

Introduction to Artificial Neural Network (ANN)

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Abstract: The artificial neural network may likely be the complete solution over the most recent decades which have been broadly utilized as a part of a huge variety of applications. This paper focuses on types of artificial neural networks, its elements and applications. To assess the impact of personalized learning in neural network applications. Artificial Neural Networks topologies and some commonly known learning algorithms is presented in this paper. The outcome focused on the importance of using neural networks in possible applications and its influence on learner's progress with personalization system.

Keywords: ANN (Artificial Neural Network); Characteristics; Applications.

1. INTRODUCTION

Artificial Neural Network (ANN) is an efficient computing system whose central idea is obtained from the concept of biological neural networks. ANNs are also known as “artificial neural systems,” or “parallel distributed processing systems,” ANN consists of large collection of entities that are interconnected in some pattern to allow communication between them. The units in these patterns also referred to as neurons, which work parallel.

Every neuron is linked with other through a connection link. Each of the links is associated with weight which consists of information regarding the Input signal. This information is considered to be the most important one for neurons to solve a problem because weight tells the signal that is being communicated. The internal state of neuron is called Activation signal. The input signals combined together with activation rule produces Output signals which are further send to other units.

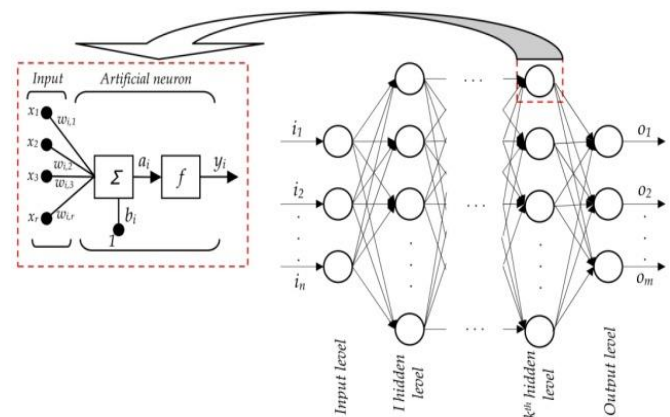
In simple terms, each neuron takes input from numerous other neurons through the dendrites. It then performs the required processing on the input and sends another electrical pulse through the axon into the terminal nodes from where it is transmitted to numerous other neurons.

2. WHAT IS ARTIFICIAL NEURAL NETWORK?

ANN stands for Artificial Neural Networks. ANN is an attempt to simulate the neurons that make up the human brain so that computer will be able to learn things and make decisions in a human way. ANN is created by programming computers to behave as though human brain cells do. The structure of ANN is affected by the flow of information. Hence ANN changes are based on input and output signals.

ANN is considered to be based on nonlinear statistical data. This means complex relationships can be defined between input and output. As a result we will find different patterns. ANN is said to be foundations of Artificial Intelligence (AI) and solve number of problems that seems to be impossible or difficult for human being. ANN has a self learning capabilities like humans that enables them to produce desirable results as large amount of data becomes available.

The general structure of a neural network looks like:



This figure shows a typical neural network along with working of a each neuron described separately. Let's discuss this.

Each neuron is like the dendrites that has the input same as in human nervous system. It assembles all inputs and comply an operation on them. And then it transfers the output to all other

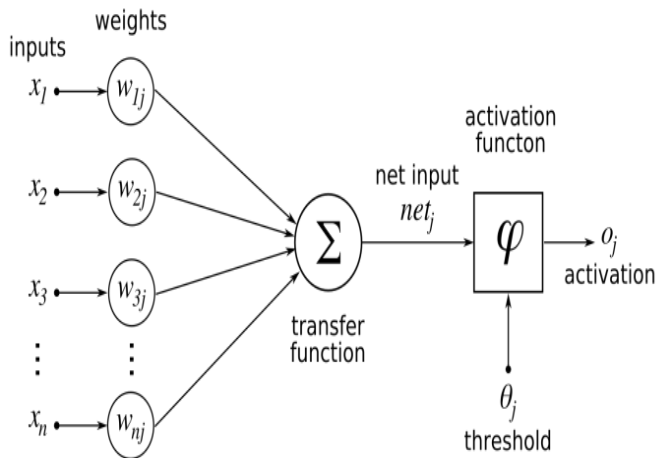
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neurons which they are connected to. Neural networks are divided into 3 layers which are as follows:

