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Artificial Neural Networks(ANN)

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Content:

Artificial Neural Networks and Deep Neural Networks

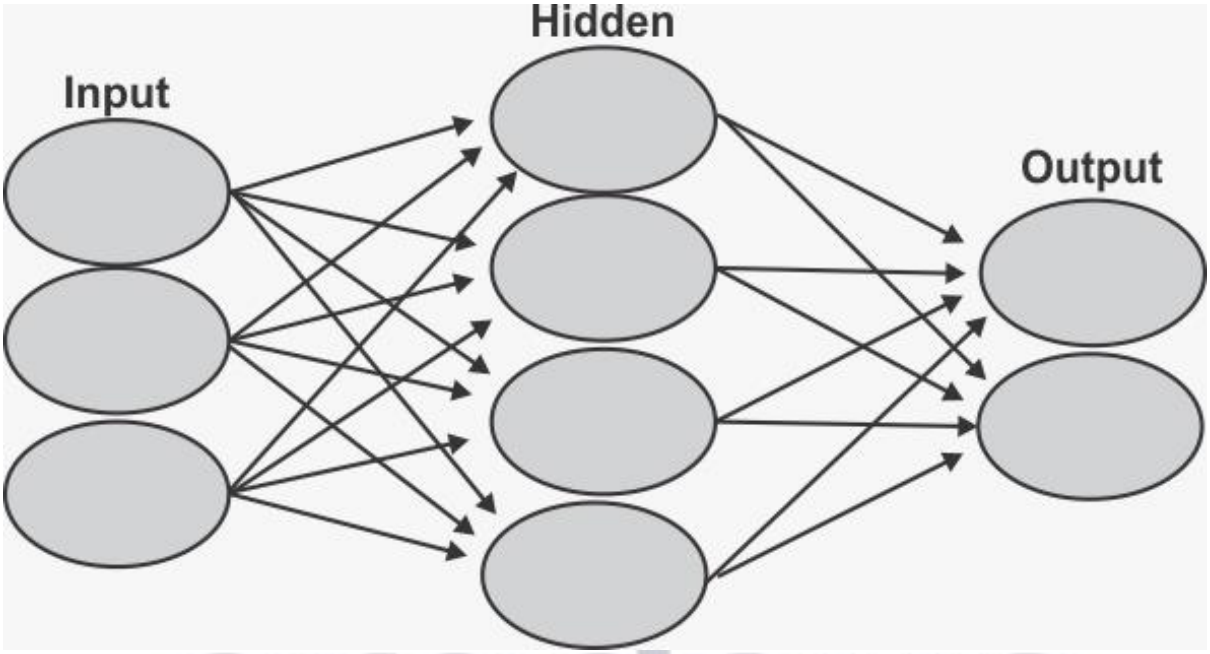
Artificial Neural Network (ANN) is a supervised loaming system built of a large number of simple elements, called neurons or perceptron. Each neuron can make simple decisions, and feeds those decisions to other neurons, organized in interconnected layers. Together, the neural network can emulate almost any function, and answer practically any question, given enough training samples and computing power. A "shallow" neural network has only three layers of neurons:

- An Input layer that accepts the Independent variables or Inputs of the model
- One hidden layer
- An output layer that generates predictions

A Deep Neural Network (DNN) has a similar structure, but it has two or more hidden layers of neurons that process inputs.

Formulation of Neural network

We will start with understanding formulation of a simple hidden layer neural network. A simple neural network can be represented as shown in the figure below.

