected by a powerful connecting to another neuron. That communication link is developed into different weights that carry input signal data. Neural net or nodes use this sort of information to solve a specific problem[1]. These weights correlate to each link, calculated by a mathematical function that results to the activation of the neuron as its own internal state. Several other functions (such as identity, bipolar step and sigmoidal function) can be used to determine the artificial neuron output (sometimes corresponding to a certain limit). In this network, the activation function applied to neurons simply sums up their inputs. Artificial neural network is like people who learn from examples which make them very effective and adaptable[2]. Because the purpose of artificial neural network is to handle and process information, it is widely used through the definition of learning process in various engineering purposes such as pattern recognition, fraud detection, medical diagnosis, and data classification. Throughout biological systems, the learning process involves modifications to the synaptic connections that exist between the neurons[3]. A typical neuron in the human brain accumulates signals from others via a series of fine structures called dendrites. The neuron sends out electrical activity projections through a long, thin stand called an axon that splits into hundreds of divisions. A structure called a synapse at the end of each branch transforms the input from the axon into electrical effects that suppress or excite activity in the neurons attached to it. Fig.1 shows the artificial neuron.

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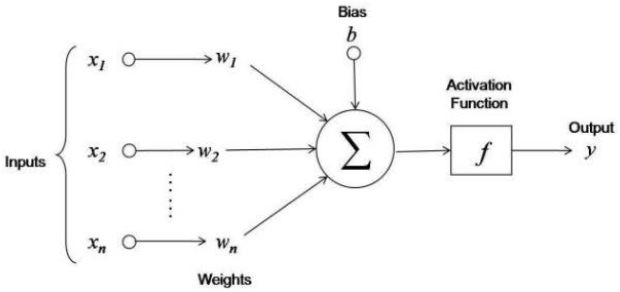

Fig. 1: Artificial Neuron

In the artificial neuron, incoming neurons have one unique input each, then weights are allocated to be combined with the particular inputs, and activation function (as a processing component) is implemented to obtain refutation of these inputs from neurons for neuron output. There are a wide range of ANNs that could be used to derive the meaning from complex or inaccurate data to procure patterns and detect patterns that are too difficult for human or other computer techniques to notice. In classifying different information that has been processed appropriately, a qualified neural network can be viewed as an expert system. An expert system consists of a series of programs that run encoded knowledge in order to solve problems in a specific domain that usually requires human expertise and address what questions are asked[4].

II. NEURAL NETWORK ARCHITECTURE

The neural network architecture is called the arrangement of neurons to form layers, and the relation link formed within and between layers. For an ANN the arrangements of such processing elements and their interconnection geometry are necessary. It is important to note the point where the relation originates and terminates, and define the function of each processing element in an ANN[5].

Single-layer feed-forward network:

By taking a processing element and combining it with other processing elements a layer being created. Practically, the input stage is indicated by a line, and the output stage is connected together. Fig.2 shows the single-layer feed-forward network.

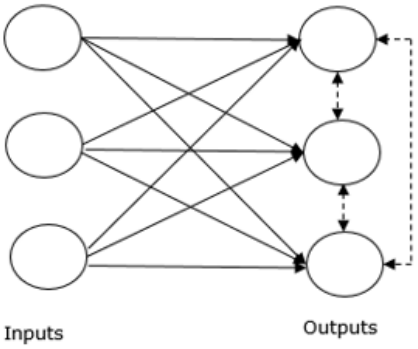

Fig. 2: Single-Layer Feed-Forward Network

Such interconnections result in the creation of different architectures for the network[6]. When a processing node layer is formed the inputs can be linked with different assigned weights to these elements, resulting in a series of outputs, one per node. Consequently, a single layer feed-forward network is created.

Multilayer feed-forward network:

The correlations between several layers form a multilayer feed-forward network. There are basically three layers as input layer, hidden layer, and output layer of artificial neural network (Fig.3).

