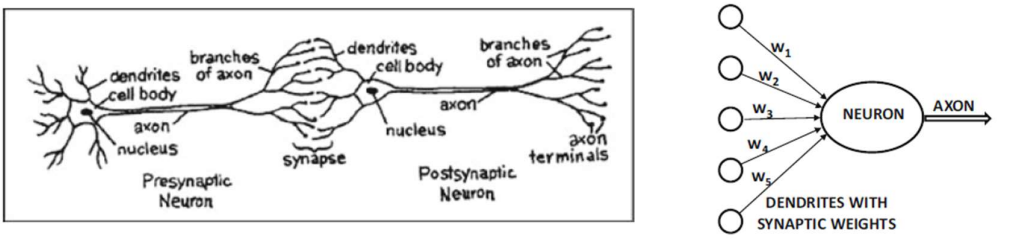
UNIT-1 INTRODUCTION

Neural Networks -notes

- Neural Networks-Application Scope of Neural Networks
- -Artificial Neural Network: An Introduction-
- Evolution of Neural Networks-
- Basic Models of Artificial Neural Network-
- Important Terminologies of ANNs-
- Supervised Learning Network.

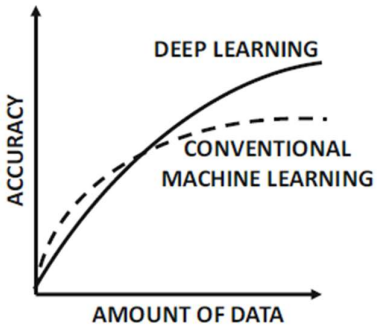
Neural networks

Artificial neural networks are popular machine learning techniques that simulate the mechanism
of learning in biological organisms. The human nervous system contains cells, which are referred to as *neurons*. The neurons are connected to one another with the use of *axons* and *dendrites*, and the connecting regions between axons and dendrites are referred to as *synapses*.



(a) Biological neural network (b) Artificial neural network

The goal of changing the weights is to modify the computed function to make the predictions more correct in future iterations.



An illustrative comparison of the accuracy of a typical machine learning algorithm with that of a large neural network. Deep learners become more attractive than conventional methods primarily when sufficient data/computational power is available.

HISTORY OF NEURAL NETWORKS

In 1943, neurophysiologist Warren McCulloch and mathematician Walter Pitts wrote a paper on how neurons might work. In order to describe how neurons in the brain might work, they modeled a simple neural network using electrical circuits.
In 1949, Donald Hebb wrote ***The Organization of Behavior***, a work which pointed out the fact that neural pathways are strengthened each time they are used, a concept fundamentally essential to the ways in which humans learn. If two nerves fire at the same time, he argued, the connection between them is enhanced.

As computers became more advanced in the **1950's,** it was finally possible to simulate a hypothetical neural network. The first step towards this was made by Nathanial Rochester from the IBM research laboratories. Unfortunately for him, the first attempt to do so failed.

In **1951**, **Narvin Minsky** made the **first Artificial Neural Network (ANN)** while working at Princeton.

In **1958**, "**The Computer and the Brain**" were published, a year after **Jhon von Neumann's** death. In that book, von Neumann proposed numerous extreme changes to how analysts had been modeling the brain.

In 1959, Bernard Widrow and Marcian Hoff of Stanford developed models called "ADALINE" and "MADALINE." In a typical display of Stanford's love for acronymns, the names come from their use of Multiple ADAptive LINear Elements.

ADALINE was developed to recognize binary patterns so that if it was reading streaming bits from a phone line, it could predict the next bit. MADALINE was the first neural network applied to a real world problem, using an adaptive filter that eliminates echoes on phone lines.

While the system is as ancient as air traffic control systems, like air traffic control systems, it is still in commercial use.

In 1972, Kohonen and Anderson developed a similar network independently of one another, which we will discuss more about later.
They both used matrix mathematics to describe their ideas but did not realize that what they were doing was creating an array of analog ADALINE circuits.

The neurons are supposed to activate a set of outputs instead of just one.

The first multilayered network was developed in 1975, an unsupervised network.

Applications of Neural Network

With an enormous number of applications implementations every day, now is the most appropriate time to know about the applications of neural networks, machine learning, and artificial intelligence. Some of them are discussed below:

Handwriting Recognition

Neural networks are used to convert handwritten characters into digital characters that a machine can recognize.

Stock-Exchange prediction

The stock exchange is affected by many different factors, making it difficult to track and difficult to understand. However, a neural network can examine many of these factors and predict the prices daily, which would help stockbrokers.

Currently, this operation is still in its initial phases. However, you should know that over three terabytes of data a day are generated from the United States stock exchange alone. That's a lot of data to dig through, and you must sort it out before you start focusing on even a single stock.

Traveling Issues of sales professionals

This application refers to finding an optimal path to travel between cities in a given area. Neural networks help solve the problem of providing higher revenue at minimal costs. However, the Logistical considerations are enormous, and we must find optimal travel paths for sales professionals moving from town to town.

