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Analytical and Systematic Study of Artificial Neural Network

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ABSTRACT

Artificial neural network may be a neural networkmotivated by the biological neural network where numbers of neurons are interconnected with each other. The neurons in artificial neural network areoperating and arranged in such a way that they invigorate the basic construction of the neurons within the human cerebrum. the basic rationale behind the factitious neural network is to implement the structure of the biological neuron in an exceedingly way that the regardless of the function that the human brain perform with the help of biological neural network, that thusly will the machines and frameworks can likewise perform with the help of artificial neural network.This paper gives a concise outline of a man-made neural network with its working, architectures, and general organization, and so forth. This paper additionally express some advantage and disadvantage , application of the artificial neural network in some most vital areas like image processing, signal processing, pattern recognition, function approximation, forecasting supported thepast data and a few more.

Keywords: *Artificial Neural Network, Feed forward network, Feedback Network, Activation functions, Artificial Neuron.*

1. INTRODUCTION

The biological brain is formed of billions of nerve cells that form a posh linked network (neurons). There are roughly 10 10 neurons in an exceedingly human brain. The brain is that the massive and complicated network system, with each neuron linked to 10 10 other neurons. The structure of the neuron is also split into three parts: soma (cell body),dendrites, and axon.

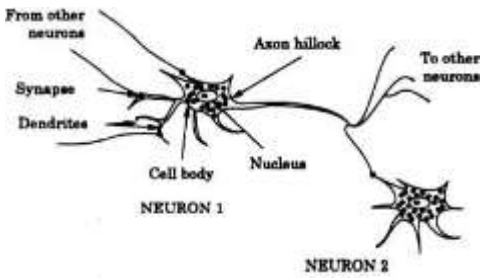

Fig 1: Schematic structure of Neuron

The structure of one neuron is created by these threecomponents. Each component or part performs an infinite role and contributes to the completion of a specific activity. the identical because the choice cells, the cell body, also mentioned because the soma contains the centre. Efflorescent is the tree alike nerve fiber that are connected to the cell body.The signals from the other neurons are received by these dendrites. Depending on their function, each neuron within the brain can have many set of efflorescent. The axon, unlike the dendrites link, it'selectrically active and functions as an output channel. The axon is that the neuron's transmitter, which delivers the signal to the neighboring neurons. The synapse of the neuron are the fundamental building block of brain information processing; theynot only convert an signal into a potential signal, butthey also contain an experienced memory functions,allowing them to perform weighted processing on the signal based on the memory

2. WHAT IS ARTIFICIAL NEURAL NETWORK?

Artificial Neural Network designs are biologically inspired within the sense that they're made of the elements that operate in a very way kind of like the fundamental biological neuron. The arrangement of artificial neurons in manner they'll excite the structure of the brain.

Artificial Neural Network Structure

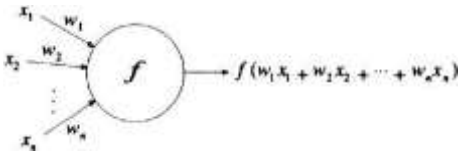

Fig 2: Artificial Neuron.

Each node receives a various input from other nodes through connections with accompanying weightsthat corresponds to the strength of the synapse. Weight is that the word employed in a neural network terminology to represent the strength of a link between any two neurons within the neural networks. Every neuron has the one output and a processing unit with a synaptic input connection. Assume that various weighted inputs are

provided atthe subsequent level of specialization, as shown in figure.

The output of neuron can be returned as

$$f(W_1X_1+....+W_nX_n)$$

Or

$$f\left(\sum_{i=1}^{n} W_iX_i\right)$$

or

$$f(net)$$

Where, $net=\sum_{i=1}^{n} W_iX_i$

Where, W is the weighted vector definedas $w \quad W1, W2 \ldots\ldots\ldots Wn$ and x is the input vectordefined as

$X \quad X1, X2 \quad Xn$.

