iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IV **Month of publication:** April 2021

DOI: https://doi.org/10.22214/ijraset.2021.34009

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IV Apr 2021- Available at www.ijraset.com

Comparing Artificial Neural Network with Human Nervous System and Developing its Propagation Techniques

Ganesh Kappavandla[1], Siddhartha Kappavandla[2], Rohan Vajanala[3]
[1]*Sreenidhi Institute of Science and Technology, Yamnampet, Ghatkesar, Hyderabad, Telangana, India*
[2] *Sree Vidyanikethan Engineering College, Sree Sainath Nagar, Tirupati, Andhra Pradesh, India*
[3]*Sreenidhi Institute of Science and Technology, Yamnampet, Ghatkesar, Hyderabad, Telangana, India*

Abstract: ***The purpose of this paper is to introduce Artificial Neural Network (ANN) and to make it simple to understand its structure by comparing it with the biological nervous system of animals and to find propagation techniques. It helps to understand it clearly when working on more complex projects in fields of Artificial Intelligence or Machine Learning. ANN is used to simulate the human thought process by mimicking processes of the biological nervous system and it helps to find optimal output solutions for specific input conditions.***
Keywords: Artificial Neural Network, Parallel Distribution, Biological Neural Network

I. INTRODUCTION

As the name suggests, Artificial Neural Network is a manufactured nervous system which helps to mimic human thought process by using nodes to replace the vast amount of neurons in the brain of humans. ANN is used to do specific tasks like classifying data, pattern recognition by using its learning process. The advantage of ANN is a neural system can be used to calculate results to nonlinear information, which means the more complex the neural network is the more data it can learn if ta neural system is complex enough it can learn anything. ANN uses a parallel distributed processing system so even it fails to process it will continue because of its parallel processing [1]. Its accuracy is dependents on the amount of training it keeps on increasing itself from previous successes and failures. It stores all its previous inputs and outputs so that it can develop itself by comparing both produced and required outputs.

II. STRUCTURE OF BIOLOGICAL NEURAL NETWORK (BNN)

The human brain is a complex computer there is it will help to solve problems [2][3]. Neurons are building blocks of the human nervous system. The nervous system is part of the animal, which is used to transmit signals throughout its body. Neurons act as the road for the delivering message. The nervous system consists of neurons and nonneuronal cells. Neurons are used to transmit the message from the brain to different parts of the body in form of electric impulses, whereas non-neuronal cells are used to maintain homeostasis and protect and support neurons. In the brain of a human being, there are eighty-six billion neurons and eighty-five billion nonneuronal cells.

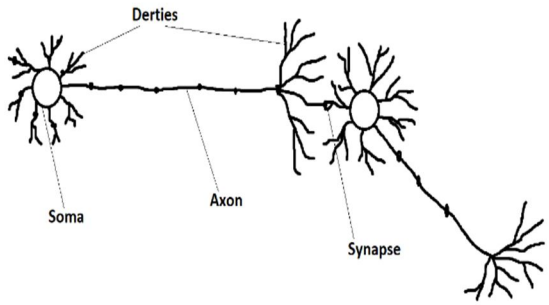


Fig.1. Structure Biological Neural Network

All neuron cells in an animal body are interlinked to each other to transfer data from the brain to all other cells in the body like muscles, glands. Neurons consist of three major parts: soma or cell body, dendrites, and axon [4].

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IV Apr 2021- Available at www.ijraset.com

A. Dendrites

Dendrites are used to receive data from neuron to neuron, these are parts of neurons that are specialized to receive messages in form of chemical signals. Dendrites convert this chemical signal into electrical signals in form of electrical impulses to transfer this signal to different cells.

B. Soma

Soma is also known as the Cell body, is used to carry genetic information through the neuron. This is the core of the neuron; this is used by the neuron to maintain its structure. Soma collects all the information gathered by Dendrites and processes this information before sending it to other cells. A neuron is connected to many other neurons and Soma decides to which neuron this information should be sent. Soma contains the nucleus of the cell and other specialized organs.