Image compression

The idea behind neural network data compression is to store, encrypt, and recreate the actual image again. Therefore, we can optimize the size of our data using image compression neural networks. It is the ideal application to save memory and optimize it.

So, what does the future of neural networks look like?

Future of Neural Networks

With the rapid pace that AI and machine learning are being adopted by companies today, we could see more advancements in the applications of neural networks in the foreseeable future. AI and machine learning will offer a wealth of personalized choices for users worldwide. For example, all mobile and web applications try to give you an enhanced customized experience based on your search history, and neural networks can make that possible.

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Hyper-intelligent virtual assistants will make life easier. If you have ever used Google assistant, Siri, or any other products, you can see how they're slowly evolving. They may even predict your email responses in the future!

We can also expect intriguing discoveries on algorithms to support learning methods. However, we are just in the infant stage of applying artificial intelligence and neural networks to the real world.

Neural networks will be a lot faster in the future, and neural network tools can get embedded in every design surface. We already have a little mini neural network that plugs into an inexpensive processing board or even into your laptop. Instead of the software, focusing on the hardware would make such devices even faster.

Neural networks will also find their way into the fields of medicine, agriculture, physics, research, and anything else you can imagine. Neural networks will also find its way into the fields of medicine, agriculture, physics, research, and anything else you can imagine.

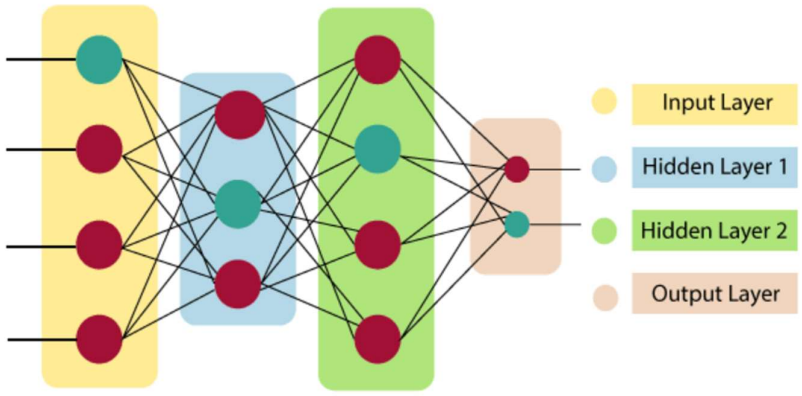
ARTIFICIAL NEURAL NETWORKS

The term "Artificial Neural Network" is derived from Biological neural networks that develop the structure of a human brain. Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks. These neurons are known as nodes.

The architecture of an artificial neural network:

To understand the concept of the architecture of an artificial neural network, we have to understand what a neural network consists of. In order to define a neural network that consists of a large number of artificial neurons, which are termed units arranged in a sequence of layers. Lets us look at various types of layers available in an artificial neural network.

Artificial Neural Network primarily consists of three layers:



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Input Layer:

As the name suggests, it accepts inputs in several different formats provided by the programmer.

Hidden Layer:

The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.

Output Layer:

The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.

The artificial neural network takes input and computes the weighted sum of the inputs and includes a bias. This computation is represented in the form of a transfer function.

$$\sum_{i=1}^{n} Wi * Xi + b$$

How do artificial neural networks work?

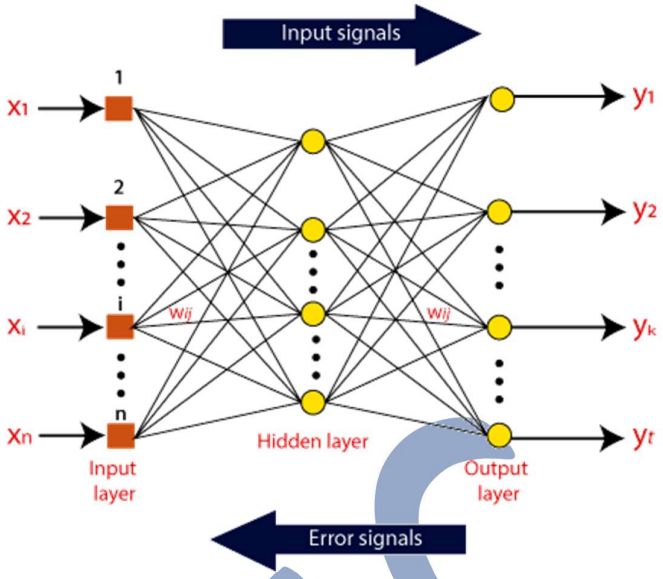
Artificial Neural Network can be best represented as a weighted directed graph, where the artificial neurons form the nodes.

The association between the neurons 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.

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Afterward, each of the input is multiplied by its corresponding weights (these weights are the details utilized by the artificial neural networks to solve a specific problem).

In general terms, 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 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. Here the total of weighted inputs can be in the range of 0 to positive infinity.