Activation functions

The activation function is primarily wont to abstract the operations of the neural network. A mathematical relation that turns or converts input tothe output and adds a magic to the neural network processing is thought as an activation function. There are several distinct form of activation function that's regularly employed, and some of them are presentedbelow.

Step function

It's the only activation function among all the activation function within the neural network.

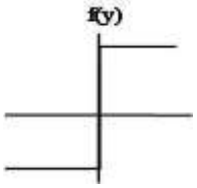

Fig 3: Step Function.

The above graphical representation depicts the step function. looking on whether the input is larger thanor but 0, the output of this function is confined to 1 of two values supported the function that's defined below, the 2 conditions are arises, Considering the primary condition where sign is larger than 0, The output are 1, another condition is when the signalingis a smaller amount than 0, then the output are goingto be -1.

Linear function

Other Activation function is Linear Activation function.

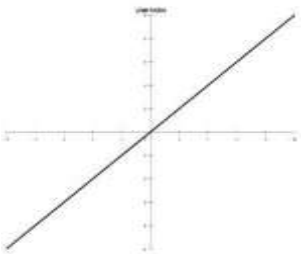

Fig 4: Linear function.

Above diagram shows graphical exposition of linear activation function. As seen within the abovefigure, the graph of linear activation function could be a line. These functions have the effect of multiplying by the constant factor to the signaling, Here the K is that the constant Factor and y is that the signal values. The range of the functionis defined in (–infinity, +infinity), and it is employed in some network nodes where dynamic range isn't a problem.

Ramp Function

Another activation function is ramp function. It incorporate the concept of the step and linear function. The output is primarily depend on the correlation of input, signal with the upper and lowerlimits. Between the upper and the lower limits the function will act as a linear function, after this restricts are reached, it will be act as a step function.

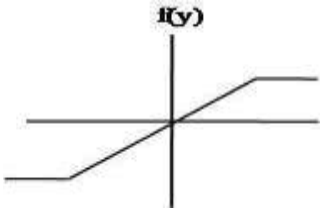

Fig 5: Ramp function.

The above graphical analysis shows the ramp activation function. This function may be define as follow,

Output = Max, y>upper limit 3. (a)

=K. y, y< upper limit & y> lower limit 3. (b)

=Min, y< lower limit 3. (c)

Sigmoid Function

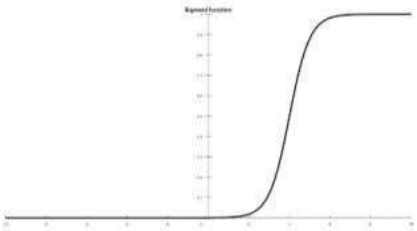

Fig 6: Sigmoid Function.

The above given figure simplify the graphical portrayal of a sigmoid function. A mathematical relation that makes a sigmoidal curve is understoodas sigmoid function, thanks to 'S' form shape. this isoften the foremost basic and sometimes used utilizedactivation method. A 'S' shaped curve will be defined employing a style of mathematical formulas,the foremost popular of which is that the equation

3. NETWORK TOPOLOGY

An artificial neural network consists of two or moreartificial neurons connected to every other. Neural topology or architecture describes the various ways during which connections may be established.

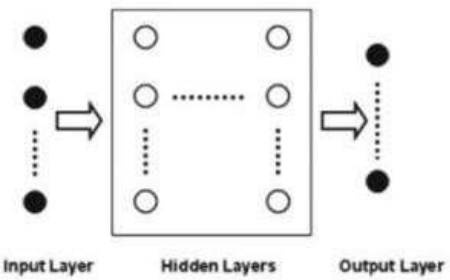

Fig 7: General Arrangement of Layers in ArtificialNeural Network.

There are three distinct kinds of layers.

Input layers- this can be the neural networks' drafting board. This layer is answerable of acceptingdata, information, or signals, and transmitting them to the subsequent or subsequent layer for further processing. This layer doesn't do any computation. the first goal of the layer is to gather the informationfrom the surface world.