C. Axon

Axon or Nerve fiber is used to connect one neuron to another, this takes information in form of electrical impulses from the cell body and transmits it to the interconnecting neurons. The length of the neuron is considered by the length of the axon. Axon's length varies by the parts of the body it is connected to. This is used to transfer chemical and electrical information signals to different cells like other neurons or muscle cells.

D. Synapse

Synapse is the small gap between two neurons. This gap is used to transfer electrical impulse signals from neuron to neuron. This is not part of a neuron, because it is not a part it is the name of space between two neurons. The smaller this space is the better information is transferred between neurons. Synapse is important in brain function. These are used to transfer information or data to other neurons or the targeted cells.

III. STRUCTURE OF ARTIFICIAL NEURAL NETWORK (ANN)

In computational systems, ANN is used to create thought processes. It is used to mimic Biological Neural networks by using nodes to replace neurons [5][6]. These nodes are called artificial neurons or processing elements (PE) [7]. Input is given to ANN in form of patterns and vectors, ANN uses a mathematical approach to process this input data and finds patterns in the model [4].

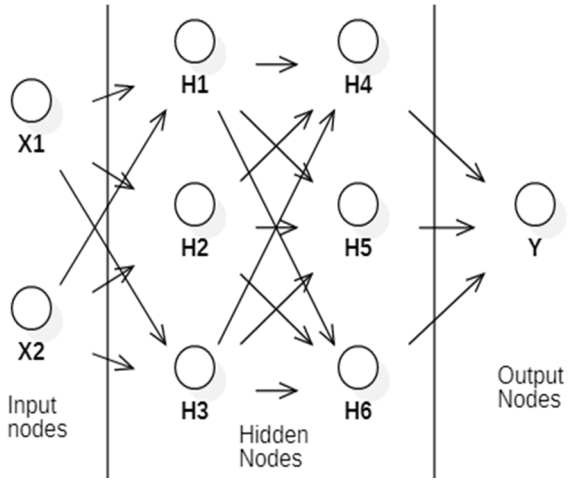


Fig.2. Structure Artificial Neural Network

For every input and output, there has to be a different type of structure to perform a certain task. This structure is defined by the perceptron algorithm. Perceptron is an algorithm or a function that helps in mapping input “x”, this will multiply with the weight of the function to generate an output function of value “f(x)”. The structure of ANN consists of three types of nodes: Input nodes, Hidden nodes, and Output nodes [4]. Input nodes collect information from the programmer and transfer this collected data to the successive nodes which are hidden nodes. Hidden nodes gather this information provided by input nodes and perform functions on this data and transfer this to the next node this will do the same until the data is transferred to the output node. Output nodes gather this data to produce an output value.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IV Apr 2021- Available at www.ijraset.com

IV. AND LOGIC GATE PERCEPTRON MODEL

Given below is a figure of a feedforward structure of AND logic gate.

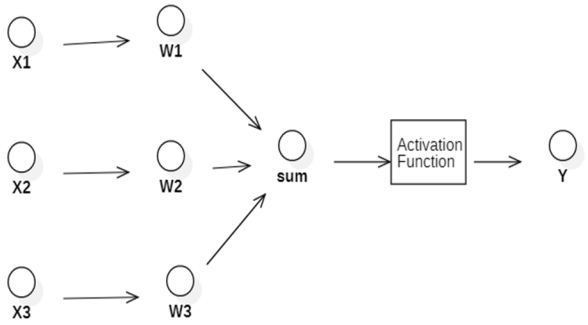


Fig.3. AND Logic Gate ANN Structure

AND gate is a logic gate that performs a specific multiplication operation, it multiplies all the inputs and produces the output according to its truth table. In AND logic gate output value will be HIGH (1) if and only if all the input values are HIGH, and the output value will be LOW (0) if any of the input values are LOW.

