ARTIFICIAL NEURAL NETWORK

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Abstract

Artificial Neural Networking or ANN is the way by which computers can mimic the biological nervous system by building a huge number of simulated neurons, which are joined together in a number of ways to form networks. A neural network has multiple processors instead of just one central processor and thus is very task efficient. They cannot be made to perform a specific task because they learn via experience, which is unlike any other computer processor. They follow certain learning laws while receiving feedback from the environment. This paper gives an overview of Artificial Neural Network, its working and training.

Keywords: *Artificial Neural Network (ANN), Neurons*

Introduction

We view computers as an advance piece of technology capable of doing large amount of computations at a very low amount of time. They have helped us complete tasks which would have been impossible without them. However, certain tasks like identification of faces, people's accents or recognising emotions, humans are still far superior than even the fastest and the most sophisticated super computer in the planet. For an example, when we meet an old friend, our brain tends to recognise their face immediately. A computer which has been programmed to recognise faces would run a scan, trying to match the person's face with all the faces stored into its data. Such process might take from minutes to even days. This could be partly because the algorithm that computers use to learn new things or adapt to certain environment is much different to that of a human. To change that, the concept of developing Artificial Neural Network came into existence in the early 1950s. The ANN concentrates of developing a huge number of simulated neurons, connected in a non-linear and parallel way to complete task. Some of the advantages of an ANN is –

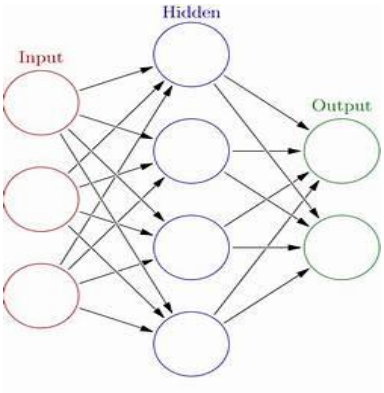
1. Non-linearity An Artificial Neural Network contains an enormous connection of simulated neuron, unlike computers today which are connected linearly.
2. Adaptivity: Neural Network can adapt the free parameters to the changes in the surrounding environment.

3. Evidential Response: ANN can make computers give decisions with a measure of confidence
4. Fault Tolerance: Artificial Neural Network follows what is called 'Graceful Degradation'. Basically, this means that the computer allows certain tolerance to some degradation in the software of in the simulated neurons.

Thus, Artificial Neural Networks take a different approach to solve a particular problem. Today, neural networks discussions are occurring everywhere. Their promise seems very bright as nature itself is the proof that this kind of thing works.

Construction

A neural Network can be constructed in a computer by having a deeper look on how information is transferred through a human brain. Certain information is first received through our sensory organs, which are then transferred through neurons to our brain, which performs certain calculations in regards to what response we want, and then sends that particular response. This exact process is imitated by the Artificial Neural Network. Neural network builds a huge number of simulated neurons, which are joined together in a number of ways to form networks. These simulated neurons are arranged in the form of layers, which works just like our nerves. These layers are connected through nodes which contain activation function. When one layer receives certain information, it passes on to the next layer. The layer might itself do the computation or pass it along. The following diagram shows how these connections are made:

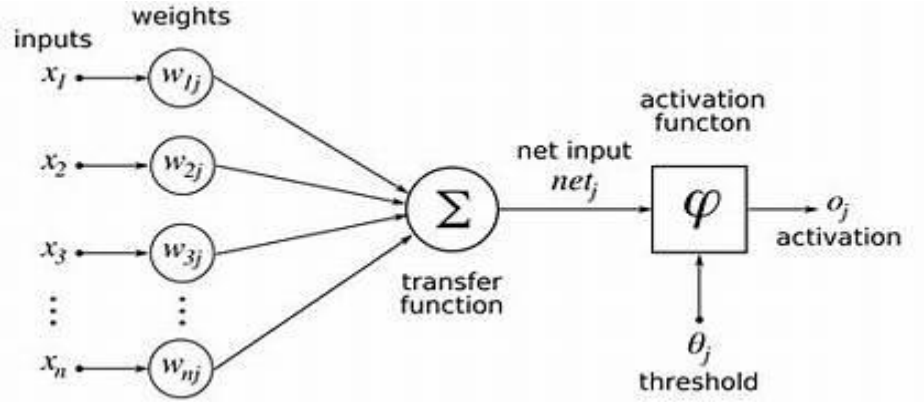


There is a total of 3 layers, the input layer imitates the sensory organs, which receives data from the user. The hidden layer is where the learning mechanism is put to use. The hidden layer could be singular, or multi-layered. A neural network consisting of multiple hidden layers can also be called as deep learning neural network.

