Practical No:05

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Aim: Implementation of the Perceptron Learning Algorithm

Theory:
The Perceptron was invented in 1957 by Frank Rosenblatt at the Cornell Aeronautics Laboratory. Based on the first concepts of artificial neurons, he proposed the "*Perceptron learning rule*".

A Perceptron is an artificial neuron, and thus a neural network unit. It performs computations to detect features or patterns in the input data. It is an algorithm for supervised learning of binary classifiers. It is this algorithm that allows artificial neurons to learn and process features in a data set.

The Perceptron plays an essential role in Machine Learning projects. It is massively used to classify data, or as an algorithm to simplify or supervise the learning capabilities of binary classifiers.

Basic Components of Perceptron

Perceptron is a type of artificial neural network, which is a fundamental concept in machine learning. The basic components of a perceptron are:

1. Input Layer: The input layer consists of one or more input neurons, which receive input signals from the external world or from other layers of the neural network.
2. Weights: Each input neuron is associated with a weight, which represents the strength of the connection between the input neuron and the output neuron.
3. Bias: A bias term is added to the input layer to provide the perceptron with additional flexibility in modeling complex patterns in the input data.
4. Activation Function: The activation function determines the output of the perceptron based on the weighted sum of the inputs and the bias term. Common activation functions used in perceptrons include the step function, sigmoid function, and ReLU function.
5. Output: The output of the perceptron is a single binary value, either 0 or 1, which indicates the class or category to which the input data belongs.

6. Training Algorithm: The perceptron is typically trained using a supervised learning algorithm such as the perceptron learning algorithm or backpropagation. During training, the weights and biases of the perceptron are adjusted to minimize the error between the predicted output and the true output for a given set of training examples.
7. Overall, the perceptron is a simple yet powerful algorithm that can be used to perform binary classification tasks and has paved the way for more complex neural networks used in deep learning today.

Types of Perceptron

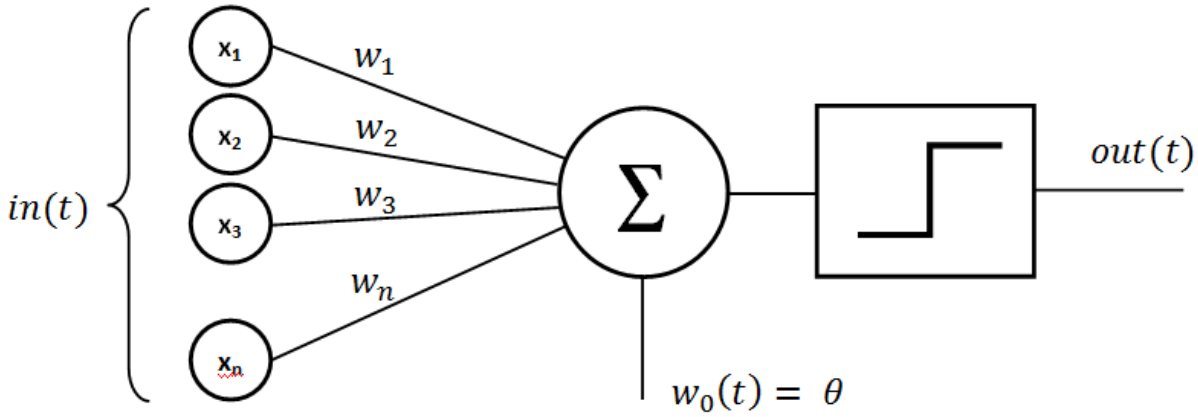
1. Single layer: Single layer perceptron can learn only linearly separable patterns.
2. Multilayer: Multilayer perceptrons can learn about two or more layers having a greater processing power.

The Perceptron algorithm learns the weights for the input signals in order to draw a linear decision boundary.

Note: Supervised Learning is a type of Machine Learning used to learn models from labeled training data. It enables output prediction for future or unseen data. Let us focus on the Perceptron Learning Rule in the next section.

Working:

AS discussed earlier, Perceptron is considered a single-layer neural link with four main parameters. The perceptron model begins with multiplying all input values and their weights, then adds these values to create the weighted sum. Further, this weighted sum is applied to the activation function ‘f’ to obtain the desired output. This activation function is also known as the step function and is represented by ‘f.’



This step function or Activation function is vital in ensuring that output is mapped between (0,1) or (-1,1). Take note that the weight of input indicates a node's strength. Similarly, an input value gives the ability the shift the activation function curve up or down.

Step 1: Multiply all input values with corresponding weight values and then add to calculate the weighted sum. The following is the mathematical expression of it:

∑wi*xi = x1*w1 + x2*w2 + x3*w3+……..x4*w4

Add a term called bias 'b' to this weighted sum to improve the model's performance.

Step 2: An activation function is applied with the above-mentioned weighted sum giving us an output either in binary form or a continuous value as follows:

Y=f(∑wi*xi + b)T

Advantages:

- A multi-layered perceptron model can solve complex non-linear problems.
- It works well with both small and large input data.

- Helps us to obtain quick predictions after the training.
- Helps us obtain the same accuracy ratio with big and small data.

Disadvantages:

- In multi-layered perceptron model, computations are time-consuming and complex.
- It is tough to predict how much the dependent variable affects each independent variable.
- The model functioning depends on the quality of training.

Characteristics of the Perceptron Model

The following are the characteristics of a Perceptron Model:

1. It is a machine learning algorithm that uses supervised learning of binary classifiers.
2. In Perceptron, the weight coefficient is automatically learned.
3. Initially, weights are multiplied with input features, and then the decision is made whether the neuron is fired or not.
4. The activation function applies a step rule to check whether the function is more significant than zero.
5. The linear decision boundary is drawn, enabling the distinction between the two linearly separable classes +1 and -1.
6. If the added sum of all input values is more than the threshold value, it must have an output signal; otherwise, no output will be shown.

Limitation of Perceptron Model

The following are the limitation of a Perceptron model:

1. The output of a perceptron can only be a binary number (0 or 1) due to the hard-edge transfer function.

2. It can only be used to classify the linearly separable sets of input vectors. If the input vectors are non-linear, it is not easy to classify them correctly.

Conclusion: I have successfully understood and implemented the Perceptron.