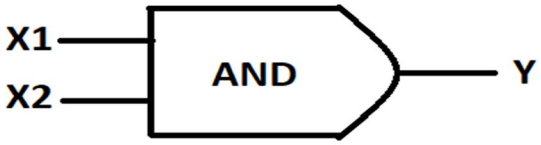


Fig.4. Basic AND Logic Gate

The Truth Table of this circuit of AND logic gate is given as:

X1	X2	Y
0	0	0
0	1	0
1	0	0
1	1	1

Fig.5. Truth Table of AND Logic Gate

This perceptron model is proposed by Minsky-Papert, it solves few limitations set by the McCulloch-Pitts neuron (M-P neuron) model. In the M-P neuron model inputs are limited to the Boolean values, this new perceptron model solves this problem by adding weights to each input. By giving them weights these inputs will have priorities.

In ANN structure of AND logic gate output value will be HIGH (1) if the product of input and its weight is a positive value, Otherwise it will be LOW (0).
Therefore, output "Y" is given as:
$Y=\sum_{i=1}^{n} Wi * Xi = (W_1*X_1)+(W_2*X_2)+(W_3*X_3)$
By observing the truth table and the above equation we can derive the following formula:
Y= 1, if $\sum_{i=1}^{n} Wi * Xi \geq \theta$
= 0, if $\sum_{i=1}^{n} Wi * Xi < \theta$
Here theta (θ) is the arbitrary threshold. By sending theta to another side of the formula this equation can be rewritten as:
Y= 1, if $\sum_{i=1}^{n} (Wi * Xi) - \theta \geq 0$
= 0, if $\sum_{i=1}^{n} (Wi * Xi) - \theta < 0$

By adding one more input to the logic gate and having negative theta (-θ) as its weight arbitrary threshold can be removed from the equation.

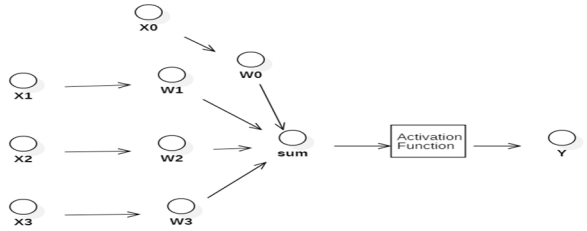


Fig.6. Updated Perceptron Model

In this model weight of the newly added input is W_0= -θ and the input value will be X_0= 1. So the output value will be given as:

Y= 1, if $\sum_{i=0}^{n} Wi * Xi \geq 0$

= 0, if $\sum_{i=0}^{n} Wi * Xi < 0$

Where X_0= 1 and $W_{0=}$ -θ.

From this, it is clear that a perceptron can be divided into two halves, positive and negative halves. Inputs that produce HIGH (1) value are stored in the positive half, and inputs that produce LOW (0) value are stored in the negative half. This proves that perceptron will be stored in the Linear separable function.

This method is also used to make other logic gates like OR, NOT, XOR.

V. PROPOGATION TECHNIQUES

In ANN there are two types of propagation methods, they are:

1) Forward Propagation

2) Backpropagation

In both propagation techniques, the execution will be different.

A. Forward Propagation Technique

In the forward propagation model, the data flow will start at the input layer and data will keep going to its successive node until it reaches the end [8].

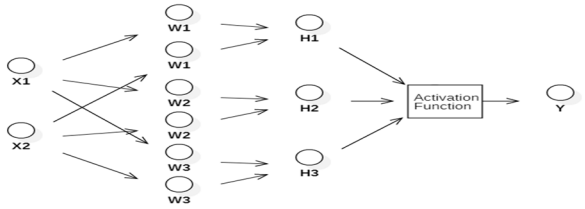


Fig.7. Forward Propagation Model

In this, every hidden node weights different importance, so the output can be calculated as follows:

Let,

W_1- Weight of node H_1

W_2- Weight of node H_2

W_3- Weight of node H_3

H_1= $\sum_{i=1}^{n}$ Wi ∗ X1

H_2= $\sum_{i=1}^{n}$ Wi ∗ X2

H_3= $\sum_{i=1}^{n}$ Wi ∗ X3

Y= f(H_1,H_2,H_3)

Here, f(.) is the function performed by the activation function node.

The forward propagation technique is useful for assuming the output of the function and is also used in hypothesis problems. This is used only in supervised learning processes because in this method data or information is transferred in a forward process, that is from the input nodes to the output node.