Here, to keep the response in the limits of the desired value, a certain maximum value is benchmarked, 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. Let us take a look at each of them in details:

Binary:

In binary activation function, the output is either a one or a 0. Here, to accomplish this, there is a threshold value set up.

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If the net weighted input of neurons is more than 1, then the final output of the activation function is returned as one 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))

Where ???? is considered the Steepness parameter.

SUPERVISED LEARNING NETWORK

Supervised learning is the types of machine learning in which machines are trained using well "labelled" training data, and on basis of that data, machines predict the output. The labelled data means some input data is already tagged with the correct output.

In supervised learning, the training data provided to the machines work as the supervisor that teaches the machines to predict the output correctly.

It applies the same concept as a student learns in the supervision of the teacher.

Supervised learning is a process of providing input data as well as correct output data to the machine learning model.

The aim of a supervised learning algorithm is to find a mapping function to map the input variable(x) with the output variable(y).

In the real-world, supervised learning can be used for Risk Assessment, Image classification, Fraud Detection, spam filtering, etc.

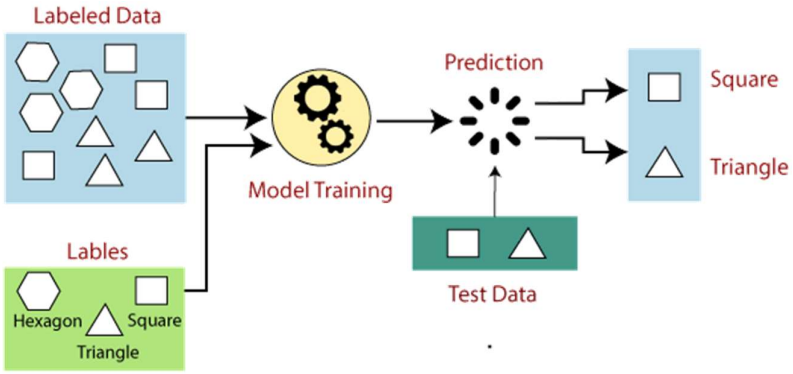
How Supervised Learning Works?

In supervised learning, models are trained using labelled dataset, where the model learns about each type of data.

Once the training process is completed, the model is tested on the basis of test data (a subset of the training set), and then it predicts the output.

The working of Supervised learning can be easily understood by the below example and diagram:

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Suppose we have a dataset of different types of shapes which includes square, rectangle, triangle, and Polygon.

Now the first step is that we need to train the model for each shape.

- If the given shape has four sides, and all the sides are equal, then it will be labelled as a **Square**.
- If the given shape has three sides, then it will be labelled as a **triangle**.
- If the given shape has six equal sides then it will be labelled as **hexagon**.

Now, after training, we test our model using the test set, and the task of the model is to identify the shape.The machine is already trained on all types of shapes, and when it finds a new shape, it classifies the shape on the bases of a number of sides, and predicts the output.

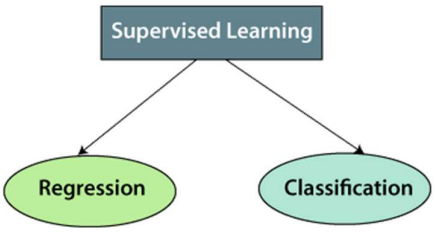
Steps Involved in Supervised Learning:

- First Determine the type of training dataset
- Collect/Gather the labelled training data.
- Split the training dataset into training **dataset, test dataset, and validation dataset**.
- Determine the input features of the training dataset, which should have enough knowledge so that the model can accurately predict the output.
- Determine the suitable algorithm for the model, such as support vector machine, decision tree, etc.
- Execute the algorithm on the training dataset. Sometimes we need validation sets as the control parameters, which are the subset of training datasets.
- Evaluate the accuracy of the model by providing the test set. If the model predicts the correct output, which means our model is accurate.

Types of supervised Machine learning Algorithms:

Supervised learning can be further divided into two types of problems:

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1. Regression

Regression algorithms are used if there is a relationship between the input variable and the output variable. It is used for the prediction of continuous variables, such as Weather forecasting, Market Trends, etc. Below are some popular Regression algorithms which come under supervised learning:

- Linear Regression
- Regression Trees
- Non-Linear Regression
- Bayesian Linear Regression
- Polynomial Regression

2. Classification

Classification algorithms are used when the output variable is categorical, which means there are two classes such as Yes-No, Male-Female, True-false, etc.

Spam Filtering,

- Random Forest
- Decision Trees
- Logistic Regression
- Support vector Machines

Advantages of Supervised learning:

- With the help of supervised learning, the model can predict the output on the basis of prior experiences.
- In supervised learning, we can have an exact idea about the classes of objects.
- Supervised learning model helps us to solve various real-world problems such as **fraud detection, spam filtering**, etc.

Disadvantages of supervised learning:

- Supervised learning models are not suitable for handling the complex tasks.

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- Supervised learning cannot predict the correct output if the test data is different from the training dataset.
- Training required lots of computation times.
- In supervised learning, we need enough knowledge about the classes of object.

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