1. **Input Layer:** It consists of initial data. The training inspections are catered through these neurons
2. **Hidden Layers:** This is the middle layer layers between input and output where the actual computation is done. It further helps the Neural Network learn the entangled relationships elaborated in data.
3. **Output Layer:** It gives the final output which is extracted from the previous two layers. For Example: In case classification problem having 5 classes, the output later will have 5 neurons.

The artificial analog of the biologic neuron is shown below in figure 2. In ANN model the **inputs** correspond to the dendrites, the body cell relates to the **transfer function, net input, and activation function**, and the **activation** corresponds to the neuron and synaptic terminal.

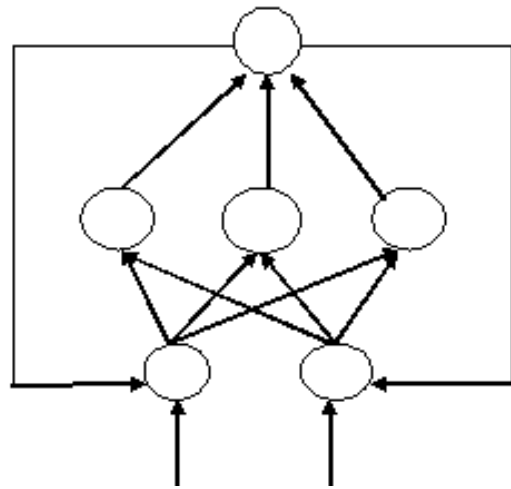


3. TYPES OF ARTIFICIAL NEURAL NETWORKS

There are different types of ANN networks depending upon the human brain neuron and network functions. Different types of ANN are as follows:

a. Feed Forward ANN

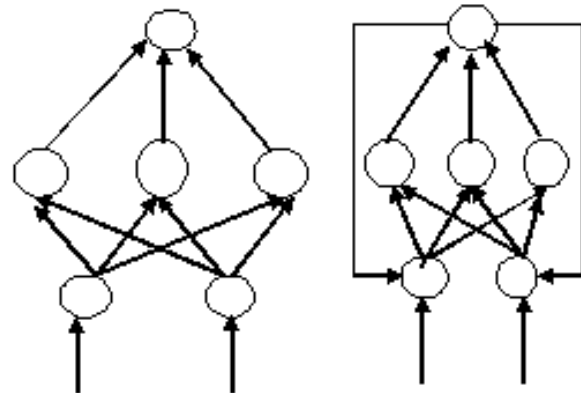
This is one of the simplest types of ANN. In this network data passes through different input nodes till it reaches the output node. That's why it is said to be Unidirectional. In this input flows in one direction from one layer till it reaches the end layer. In this no back propagation is present. Although it is used in recognition of patterns so they contain fixed inputs and outputs.



b. Feedback ANN

As the name implies Feedback ANN allows

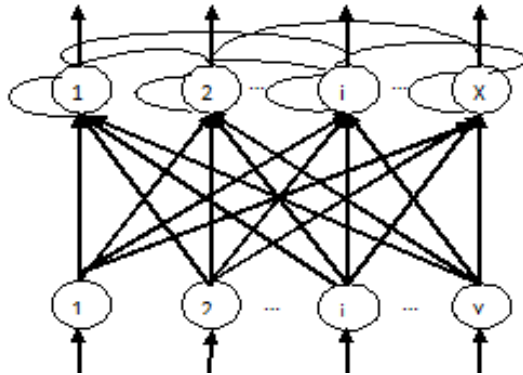
Feedback loops. If output can be directed back acting as inputs to same or previous layers then it is said to be feedback networks. Recurrent networks with closed loop are known as Feedback networks.



c. Competitive Learning Neural Networks

This is the combination of both the networks discussed above. In this the input layer is linear and its outputs are sending to all the parts in the next layer. During the training session the output parts that posse the highest activation to a given input pattern is announced as the winner of weights and is shifted closer to input without changing the rest of the neurons.