B. Backpropagation

The backpropagation model is used to reduce the errors in the output function of the model, it is used to train the program. In this model, if there are any errors in output then this value along with the expected output value are sent to previous nodes to rectify these errors [9].

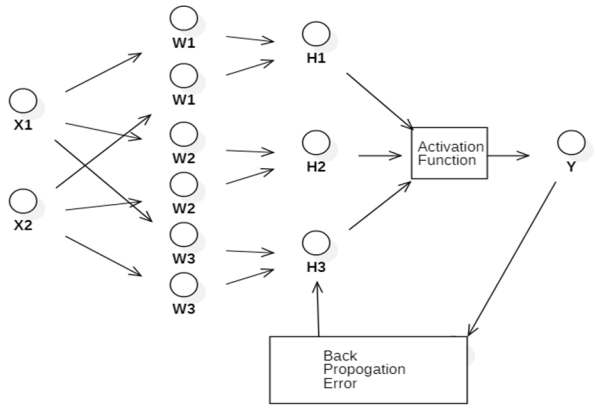


Fig.7. Backpropagation Model

The total error is calculated by subtracting the expected output value from the observed output value.

Error= Expected Output-Observed Output

After finding the error, it will be used to update weight for minimizing the errors [10]. Partial differentiation of error with weight is needed in finding the updated weights. This partial differentiation will be multiplied with a small value called Learning Rate (η). This will produce the error between actual weight and given weight. So given weight value will be subtracted with the error function value.

$W_1 = W_1 - (\eta * \partial(\text{error}) / \partial(W_1))$

$W_2 = W_2 - (\eta * \partial(\text{error}) / \partial(W_2))$

$W_3 = W_3 - (\eta * \partial(\text{error}) / \partial(W_3))$

After updating, the output value will be calculated again this process will be until the output will get close to the expected output, and the error is almost negligible.

VI. CONCLUSION

This paper is focused on the similarities between the biological neural network and the artificial neural network to understand its structure and process, also on the Perceptron concept, and explain the perceptron model with an example of AND logic gate. In this paper, we also pointed out the propagation techniques. This paper will help to understand the concepts of neural network models and their propagation techniques.

REFERENCES

[1] R. E. Uhrig, "Introduction to artificial neural networks," Proceedings of IECON '95 - 21st Annual Conference on IEEE Industrial Electronics, 1995, pp. 33-37 vol.1, doi: 10.1109/IECON.1995.483329.

[2] A. K. Jain, Jianchang Mao and K. M. Mohiuddin, "Artificial neural networks: a tutorial," in Computer, vol. 29, no. 3, pp. 31-44, March 1996, doi: 10.1109/2.485891.

[3] M. Mishra and M. Srivastava, "A view of Artificial Neural Network," 2014 International Conference on Advances in Engineering & Technology Research (ICAETR - 2014), 2014, pp. 1-3, doi: 10.1109/ICAETR.2014.7012785.

[4] N. A. Al-Sammarraie, Y. M. H. Al-Mayali and Y. A. Baker El-Ebiary, "Classification and diagnosis using back propagation Artificial Neural Networks (ANN)," 2018 International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2018, pp. 1-5, doi: 10.1109/ICSCEE.2018.8538383.