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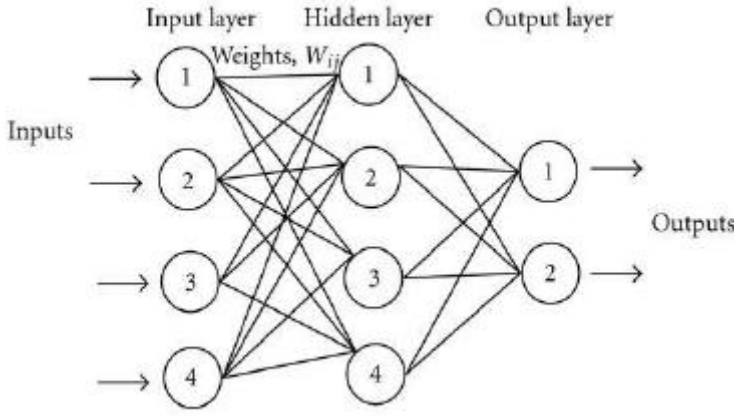

Fig. 3: Multilayer Feed-Forward Network

The input layer gets the input and there is no function to this layer except to buffer the input signal. Output layer generates network output. Between the input and output layers is formed another layer called hidden layer[7]. The hidden layer is dynamically connected to the network (no direct contact with outside environment). The behavior of each hidden unit is regulated by the input unit operations and the weights allocated to the connections between the input and the hidden units. More the hidden layers number more is the network complexity.

Activation function:

Activation function's principal role is to determine an ANN's exact performance. Neuron information processing can be seen as having two vital parts: input and output. Input of a processing unit (neuron) is correlated with an integration function (f). This function conducts combining data or activation to a processing element from an external source or other different processing elements into a net input. Non-linear activation function refers to ensuring that specific neuron response is bounded as neuron actual output is conditioned as a result of triggering stimuli and can be controllable.

Activation features are as follows:

Identity function: This function is usually linear and defined as:

For all x, f(x) = y, the output here remains identical to the input. The input layer essentially uses the activation function for identity.

Binary phase function: Can be described as:

$$f(x) = \begin{cases} 1 & \text{if } x >= \Theta \\ 0 & \text{if } x < \Theta \end{cases}$$

Where, the threshold value is expressed by Θ. This activation function is widely used for converting the input to output in binary form (1 or 0) on a single layer network.

Bipolar phase function: It can be described as:

$$F(x) = \begin{cases} 1 & \text{if } x >= \Theta \\ -1 & \text{if } x < \Theta \end{cases}$$

Where, the threshold value is defined by Θ. This activation method is commonly used for transforming the input to output in bipolar form (+ 1 or -1) in single layer networks.

Learning process:

A learning process can be defined in the ANN as the procedure for updating network architecture and link weights so a network can perform a specific task efficiently. Typically the network must maintain the weights of connections from unused training pattern. Network efficiency is enhanced by the iterative updating of the allocated weights over time. There are typically three groups that can be categorized as: supervised learning, unsupervised learning, and reinforcement learning in the learning process of an artificial neural network.

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Supervised Learning:
ANNs adopt supervised learning in a way that requires a corresponding target vector for each input vector which represents the desired output. Compared to the goal vector the input vector represents training pair (Fig.4).

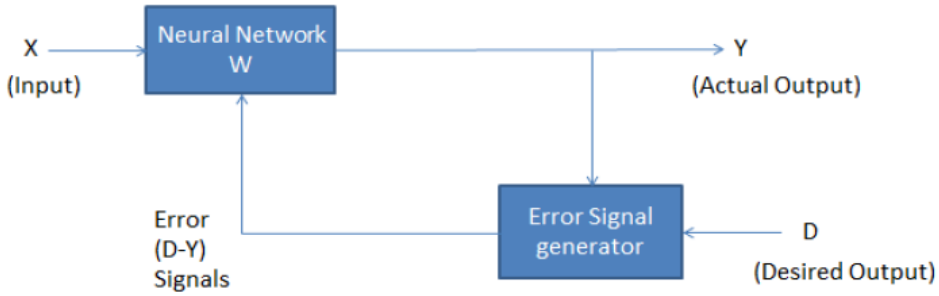

Fig. 4: Supervised Learning

The input vector is granted to the network during preparation, thus giving the output vector (actual output). The actual output is then compared with the desired output vector. If there is a difference between these two vectors then the network produces an error signal. This error message is used in weight adjustments until the actual output corresponds to the desired (target) output. A kind of supervisor or teacher is required for error minimization in this type of learning process or training. Under supervised learning, correct target output values for each input node are presumed to be predefined. Supervised learning ideal includes learning for error-correction, learning for reinforcement and stochastic learning.