Hidden layer : This layer is between input and outputlayer. The hidden layers main job is to process or compute the information with the assistance of computational nodes from the input layer. during a neural network, there is one or more hidden layers. This layer is also performs the distinct task that the opposite layers can't do. the inner processing duringthis layer is analogues to the processing that happenswithin the human brain. It pass on the resultant output to the output layer with the help of an activation function, after the processing and computing the signals fed from the input layer.

Output layer-This layer of the neural network is to blame for creating the output that arises from processing or computing conducted by the neurons within the preceding layers. There are different of artificial neural networking topologies, like feed forward and feedback neural network, are briefly discussed here.

Feed Forward network

A signal flows through a neural network are ofteneither in one-way or recursive. We named the neural specification of the feedforward within the first scenario because the input signals are fed into the input layers then processed before being transferredto the subsequent layer. In such case, data is to be passed on strictly from the input node to the exit i.e.,output node. Single layer feed forward neural network, multilayer feedforward neural network, and therefore the radial basis function are examplesof feed forwarded networks.

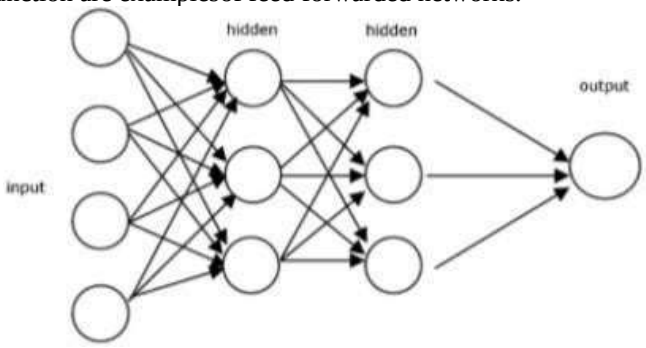

Fig 8: Feed Forward Network.

Feedback Network

The outcome of one layer of the neuro feedback network is to be sent back to previous layer. By establish a loop into the network, that network can also have signal thatpropagate in both direction.

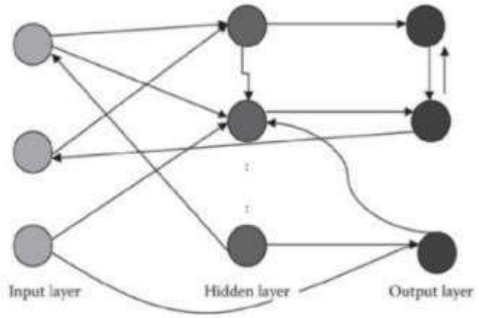

Fig 9: Feedback Network.

Single Layer Feedforward Network

As definition of feedforward network layer stated above, signal are move into either only in one direction from input layer to output layer in feedforwarding network. so as to form an output, a neural network fundamental structure encompass aninput layer in addition to hidden layer, which is thenconnected to an output layer. the identical reasoningas within the feedforward network is employed here, with alittle adjustment within the network structure.

Only two layers are utilized in this sort of feed forward network, the input layer and also the outputlayer. The signaling is received by the input layer neuron, while the signal is received by the output layer neurons. during this paradigm, the output layeris barely with computational nodes. With support ofthe computing nodes, output layer in the networks alone may compute a computing task. Therefore, it's termed to as single layer feed forward network.

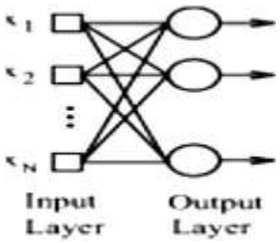

Fig 10: Single- Layer Feedforward Network.

One layer feed forward network with n inputs and moutputs is shown within the diagram. the amount of outputs within the network adhering to the current design will always coincide with the quantity of neurons, as shown within the figure. Pattern classification and linear filtering problems are common applications of those networks.