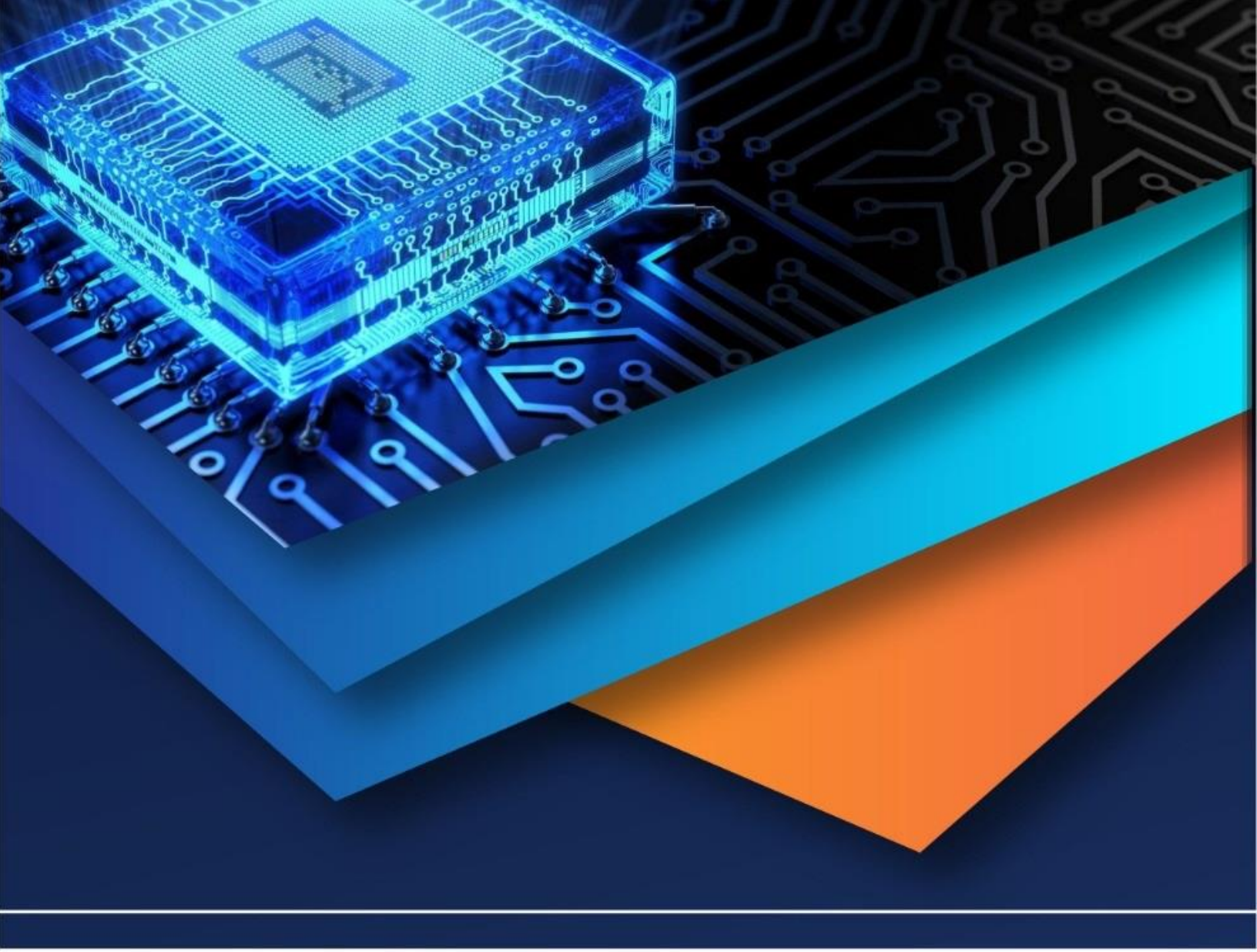
[5] J. Dalton and A. Deshmane, "Artificial neural networks," in IEEE Potentials, vol. 10, no. 2, pp. 33-36, April 1991, doi: 10.1109/45.84097.

[6] Gao Ningning, "Artificial neural network management system," The 2nd International Conference on Information Science and Engineering, 2010, pp. 1891-1894, doi: 10.1109/ICISE.2010.5690052.

[7] Er.Parveen Kumar , Er.Pooja Sharma, "Artificial Neural Networks-A Study", International Journal of Emerging Engineering Research and Technology Volume 2, Issue 2, May 2014, PP 143-148 https://en.wikipedia.org/wiki/Artificial_neural_network

[8] Krenker, A., Bester, J., & Kos, A. (2011). *Introduction to the Artificial Neural Networks. Artificial Neural Networks - Methodological Advances and Biomedical Applications.* doi:10.5772/15751

[9] Grossi, E., & Buscema, M. (2007). *Introduction to artificial neural networks. European Journal of Gastroenterology & Hepatology, 19(12), 1046–1054.* doi:10.1097/meg.0b013e3282f198a0



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY