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Artificial Neural Networks

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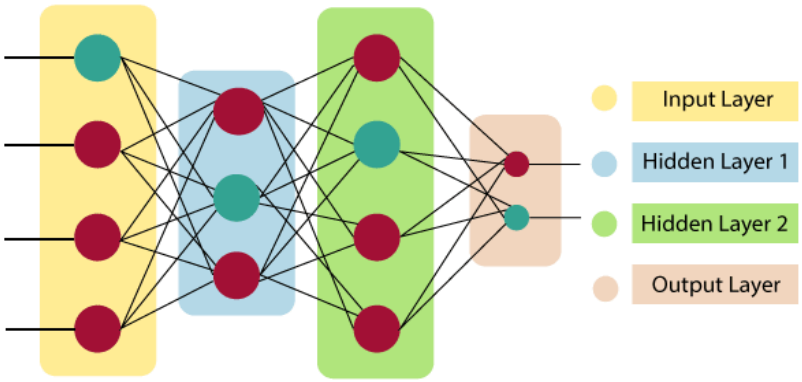
Abstract: Artificial neural networks (ANNs) also known as neural networks (NNs), are computing systems inspired by the biological neural networks constituting the animal brains. It is based on a collection of connected units or nodes called artificial neurons modeled upon the neurons in a biological brain. The neurons are split up into layers. Different layers perform different transformations based on their inputs. Signals travel from the input layer to the output layer possibly after traversing the layers several times.

An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Every connection unlike the biological brain can transmit a signal to other neurons. An artificial neuron receives a signal processes it and signals the neurons connected to it. The signal in the connection is a real number and the output is computed by non-linear function of the sum of its inputs. The connections are called edges. Neurons and edges typically have a weight that adjusts as learning proceeds, at a connection the weight increases or decreases the strength of the signal determining the strength of one node's influence on another. Neurons have a threshold which state that a signal is sent only if the aggregate signal crosses that threshold. Typically neurons are aggregated into layers. Different layers may perform different transformations on their inputs. The signals travel from the first layer to the last layer possibly after travelling the layers multiple times.

Each artificial neuron has inputs and produces a single output which can be sent to multiple other neurons. The inputs can be the feature values of a sample of external data, such as images or documents, or they can be the outputs of other neurons. Neurons are connected to each other in various patterns allowing the output of some neurons to become the input of others. Each neuron is a node which is connected to other nodes through links that correspond to biological "axon-synapse-dendrite" connections. The neurons are typically organized into multiple layers, especially in deep learning. Neurons of one layer connect only to neurons of the immediately preceding and immediately following layers. The layer that receives external data is the input layer. The layer that produces the ultimate result is the output layer. In between them exists a zero or more hidden layers. Between two layers, multiple connection patterns are possible. A full connection is established with every neuron in one layer connecting to every neuron in the next layer. They can be pooled where a group of neurons in one layer connect to a single neuron in the next layer, thereby reducing the number of neurons in that layer. Neurons with only such connections form a directed acyclic graph and are known as "feed-forward networks". Alternatively, the networks that allow connections between neurons in the same or previous layers are known as recurrent networks.

The human brain has around 1000 billion neurons. Each neuron has an association point somewhere in the range of 1,000 and 100,000. The data is stored in a distributed manner, and more than one piece of this data can be extracted when necessary parallelly from our memory, the human brain is made up of incredibly astonishing parallel processors.

Architecture:



Input Layer:

It accepts inputs in several different formats provided by the programmer.

Hidden Layer:

The hidden layer exists in-between input and output layers performing all the calculations to find hidden features and patterns.