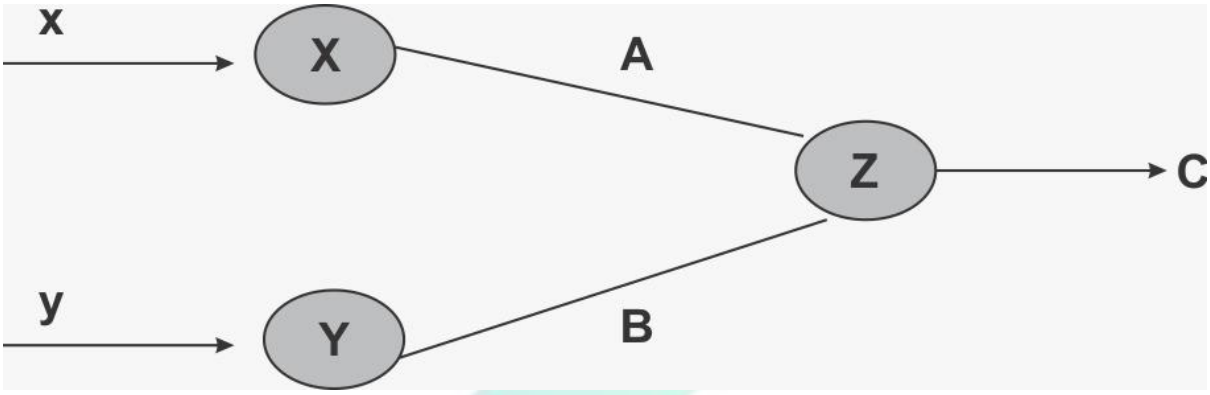


Characteristics of Artificial Neural Network

- It is neurally implemented mathematical model.
- It contains huge number of interconnected processing elements called neurons to do all operations.
- Information stored in the neurons are basically the weighted linkage of neurons.
- The input signals arrive at the processing elements through connections and connecting weights
- It has the ability to learn, recall and generalize from the given data by suitable assignment and adjustment of weights.
- The collective behavior of the neurons describes its computational power, and no single neuron carries specific information.

Neuron Working

Let there are two neurons X and Y which is transmitting signal to another neuron 2. Then, X and Y are input neurons for transmitting signals and Z is output neuron for receiving signal. The input neurons are connected to the output neuron, over a interconnection links (A and B) an shown in figure.



For above neuron architecture, the net Input has to be calculated in the way

1=xAB + Yb

where x and y are the activations of the input neurons X and Y. The output z of the output neuron Z can be obtained by applying activations over the net input.

O=f (1)

Output = Function (net input calculated)

The function to be applied over the net input is called activation function. There are various activation function possible for this.

A Neuro Genetic hybrid system is a system that combines Neural networks: which are capable to learn various tasks from examples, classify objects and establish relation between them and Genetic algorithm: which serves important search and optimization techniques. Genetic algorithms can be used to improve the performance of Neural Networks and they can be used to decide the connection

weights of the inputs. These algorithms can also be used for topology selection and training network.

Supervised learning

If you're learning a task under supervision, someone is present judging whether you're getting the right answer. Similarly, in supervised learning, that means having a full set of labeled data while training an algorithm.

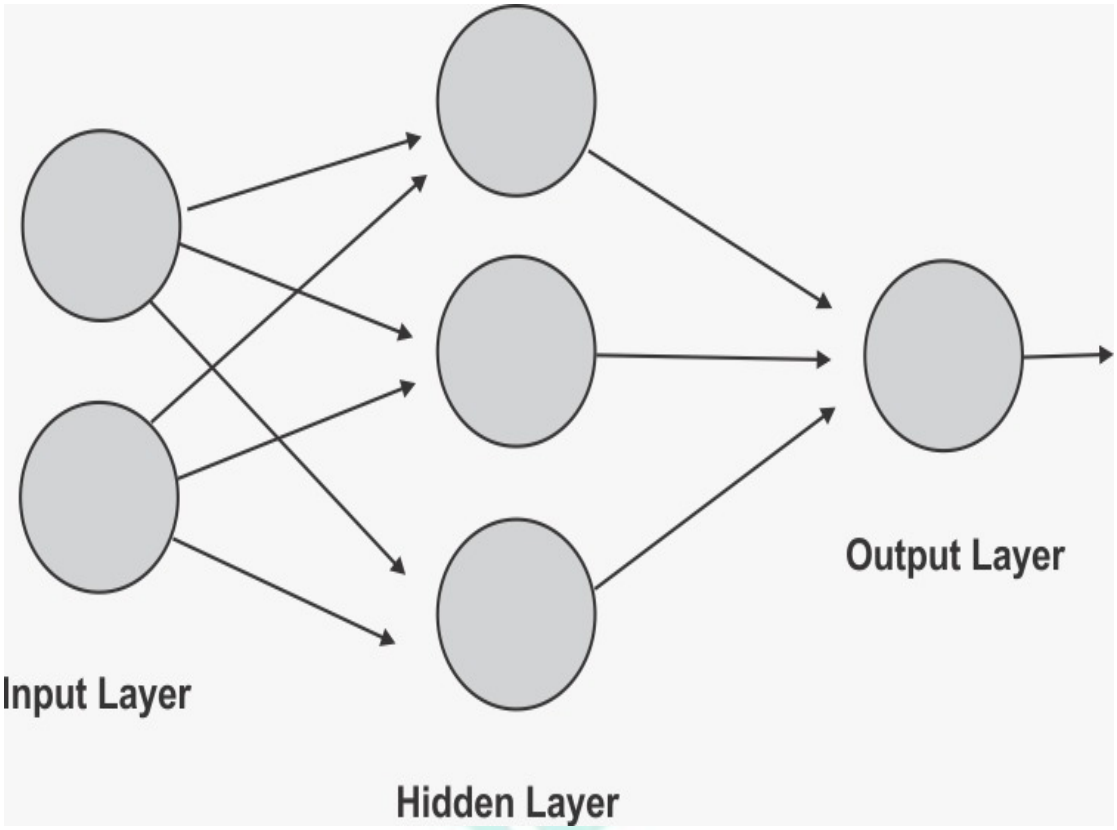
Fully labeled means that each example in the training dataset is tagged with the answer the algorithm should come up with on its own. So, a labeled dataset of flower images would tell the model which photos were of roses, daisies and daffodils. When shown a new image, the model compares it to the training examples to predict the correct label.

