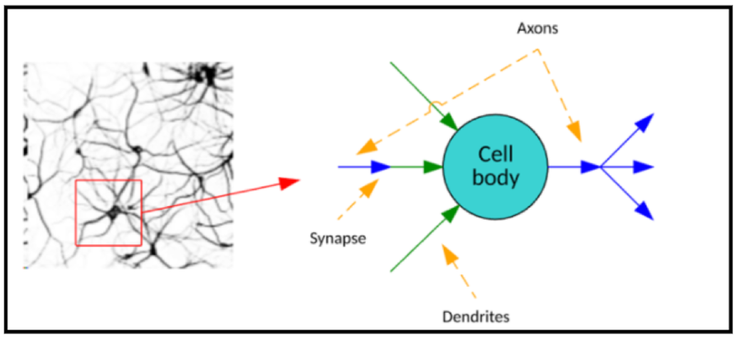
Machine Learning V2

Neural Networks

Neural networks represent an information-processing paradigm that is inspired by the human brain. In the brain, neurons are highly connected and communicate chemical signals through the synapses (a junction between two nerve cells) between the axons and dendrites. The human brain is estimated to have 100 billion neurons, with each neuron connected to up to 10,000 other neurons.

The figure shows a representation of a network of neurons in the brain.



Biological neural network

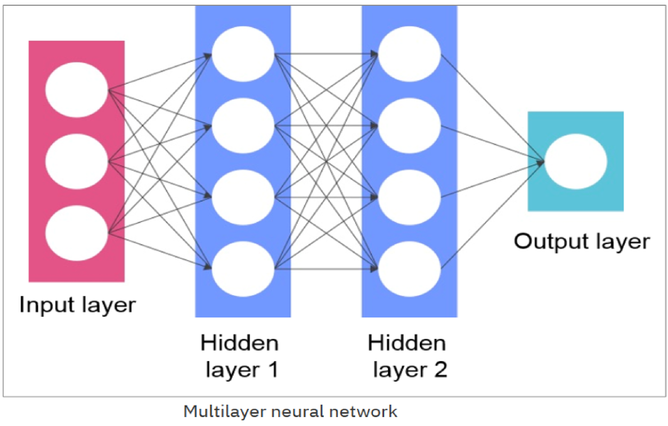
Artificial neural networks communicate signals (numbers) through weights and activation functions that activate neurons. Using a training algorithm, these networks adjust those weights to solve a problem.

Each node applies a mathematical transformation to the data it receives; it then passes its result to the other nodes in its path. Each connection between nodes represents a different parameter to the model.

A neural network is useful for machine learning tasks that have too many features (millions). For example:

- Object detection, tracking, and image and video analysis by using a Convolutional Neural Network (CNN)
- Natural language processing tasks like speech recognition and machine translation by using a recurrent neural network (RNN)
- Autonomous cars and robots (more complex neural networks)

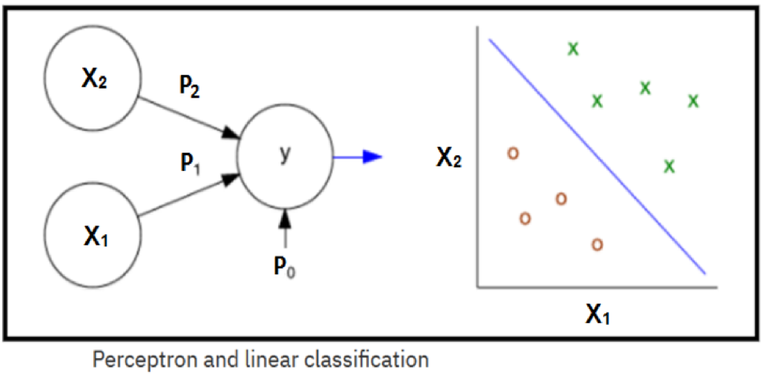
A neural network is composed of three or more layers: an input layer, one or many hidden layers, and an output layer. Data is imported through the input layer. Then, the data is modified in the hidden and output layers based on the weights that are applied to their nodes. The typical neural network can consist of thousands or even millions of simple processing nodes that are densely interconnected.



Multilayer neural network

Perceptron

A perceptron is a single neuron model that was an originator for neural networks. It is similar to linear regression. Each neuron has its own bias and slope (weights). For example, assume that a neuron have two inputs (X1 and X2), so it requires three weights (P1, P2 and P0). The figure below shows a weight for each input and one for the bias.



Perceptron and linear classification

Backpropagation

Backpropagation is an algorithm for training neural networks that have many layers. It works in two phases:

- Propagation of inputs through a neural network to the final layer (called feedforward).
- The algorithm computes an error. An error value is then calculated by using the wanted output and the actual output for each output neuron in the network. The error value is propagated backward through the weights of the network (adjusting the weights) beginning with the output neurons through the hidden layer and to the input layer (as a function of the contribution of the error).

Backpropagation continues to be an important aspect of neural network learning. With faster and cheaper computing resources, it continues to be applied to larger and denser networks.