Research Study on basic Understanding of Artificial Neural Networks

By Pritom Bhowmik

Institute of Engineering & Management

Abstract- Artificial neural networks are a computing system inspired by human neuron, designed to simulate the way human brain analyzes and processes information. They are the foundation of artificial intelligence and machine learning technology. This research paper focuses on the basic understanding of Artificial neural networks. ANN create a lots of excitement in Machine learning research and that results a huge development on many AI and machine learning systems like text processing, speech recognition, image processing. Neural networks consist of input and output layers, in many cases hidden layer consisting of units that transform the input into something that the output layer can use. They are essential tools for finding patterns which are far too complex or numerous for a human programmer to extract and teach the machine to recognize.

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GJCST-D Classification: *F.1.1*

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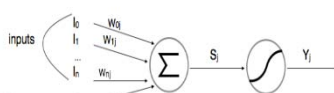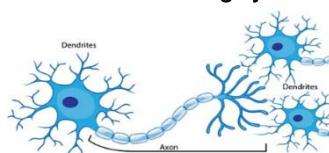
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Research Study on basic Understanding of Artificial Neural Networks

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Abstract- Artificial neural networks are a computing system inspired by human neuron, designed to simulate the way human brain analyzes and processes information. They are the foundation of artificial intelligence and machine learning technology. This research paper focuses on the basic understanding of Artificial neural networks. ANN create a lots of excitement in Machine learning research and that results a huge development on many AI and machine learning systems like text processing, speech recognition, image processing. Neural networks consist of input and output layers, in many cases hidden layer consisting of units that transform the input into something that the output layer can use. They are essential tools for finding patterns which are far too complex or numerous for a human programmer to extract and teach the machine to recognize.

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I. Introduction

A human brain is highly complex, non-linear and parallel computer but it computes in an entirely different way from the conventional digital computer. Human brain can perform certain computations like motor control, recognition & perceptions much faster than the fastest digital computer in existence today. And to perform such tasks, human brain has the capability to organize brain's structural constituents, known as neurons. Artificial Neural networks are typically organized in layers. Layers are made up of a number of interconnected nodes which contain an activation function. Patterns are presented to the network via the input layer, which communicates to one or more hidden layers where the actual processing is done via a system of weighted connections.

Neurons in a neural net can be viewed as nodes in a layer network, but as a node in a neural net the neuron not only sums up the weighted inputs from other nodes in one of the neighboring layers but also performs a nonlinear transformation on the summation, then the output of this neuron will be sent to all neurons in the next layer with links to it. Nodes or computational elements in neural nets are nonlinear and typically realized by analog circuits. Different types of nodes, distinguished by types of nonlinearities, can be used in one network. So there are three key factors for specifying a neural net:
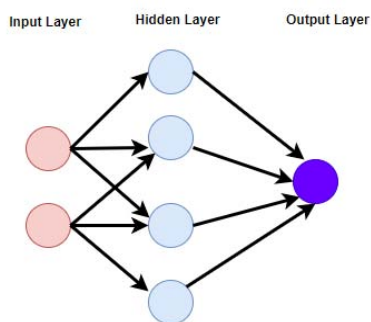
Author: Department of Computer Science & Engineering   Reg. Institute of Engineering & Management, Sector-V, Salt-Lake, Kolkata.
e-mail: pritom01bh@gmail.com

The net topology: Topological factors include feed forward type network or feedback type network, the number of layers, and the number of nodes in each layer.

The weights specification: There are two cases: predetermined weights and adapted weights. Adaptation or learning is the main feature of artificial neural nets. The ability to adapt and continue learning is essential in areas such as speech recognition.

The type of nodes (neurons): Different nonlinearities realized by analog circuits or more complex mathematical operations realized by digital circuitries can be considered. The type of neurons also determines the time feature of the network operation: the nodes operate continuously or at discrete amounts of time.

II. A Simple Artificial Neural Network

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. And the brain basically learns from experience. Artificial neural network is the basic tools used in machine learning. A neural network consists of input layers, hidden layers, output layers. A hidden layer is consisting of units that take data from input and process so that output layer can use it.

Neural networks are sometimes described in term of their depth, number of layers have between input and output. They are also described by the number of hidden nodes the model has. Also by the number of input output each of the node has.

III. An Artificial Neuron

The basic unit of computation in a neural network is the neuron, often called a node or unit. It receives input from some other nodes, or from an external source and computes an output. The working of an artificial neuron is completely different from human brain's neuron. An artificial neuron is a device with many inputs and one output. Training mode and using mode; are two modes of operation for an artificial neuron. In training mode, the neuron can be trained to fire or not to fire for a particular input patterns. In using mode, when trained input pattern in input, its associated output becomes the current output. But if the input pattern does not match with the pattern the neuron knows, means the input pattern does not belong in the taught list of the neuron, the firing rule is used to determine whether to fire or not.

IV. The *Perceptron* Model

The perceptron model, proposed by Minsky-Papert, is a general computational model than McCulloch-Pitts neuron. The most basic unit of Neural Network is known as artificial neuron that works as Sigmoid. It takes input, process it, passed it through an activation function and returned the activated output.