Unsupervised learning

In unsupervised learning, a deep learning model is handed a dataset without explicit instructions on what to do with it. The training dataset is a collection of examples without a specific desired outcome or correct answer. The neural network then attempts to automatically find structure in the data by extracting useful features and analyzing its structure.

Reinforcement learning

Video games are full of reinforcement cues. Complete a level and earn a badge. Defeat the bad guy in a certain number of moves and earn a bonus. Step into a trap- game over. These cues help players learn how to improve their performance for the next game. Without this feedback, they would just take random actions around a game environment in the hopes of advancing to the next level.



Reinforcement learning operates on the same principle - and actually, video games are a common test environment for this kind of research.

Perceptron

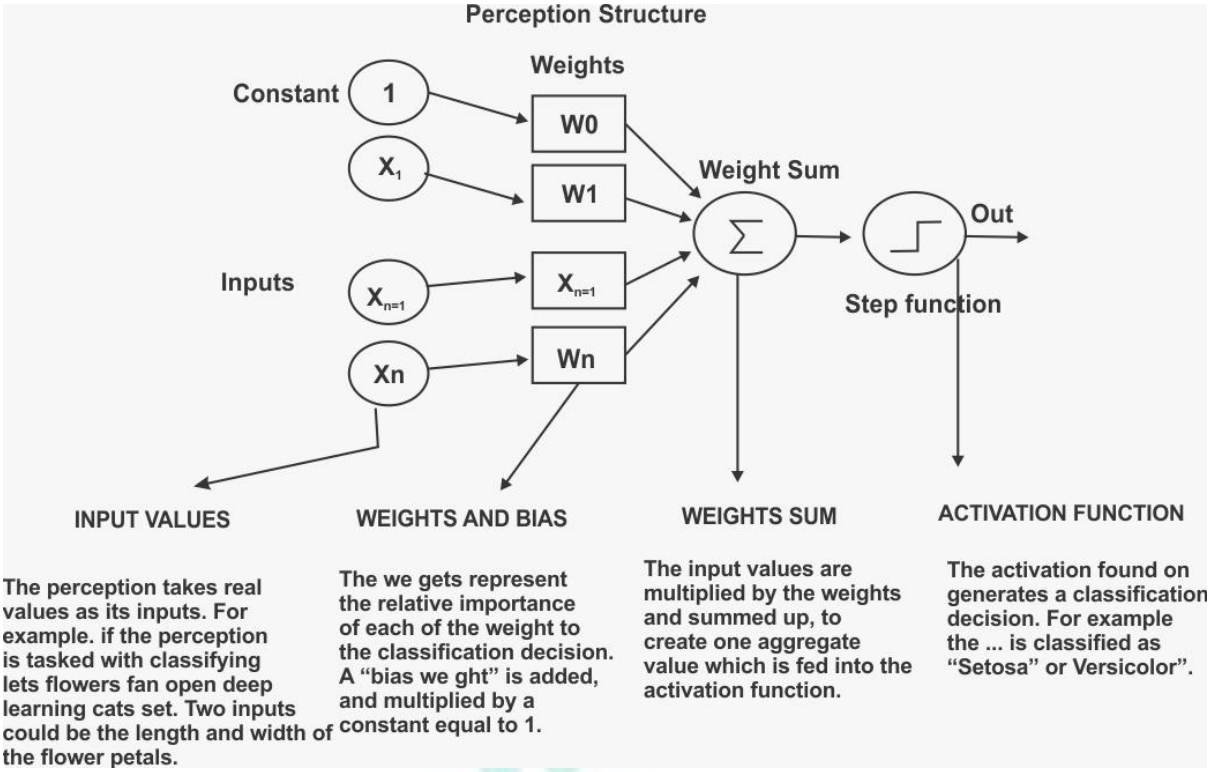
A perceptron is a simple binary classification algorithm, proposed by Cornell scientist Frank Rosenblatt. It helps to divide a set of input signals into two parts--"yes" and "no". But unlike many other classification algorithms, the perceptron was modeled after the essential unit of the human brain-the neuron and has an uncanny ability to learn and solve complex problems. A perceptron is a very simple learning machine. It can take in a few inputs, each of which has a weight to signify how important it is, and generate an output decision of "0" or “1”. However, when combined with many other perceptron’s, it forms an artificial neural network. A neural network can, theoretically, answer any question, given enough training data and computing power.

