

ARTIFICIAL NEURAL NETWORK: IN DEPTH

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Abstract: *Abstract: Artificial neural network (ANN) also known as Neural Network (NN) is the foundation of Artificial Intelligence (AI) and solves problems which are impossible to solve by statistical or human standards. Neural networks are biologically motivated computer programs which processes information like human brain. ANNs were first used in the fields of cognitive science and engineering but recently their usage has significantly increase in other fields because they gather their information by finding patters and relationship in data and learn via experience. This paper is concerned with the notions behind design; implementation, working and application of neural networks. In this paper I have focused on explaining what neural networks are and how they form and work. This paper also focuses on scope of the neural network which will helpful in the further research.*

Keywords: *Neural network (NN), Artificial Intelligence (AI)*

I. INTRODUCTION

Innovations in computer technology and internet have change the way we live. Nowadays a huge amount of data get generated, stored and processed in minutes. In a report IBM mentioned that every single day, 2.5 quintillion bytes of data get generated. This presents a huge opportunity for anyone who can work out with this data and decode the information. In this paper I discuss how neural network (NN) function can be used to recognize pattern within data. Those can learn NN can go a long way in making better products for society which solves specific problems like classification. I used introduction to discuss what NN is and later sections to explain how it form, how it work, what it do and what challenges it faces and may be solved.

II. NEURAL NETWORKS

Dr. Robert Hecht Nielsen the inventor of first neurocomputer define neural network as:

"...a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.

In "Neural Network Primer: Part I" by Maureen Caudill, AI Expert, Feb. 1989

In simple words we can define neural network as a computer program which processes information like human brain and has the power to correct itself in order to generate better outcomes with an increase in the size of data.

Neural network are non linear predictive model they differ from other predictive linear models because they do not involve programming but creation of numerous parallel networks and the training of those networks to solve specific problems.

III. AIM OF THE STUDY

- Analytic study of neural network structure.
- Working of neural network.
- Limitations and advantages of neural network over other computing techniques.

IV. NEURAL NETWORK STRUCTURE

A neural network is formed from a large number of single units, processing elements or artificial neurons, joined with coefficients (weights), which makes up a neural structure and organised them in layers. The power of computation comes from joining neurons in a network. Each artificial neuron has coefficient input, transfer function and one as represented in figure 1

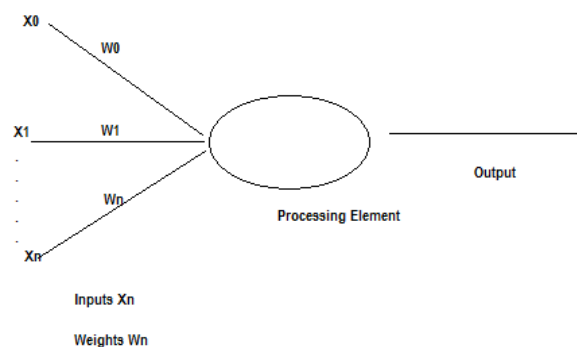


Figure 1

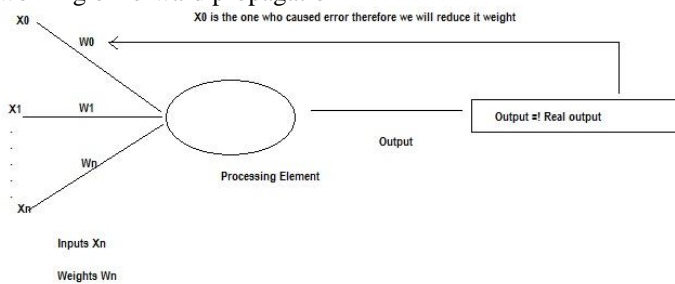
Fig.1. Representing neural network structure

In figure 1, various single units to the network are represented as X_n . Each of these single units are multiplied by a connection weight which are represented as W_n . These functions simply combined as per the given rule (rule can be like $I = \sum W_n X_n$) and move through a transfer function (transfer function can be like $y = f(I)$) to generate a result and then output.

V. WORKING OF NEURAL NETWORK

As shown in figure 1 neural networks takes large number of inputs, process them through multiple processing elements (for simplicity in figure 1 only one processing element is shown) and returns the output. This output estimation is called "Forward Propagation". After getting the neural network output, we compared it to real output. The objective is to trained neural network in such a way that output we get from it is close to real output. Therefore, those neurons which are contributing some error to neural network output we reduce their weight. To identify the neurons which are contributing to error we travel back to the artificial neurons of the neural network. This process of travelling back is known as "Backward Propagation". All neural networks use a common algorithm "Gradient Descent" to reduce errors.

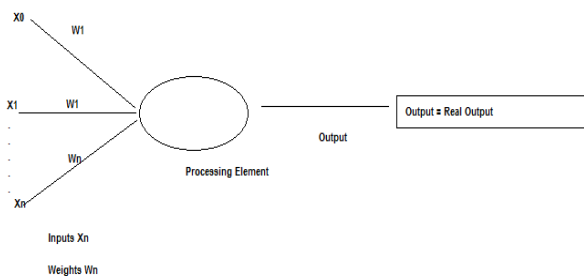
Figure 2 and figure 3 together shows working of backward propagation graphically (for simplicity we have shown only one processing element). We can consider figure 1 as working of forward propagation



When X0 weight is W0

Figure 2

Fig.2. Representing back propagation when weight of X1 is W0



When X0 weight is W1

Figure 3

(Here neural network output = real output)

Fig.3. Representing Neural Network working when weight of X1 is W1

As shown in figure 2 and figure 3 above we can fix neural network to get its output = real output but this process need lot of data. We can conclude neural networks learn by example like children learn to recognize ball from examples of balls.

VI. LIMITATIONS AND ADVANTAGES OF NEURAL NETWORK OVER OTHER COMPUTING TECHNIQUES

There are many limitations and advantages of neural network but to discuss them we have to look at each individual type of network, which is beyond the scope of this paper therefore we will focus only on backpropagational neural network

Limitations

- Backpropagational neural networks are considered equivalent to 'black boxes'. Other than defining the general structure of a networks and starting it with a random numbers, the user has no other work to do.
- Backpropagational neural networks are slower to train than other types of networks and generally need thousands of fixes. We can overcome this issue by running on a parallel computer.

Advantages

- When the relationship is dynamic or non-linear we can expect the network to train quite well as it backward propagation technique has the power to gain from internal data patterns.
- ANN unlike other techniques is not limited by strict assumptions of variable independence, linearity, normality etc.
- ANN can capture different kinds of relationships which are very difficult for a user to explain otherwise.

VII. SUMMARY

This paper provides a general idea of how neural networks work. The main objective of neural network is to make an algorithm which learns from experience and product output which is equal to real output. Neural networks are one of the hottest areas of research today their ability to learn from observing data sets give them a big edge over other linear predicting models. All data giants (Facebook, Google, Baidu etc.) have invested heavily in learning these algorithms. Classification, prediction, modelling and recognition all are application of neural networks. Hopefully in future neural networks will be used across industries.

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