Machine Learning Assignment-1

Documentation

3. Perceptron

The Perceptron is a linear machine learning algorithm for binary classification tasks. It takes an input, aggregates it (taking a weighted sum) and returns 1 only if the aggregated sum is more than 0, otherwise it returns 0. A single perceptron can only be used to implement linearly separable functions. It takes both real and boolean inputs and associates a set of weights to them

Our goal is to find the **w** vector that can perfectly classify positive inputs and negative inputs in our data.

For preprocessing we split our dataset into 70% as training data and 30% as testing data.

Implementation

- We initialized **w** with some random vector.
- For each iteration:
    - A set of misclassified points is created
    - Misclassified is a mask that contains 1 if the i^{th} datapoint is misclassified and 0 if datapoint is correctly classified
    - We find the cost which is the number of misclassified points
    - The weights are updated for the first misclassified point of the misclassified set by multiplying with the learning rate.
    - If the cost becomes zero(i.e. There are zero misclassified points) in that case also we stop training our weights.

- The maximum number of iterations is 10^6

- The perceptron function returns the trained weights and cost
- The trained weights can now be used with the testing data to test the accuracy of the model.
- And once a significant level of accuracy is attained we can use the weights to make predictions.

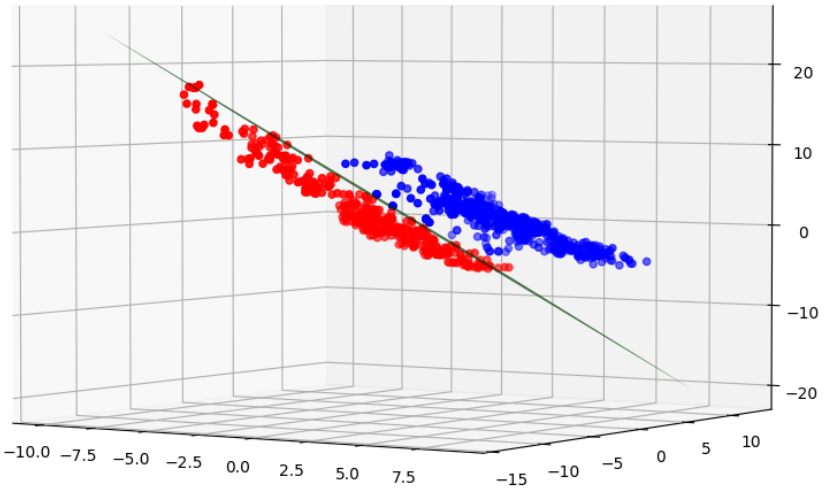

Figure 1: Training results on Dataset 1

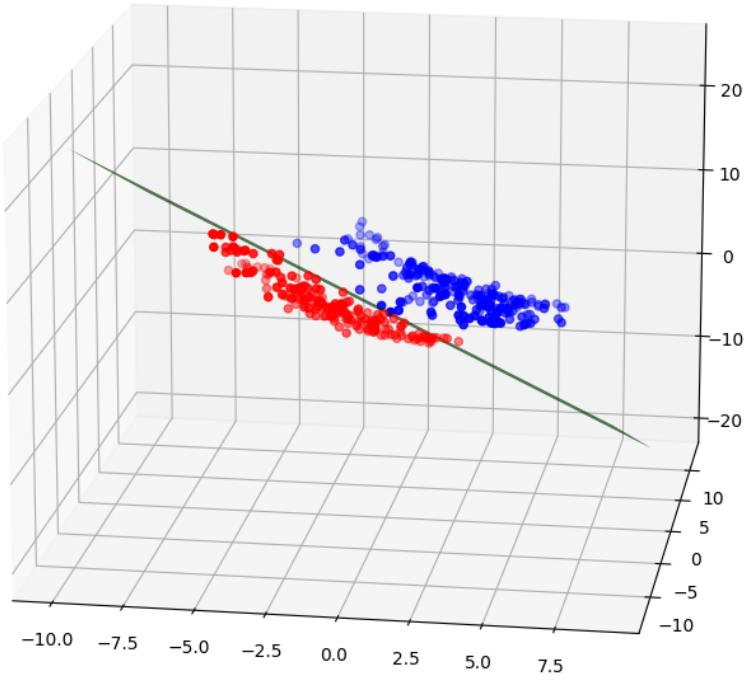

Figure 2: Testing results on Dataset 1

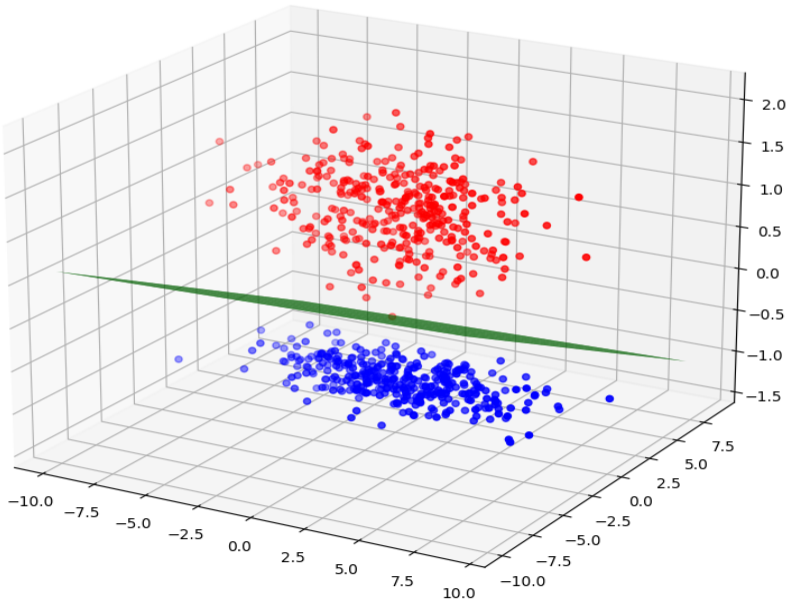

Figure 3: Training results on Dataset 2

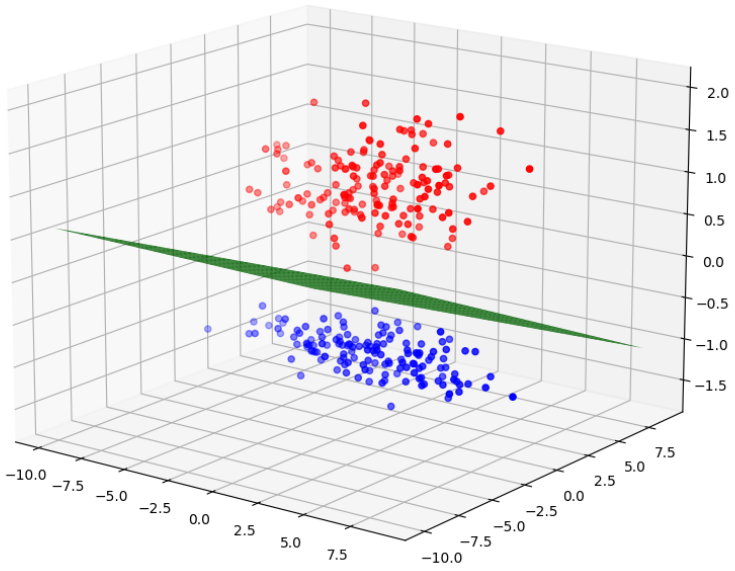

Figure 4: Testing results on Dataset 2

Results

Dataset 1
w = [0.44035917, -0.66870335, -0.37811071, -0.45372539, -0.10042506]
Training Accuracy : 99.0625
Testing Accuracy: 98.7864077669903

Dataset 2
w = [0.26799168, -0.0062942, 0.09256155, 0.9589438]
Training Accuracy : 100.0
Testing Accuracy: 100.0

From the training and testing accuracy, we can conclude that Dataset 2 was more linearly separable than Dataset 1, as the accuracy is 100% for both training and testing data for Dataset 2, but not for Dataset 1.

Major Limitations of Perceptron Classifier

Perceptron only works when the dataset is linearly separable. If it is given a non-linearly separable dataset, it would get stuck in an infinite loop and would never terminate (as would have been the case for Dataset 1, had there not been a limit on the number of iterations).