Multilayer Perceptron

A multilayer perceptron (MLP) is a perceptron that teams up with additional perceptron's, stacked in several layers, to solve complex problems. The diagram below shows an MLP with three layers. Each perceptron in the first layer on the left the input layer), sends outputs to all the perceptron's in the second layer (the hidden layer), and all perceptron's in the second layer send outputs to the final layer on the right (the output layer). Each perceptron sends multiple signals, one signal going to each perceptron in the next layer. For each signal, the perceptron uses different weights. In the diagram above, every line going from a perceptron in one layer to the next layer represents a different output. Each layer can have a large number of perceptron's, and there can be multiple layers, so the multilayer perceptron can quickly become a very complex system. The multilayer perceptron has another, more common name a neural network. A three-layer MLP, like the diagram above, is called a Non-Deep or Shallow Neural Network. An MLP with four or more layers is called a Deep Neural Network. One difference between an MLP and a neural network is that in the classic perceptron, the decision function is step function and the output is binary. In neural networks that evolved from MPs, other activation function can be used which result in outputs of real values, usually between O and 1 or between - 1 and 1. This allows for probability based predictions or classification of items into multiple labels.

Structure of a perceptron

The perceptron, or neuron in a neural network, has a simple but ingenious structure. It consists of four parts, illustrated below.



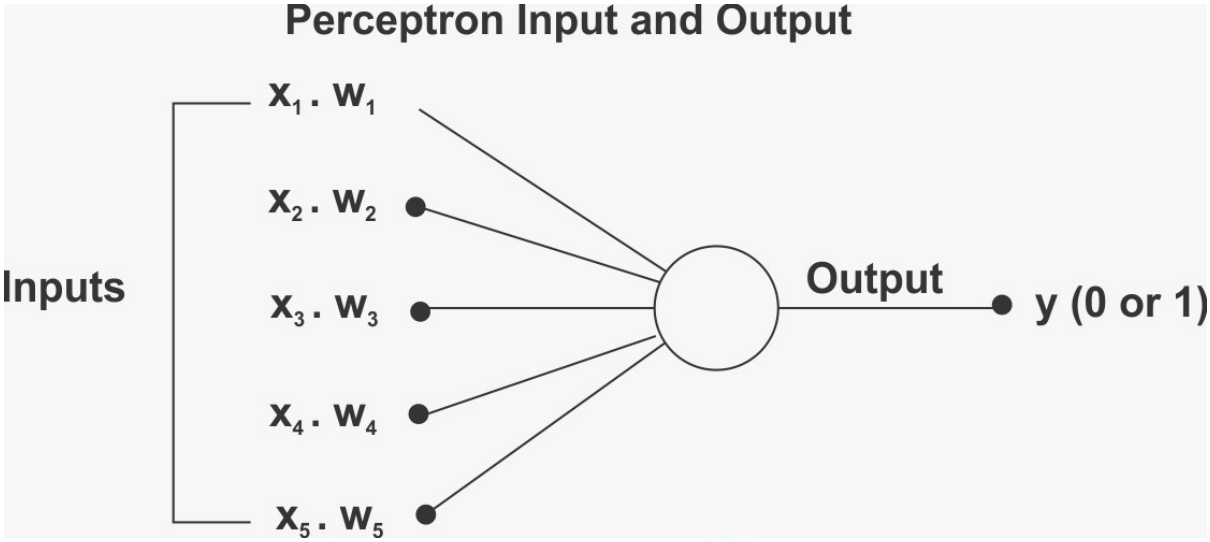
The perceptron learns as follows:

Takes the inputs which are fed into the perceptron's in the input layer, multiplies them by their weights, and computes the sum.

Adds the number one, multiplied by a "bias weight". This is a technical step that makes it possible to move the output function of each perceptron (the activation function) up, down, left and right on the number graph.

Feeds the sum through the activation function→ in a simple perceptron system, the activation function is a step function.

The result of the step function is the output.



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