Multilayer feed forward Network layer

This network features a numerous layer, including ahidden layer that performs a valuable intermediate calculation before sending the input to the output layer as critical the only feedfoward network layer design with few similarities. The network units are organized in layers, including an input layer, one ormore hidden layer, and an output layer during a sequential manner.

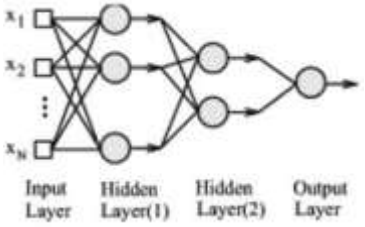

Fig 11: Multi-layer Feedforward Layer.

The above figure depicts the feedforward network made of input layer and middle layer i.e., (hidden orcomputational layer) and therefore the output layer that reflect the matter output values being analyzed. they're accustomed solve a good range of problems including those involving function approximation, pattern classification, process control, optimization,robotics then on.

Recurrent Neural Networks

the planning of this network differ from that feedforward networks

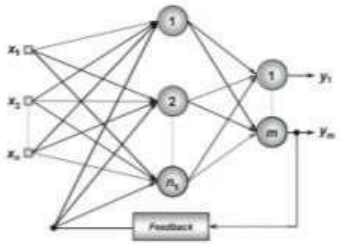

Fig 12: Recurrent Network Layer.

The output of this function of a neurons is employedas feedback inputs for other neurons within the network. The network feedback function suitable fordynamic informatics i.e., it will be used for time varying systems, statistic forecasting systems, identification and optimization, process control andlots of more. one among the input signals of a perceptron network with feedback to the center layeras shown in figure above.

4. CHARACTERISTICS OF NEURAL NETWORK

The neural network has mapping capabilities, whichmeans it can convert input patterns to output patterns. The neural network has the capacity to generalize, which means it can forecast new findingsor outcomes supported the previous trends. Becausethe neural network are resilient and fault resistant, they'll be noted as full patterns instead of incomplete, partial, or noisy patterns. The input is processed in parallel and in an exceedingly dispersed manner by the neural network

Applications

Image Processing and Computer vision also include image mapping, subdivision and analysis, image compression, computer vision ,stereo vision, and interpretation of your time varying visuals. Signal Processing: Seismic, signal analysis and morphology are also incorporated in to the signal processing. The Pattern Recognition comes with features like feature extraction, and classification, radar analysis, speech recognition, biometric authentication such as fingerprint identification, handwriting and character recognition analysis. Health: cytology, egg analysis and electrocardiogram, carcinoma, prosthetic designing, reduce hospital cost, improve hospital quality, consultation of new energy test, are just few of the medical topic addressed. Function Approximation: matter of learning how design a function that cause nearly identical output from the input vectors that has been modelled based on available training data. Forecasting: There are many real world issue in which the future occurrence must be predict using data. One such work is predict the behaviour of securities market indices

Advantages of Artificial Neural Network

A neural network can complete a task that a linear programme can't. When one amongst the neuralnetwork element fails, the remainder of the networkcan function normally because to their parallelism. Can manage data that's noisy or incomplete. thanks to their capacity that find out, That they are doing programming which is not require, making the artificial neural network straight forward to use during a type of applications. Artificial neural networks can pander to situations when there's not enough data or information. Artificial neural network has fast processing Speed

Disadvantages of Artificial neural networks

Large neural network need a protracted time interval. to coach a synthetic neural network, you may need an oversized data collection, and that theyhave an inclination to over fit. Before they'll operate,they need to be trained. It's tough to decipher their internal structure thanks to their black-box characterand radial basis function. whether or not data is
wrong, artificial neural network always produce accurate results

5. CONCLUSION

during this paper, we've learned about the basic of artificial neural network, it working, architectures, attributes and some applications to some critical regions. because the progressions of innovation are developing step by step, the importance of computerscience is subsequently increments. In current days, various investigations are created, and specialists are kept on propelling their insight in these fields of computing. For the longer term perspectives, there should be progression in fostering a calculations andmethods to beat the restrictions of artificial neural networks.

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