[A simple Neuron]
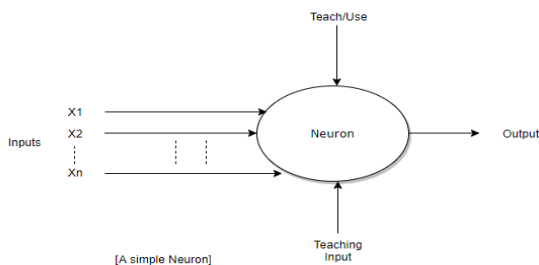
A perception can have any number of inputs. If we take binary inputs X1, X2, ------ Xn and produce binary output which is called its activation. Now the amount of influence each of the input has over output is weight (W). So X1 has a weight W1, X2 has a weight W2, Xn has a weight Wn. We take the weighted sum of each of the inputs and can determine if it is above or below a certain threshold. The formula can be presented by this.

$$\text{Output} = \begin{cases} 0 \text{ if } \sum_j w_j x_j \leq \text{Threshold} \\ 1 \text{ if } \sum_j w_j x_j > \text{Threshold} \end{cases}$$

In this formula, Output is the activation of the perception. Output=0 presents the weighted sum is less or less than equal to the Threshold and output=1 presents the weighted sum is greater than the threshold.

V. A Single Neuron's Operation

A neuron's operation follows by perceptron model. Each neuron adds up the value of every neuron from the previous column it is connected to. And each of the value is multiplied by the weight of that neuron before addition. Weight determines the connection between two neurons and each connection has its own weight. Now when the learning process goes on, the weights of each connection between neurons changes. Then a bias value maybe added to the total value calculated. Bias is like the intercept added in a linear equation. It is an additional parameter in the neuron and that helps the model to fit best for the given data.

*Output = sum (weights * inputs) + bias*
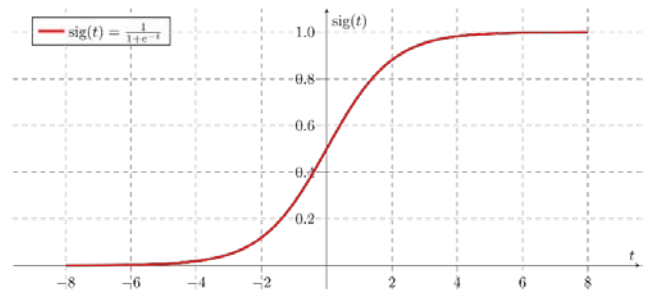
After that the neuron finally applies a function called activation function. The job of activation function is to turn the calculated output value into 0 and 1 using sigmoid function. Every activation function takes a single number and performs a certain fixed mathematical operation on it. There are several activation functions you may encounter in practice:

- *Sigmoid:* Takes a real-valued input and squashes it to range between 0 and 1

$\sigma(x) = 1 / (1 + \exp(-x))$
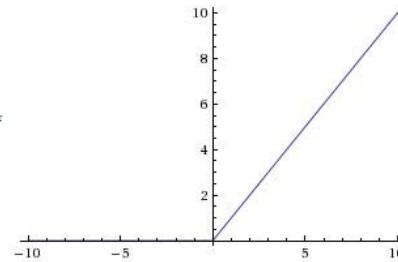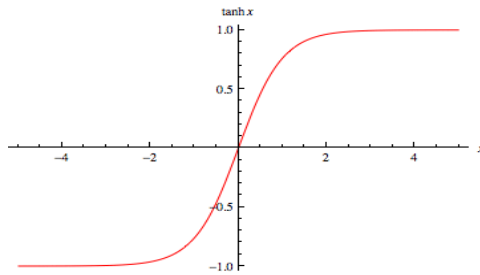
- *Tanh:* Takes a real-valued input and squashes it to the range [-1, 1]

$\tanh(x) = 2\sigma(2x) - 1$

- *ReLU:* ReLU stands for Rectified Linear Unit. It takes a real-valued input and thresholds it at zero (replaces negative values with zero)

$f(x) = \max(0, x)$

To compute the gradient of the cost function we use an algorithm that is known as backpropagation. This algorithm is much faster than the earlier approaches for learning and make it possible for neural nets to solve problems. The backpropagation algorithm looks for the minimum of the error function in weight space using the method of gradient descent. The combination of weights which minimizes the error function is considered to be a solution of the learning problem.

VI. ARTIFICIAL NEURAL NETWORKS AND BEYOND

Artificial Neural networks deals with big quantities of data and work on traditional computation system. ANNs or artificial neural networks work on such problems where human can perform way much better than computer system such as image recognition, handwritten recognition, face recognition etc. Computer system are not as good as to solve at these problems. But in last decades we progress significantly on Artificial intelligence or AI. And ANN is the most crucial part. Simulating human consciousness and emotion is still the realm of science fiction. Of course, there are huge philosophical arguments about what consciousness is. But scientists around the world are working on developing such AI system. Perhaps Artificial Neural Network can make it possible in future. So ANN might in near future allow robot to see, predict the world around them, improve the stock prediction, composition of music. Self-driving car is not a science friction anymore.

VII. CONCLUSION

Neural networks are suitable for predicting time series because ANN learn from experience. Neural Network is a complex decision making process but they are very much good at generating result. ANN emulate human brain. It plays a very key rule in some most successful machine learning algorithms. The development of Neural network teach computer to think and perform as human do. The machine learning has gain a lot from machine learning. The ability of Neural Networks to learn from experience make it very much flexible and powerful. Neural network contributes in medical industry as well. Neuro-technology, phycology. They are used to understand internal mechanism human brain and also making model parts of living organism. So Artificial Neural Networks are very promising in the field of machine learning industry. In near future we might see autonomous computer that can solve problems as human. And hope it will be used for the welfare of human being and for a better world.

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