Depending on the situation the output of second layer can be linear or non-linear.



d. Classification-Prediction ANN –

This network is based on data mining scheme. In this patterns are identified and divided into particular groups on the basis of which network is trained and then further divide them into different patterns which are said to be new to network.

An artificial neural network is a technique similar to biological neural network. They operate in the similar fashion as neurons and the electric signals in which they communicate as our eyes and brain in human body.

e. Radial Basis Function Neural Network

This network acknowledges the distance of any point respective to the centre. In this it has two layers. In the covering layer with the help of radial basis function the attributes are combined. After this output of these attributes is taken into account in order to calculate result in the following step. This network is applicable extensively in power mending systems. In these days power systems have become more complex which increased the risk of knockout. So this network helps to recover power in the shortest possible time.

f. Multilayer Perceptron

It consists of three or more layers. It is used to differentiate data that is difficult to get separated linearly. It is a fully connected network in which every node is connected to other node in the next layer. It uses a non linear activation function.

How Artificial Neural Networks work?

ANN develops algorithms using the concept of brain processing to model complex patterns and prediction problems. It is viewed as the weighted directed graphs where nodes represents the artificial neurons and connection between neurons input and output is represented with directed edges with weights.

An ANN involves a number of processors operating in parallel and arranged in layers. The first layer receives the raw input from the outside world. This is where the actual learning for network happens. Each successive tier receives the output from the layer preceding it. The output layer responds to the information fed into it and produces the result.

Each operating node has its own circle of knowledge including rules it was programmed with. The layers are extremely connected which means each node in layer will be connected too many nodes to layers n-1. Output layer may consist of one or multiple nodes from which the answer it produces can be interpreted.

Artificial neural networks are notable for being adaptive, which means they modify themselves as they learn from initial training and subsequent runs provide more information about the world. The most basic learning model is centered on weighting the input streams, which is how each node weights the importance of input data from each of its predecessors. Inputs that contribute to getting right answers are weighted higher. In ANN activation functions is the set of transfer which helps in getting the desired output.

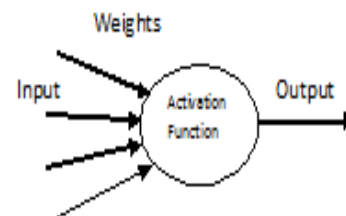
Training set helps in providing tremendous amount of information so that ANN can learn from it. During its training period it learns a lot from number of images tagged. Once the network is trained its output is compared with the human provided output if they are same then that machine is said to be validated. If they deviate it uses back propagation method to correct its learning. This is what is known as Deep Learning that makes a network intelligent.

4. ELEMENTS OF ARTIFICIAL NEURAL NETWORKS

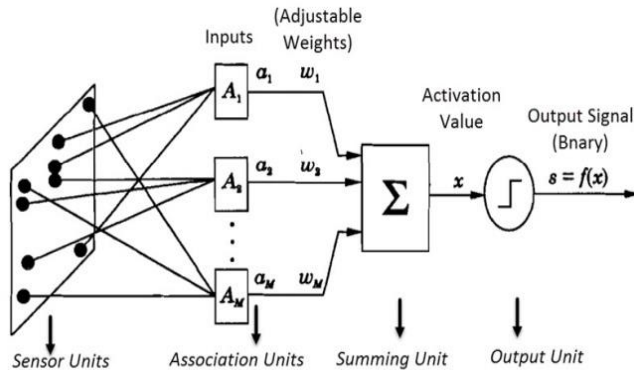
Basic elements of Artificial Neural Network are as follows:

- Processing Elements
- Topology
- Learning Algorithm
- **Processing Elements**

ANN is a simple computational model of biological neural network. It consists of number of processing units same as that of neurons in human brain.