Unsupervised Learning:
This form of learning process is self-determining and is not under teacher supervision. In ANNs, homogeneous type input vector is grouped without training data needing to identify how each group component looks or belongs to which category (Fig.5).

Fig. 5: Unsupervised Learning

The network acknowledges the input patterns in this training process, and classifies these patterns into clusters. When a new input pattern is introduced, an output response is generated by the neural network, defining the class to which the input pattern is part[8]. If it is not possible to find the pattern class, a new class is created. It's obvious that there is no environmental feedback to determine whether or not the outputs are correct. In these criteria, the network itself must evaluate patterns, attributes, or categories from the input data and get relationships over the output. This process is known as self-organizing by identifying similarities and dissimilarities between the objects in which clusters will be created. Hebbian and competitive learning law are embodiments of unsupervised instruction.

Reinforcement Learning:
This learning process is similar to supervised learning (in the case that each input pattern is known for the correct target output values). Only interpreted information is available, rather than precise information[9]. Training is basically called as reinforcement learning based on this interpreted knowledge, and the feedback sent is called as reinforcement signal. Reinforcement learning is supervised learning category in which the trained network received some form of input from their environment (Fig.6).

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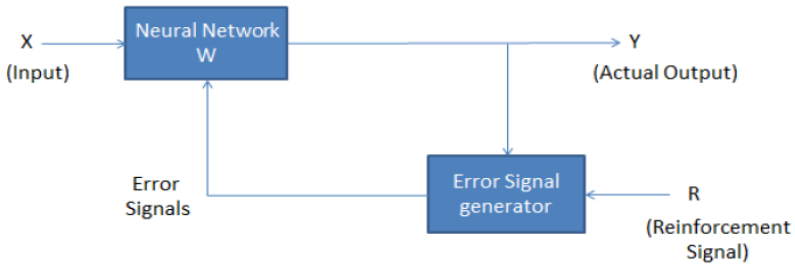

Fig. 6: Reinforcement Learning

In the error signal generator, the external reinforcement signals are processed and the interpreted signals received are transmitted to the ANN for weight changes in order to obtain better feedback in the future.

III. APPLICATIONS

Neural network in medicine:
Artificial Neural Networks (ANN) is presently a famous pharmaceutical research field. The research is based on modeling parts of the human body and identifying diseases through various scanning methods (e.g. cardiograms, CAT scans, ultrasound scans, etc.).
Neural network in business:
To accomplish resource allocation and scheduling, neural network will fit into the business domain or financial analytics. Implicit trends for data base mining can be searched within the databases for specific storage of information[10].
Marketing:
Such a marketing technology as Airline Marketing Tactician (AMT) is a computer system consisting of many practical technologies and systems of expertise. A neural network method is federated with the AMT and learned by back-propagation in order to accommodate marketing regulation of airline seat allocations. The program is designed to track each departure and to recommend booking advices. This implementation can provide device users with a technological advantage.

IV. CONCLUSION

The artificial neural network's exceptional expertise in processing information and its ability to learn from examples make them a comprehensive problem-solving tool. This study, by identifying the idea of biological neurons and artificial neurons, explores artificial neural networks. Training takes place in biological neural networks by updating the synapses output to impact one neuron on another update. Interconnected units or nodes are known as artificial neurons (processing elements) in artificial neural networks. Through communication between these units / elements of processing will transmit a signal from one to another. It can be interpreted appropriately by the artificial neuron receiving the signal. This paper also explores the actions of learning processes (such as supervised, unsupervised, and reinforcement learning) to modify the network architecture and weights allocated to a specific link between processing elements in order to achieve better efficiency for specific tasks.

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