Working

Scientists McCulloch and Pitts developed a network model for an ANN. This network model consisted of several inputs (x_1, x_2, x_3…., $x_{n)}$ with each input's effect being decided by the amount of weight associated with it (w_{k1}, w_{k2}, w_{k3}…., w_{kn}). The input is then multiplied with its corresponding weight to give the synaptic weights (u_k). A bias is associated along with the input to fit the prediction. These synaptic weights are then summed up along with the bias to give in

the transfer function to give a net input (v_k). v_k is then passed through an activation function, which contains a certain threshold, and only allows certain limited number of output. The output is thus obtained. All these process is represented in the diagram below.



The threshold is a particular graph that we feed into the activation function. The graph can be a unit step function graph, where if v_k is any positive integer, the output will be 1, otherwise 0.

Threshold function can also be a signum function, sigmoid function, or a Rectified Linear Unit function or RELU function.

Let's take an example to better understand the model. Consider that we have already trained an ANN on how to decide whether an individual is hospitalised or not. Based on the inputs such as the individual's age, gender, their location and income. Older people have a much higher chance of being hospitalised than younger men, and statistically men have a higher chance of being hospitalised than women. Our ANN can be trained to find the correlation between the distance of the hospital to the individual's location, and higher income means being able to afford the bills of the hospital, thus higher chance of being in the hospital. The threshold function is a unit step function. If the net input (v_k) is positive, then the individual is hospitalised, and if it is negative, then the individual is not hospitalised. The hidden layer does the main computations to decide the output. The weight of each particular input and the bias is developed by the program itself, based on how it has been trained.

Training is a vital step of making an ANN after constructing the model. A human child cannot learn everything on its own. It is the job of the parents and the teachers to constantly guide and supervise the child to explain them how to perform certain tasks, what things are morally right or wrong. But their learning is not just limited to the knowledge acquired by their supervisors. There are certain things which an individual learns on its own during its growth. In a very similar way, the ANN is trained. There are three ways by which an ANN can be trained:

1. Supervised Training: In a supervised training, we have a large housing of datas that we feed into the ANN. Thus, the ANN knows what type of inputs will be fed to it and what output needs to be derived. Thus, the input data is run through multiple programs in the hidden layers in such a way to derive the desired output. This is called forward propagation. In each complete step an error is found, which the computer recognises. We try to minimise the weights of the neuron for those that are contributing more to the error, and this happens while we go back to the neurons. This is called backward propagation. The computer repeats these steps, slowing the amount of adjustment made to the weights at every step, adjusting the weights in such a way that the error is minimised, until the desired output is found. Process of reduction of error can take a lot of time and power, so we had to develop a smart way to do these steps. A process called gradient descend is used to tackle with the problem of error reduction.
2. Unsupervised Training: In an unsupervised training process, only the inputs of the network has been provided, while the computer adjusts the weights on its own to give the desired output. The learning process is similar to that of the supervised training, but the decision whether the output is relevant or not is decided by the computer itself. This training allows the computer to learn new things on its own and adapt to certain changes without being told to do so. This is called "Artificial Intelligence".
3. Semi-supervised Training: In a semi-Supervised training process, the output is unknown, but the network provides the feedback whether the output is correct or incorrect.

Applications

An ANN is going to be beneficial to the human society in many ways, some of which are listed below:

1. Forecasting of weathers and stock markets.
2. Biometric securities such as facial recognition, fingerprint recognition or iris recognition.
3. Development of Artificial Intelligences among computers and making of robots.
4. Development of self-driving cars and regulation of traffic.
5. Diagnosis of certain undetectable diseases.
6. Recognition of handwriting and certain other calligraphy.

Conclusion

Neural networking is the future of computers. Its applications have already been vastly adopted in our day to day life such as in electronics like smartphones and smart TVs, to development of "Artificial Intelligence (AI)". With introduction of NPUs for dedicated AI tasks, our computer processor does not need to rely upon its CPU for every ANN tasks. The computer's dependency on us humans would lessen as they would learn how to adapt and change from time to time and reduce errors, create self-organisations and perform real time operation. With active study going on upon how to improve upon its learning law and create better ones, we must expect computers to soon outsmart us.

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