A processing unit is made up of aggregating unit followed by an output unit. The function of an aggregating unit is to get n input values, weight each of these units and then calculate weighted sum of all those values.



On the basis of sign of the weight of each input, it is decided whether the input has a positive weight or negative weight. The weighted sum of the processing unit produces what we call Activation value and based on the indicator value from activation function, the output is produced.

Both the input and output can be either continuous or particular.

• **Topology**

The organization of the processing units, their interconnections, inputs and outputs is known as Topology. It becomes useful when all the processing elements are organized in an appropriate manner so that the task of pattern recognition can be accomplished.

Some of the commonly used Topologies in Artificial Neural Networks are:

- Instar
- Outstar
- Group of Instars
- Group of Outstars
- Bidirectional Associative Memory
- Auto associative Memory

• **Learning Algorithm**

The final element of ANN is Learning Algorithms. They are implementations of synaptic dynamics and are first derivative of the weights. These laws can be supervised, unsupervised or hybrid of both.

In supervised learning, both the inputs and outputs are provided. During the training of a network the same set of data is processed many times to refine the connection weights. In unsupervised training, the network is having inputs but not with desired outputs. The system will decide itself what characteristics it will use to combine input data. This are known as adaption.

5. APPLICATION OF NEURAL NETWORK

1. Every new technology needs assistance from previous one i.e. data from previous ones and these data are analyzed so that every pros and cons should be studied correctly. All of these things are possible only through the help of neural network.
2. Neural network is suitable for the research on *Animal behavior, predator/prey relationships and population cycles*.
3. It would be easier to do *proper valuation* of property, buildings, automobiles, machinery etc. with the help of neural network.
4. Neural Network can be used in betting on horse races, sporting events and most importantly in stock market.
5. It can be used to predict the correct judgment for any crime by using of crime details as input and the resulting sentences as output. a large data
6. By analyzing data and determining which of the data has any fault (files diverging from peers) called as *Data mining, cleaning and validation* can be achieved through neural network.
7. Neural Network can be used to predict targets with the help of echo patterns we get from sonar, radar, seismic and magnetic instruments.
8. It can be used efficiently in *Employee hiring* so that any company can hire right employee depending upon the skills the employee has and what should be its productivity in future.
9. It has a large application in *Medical Research*.
10. It can be used to for *Fraud Detection* regarding credit cards, insurance or taxes by analyzing the past records.

6. CHARACTERISTICS OF NEURAL NETWORKS

Any Artificial Neural Network, irrespective of the style and logic of implementation, has a few basic characteristics. These are mentioned below.

- It consists of large number of neurons like processing units.

- There exist a large number of weighted connections among these processing elements.
- Distributed representation of data is provided by the connections.
- The connections between the elements provide a distributed representation of data.
- The knowledge is acquired with the help of learning process.
- It is neutrally implemented mathematical model
- It contains huge number of interconnected processing elements called neurons to do all operations
- Information stored in the neurons are basically the weighted linkage of neurons
- The signals from input unit reached at the processing units through connections and their weights.
- This network has the capability to learn, recall and generalize from the data given by doing the adjustments of weights and assignments.
- The collective behavior of the neurons specifies its computational power and not a single neuron transfer's specific information.

7. CONCLUSION

This paper focuses on types of artificial neural networks, its elements and applications. In these paper topologies of

Artificial Neural Networks is presented. The commonly used Learning Algorithms are discussed. Different characteristics of Artificial Neural Network are given.

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