Output Layer:

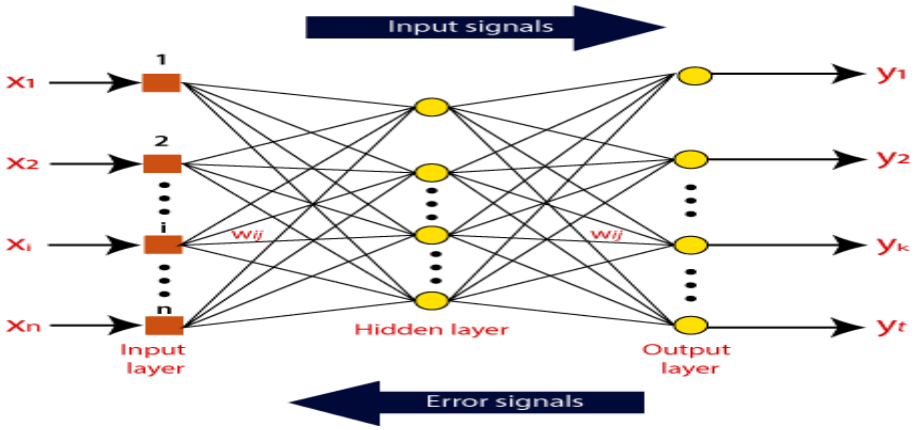
The input goes through a series of transformations using the hidden layer resulting in output that is conveyed using this layer.

The artificial neural network takes input and computes the weighted sum of the inputs thus including a bias. This computation is represented in the form of a transfer function. It determines that the weighted total is passed as an input to an activation function to produce the output. Activation functions choose whether a node should fire or not. Only those who are fired make it to the output layer. Various activation functions are available that can be applied upon the kind of task to be performed.

Functionality:

Artificial Neural Network can be best represented as a weighted directed graph, where the artificial neurons form the nodes. The association between the neuron outputs and neuron inputs can be viewed as the directed edges with weights. The Artificial Neural Network receives the input signal from the external source in the form of a pattern and image in the

form of a vector. These inputs are then mathematically assigned by the notations x(n) for every n number of inputs.



Each of the input is multiplied by its corresponding weights, these weights normally represent the strength of the interconnection between neurons inside the artificial neural network. All the weighted inputs are summarized inside the computing unit. If the weighted sum is equal to zero then the bias is added to make the output non-zero or something else to scale up to the system's response. Bias has the same input, and weight equals to 1 and the total of weighted inputs is passed through the activation function. The activation function refers to the set of transfer functions used to achieve the desired output. There is a different kind of the activation function, but primarily either linear or non-linear sets of functions. Some of the commonly used sets of activation functions are the Binary, linear, and Tan hyperbolic sigmoidal activation functions.

Binary: In binary activation function, the output is either a 1 or a 0 and to accomplish this a threshold value set up. If the net weighted input of neurons is more than 1, then the final output of the activation function is returned as 1 or else the output is returned as 0.

Sigmoidal Hyperbolic: The Sigmoidal Hyperbola function is generally seen as an "**S**" shaped curve. Here the tan hyperbolic function is used to approximate output from the actual net input. The function is defined as: **F(x) = (1/1 + exp(-????x))**

Types of Artificial Neural Network:

There are various types of Artificial Neural Networks (ANN). Depending upon the human brain neuron and network functions, an artificial neural network performs tasks. Majority of the artificial neural networks will have some similarities with a more complex biological partner and are very effective at their expected tasks.

Feedback ANN:
In this kind of ANN, the output returns into the network to accomplish the best-evolved results internally. The feedback networks feed information back into itself and are well suited to solve optimization issues. The Internal system error corrections utilize feedback ANNs.

Feed-Forward ANN:
A feed-forward network is a basic neural network comprising of an input layer, an output layer, and at least one layer of a neuron. Through assessment of its output by reviewing its input, the intensity of the network can be noticed based on the group behavior of the associated neurons and then the output is decided. The primary advantage of this network is that it figures out the evaluation and recognition of input patterns.

Conclusion:

Neural networks are suitable for predicting time series mainly because of learning only from examples without the need of additional information that can bring more confusion than the prediction effect. Neural networks are resistant to noise and feasibly handle almost any computational or contemplative task automatically, with greater processing power than the human brain they are an impressive technology responsible for tremendous breakthroughs in everything from speech recognition to medical diagnosis.

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