Classification Using Perceptron

Comparison of Logistic Regression, Naive Bayes Classifier and Perceptron

Test accuracy Metric	Logistic Regression	Naive Bayes Classifier	Perceptron
Dataset 1	0.9989795918367348	0.9989795918367348	1.0
Dataset 2	0.503061224489796	0.5061224489795919	0.5010204081632653
Dataset 3	0.7064586357039188	0.7714078374455733	0.5092162554426706

The above values are of test accuracy metrics calculated using K-Fold cross validation on train dataset. For uniformity, test accuracy metric for all the models and datasets is done with a number of folds equal to 5. Train dataset is split into train and test parts, train is used to train the model and test is used to calculate the accuracy(number of correctly classified predictions divided by total number of predictions). This calculated accuracy is summed and averaged over each iteration of fold, the result is the test accuracy score metric.

For dataset 1, Logistic Regression is trained for maximum iterations of 100 and Perceptron is trained for 100 iterations. Perceptron achieved test accuracy score 1, whereas Logistic Regression and Naive Bayes Classifier achieved test accuracy score close to 1.

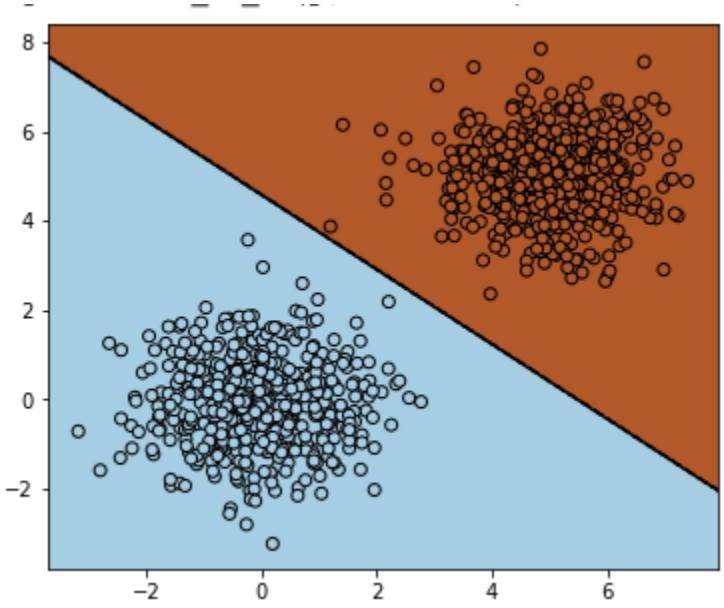
For dataset2, Logistic Regression is trained for a maximum iterations of 100 and Perceptron is trained for 100 iterations. All the three models achieved almost the same score of approximately 0.5.

For dataset3, Logistic Regression is trained for a maximum iterations of 500 and to maintain uniformity across the dataset, Perceptron is also trained for 500 iterations. Logistic Regression achieved a test accuracy score of approximately 0.7, Naive Bayes Classifier achieved a test accuracy score of approximately 0.77 and Perceptron achieved a test accuracy score of approximately 0.5.

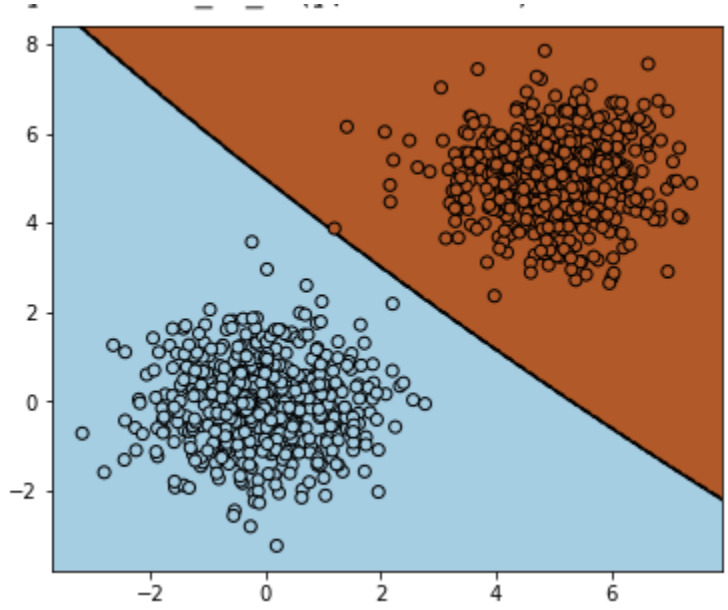
Decision Boundary Plots of Logistic Regression, Naive Bayes Classifier and Perceptron

For Dataset 1

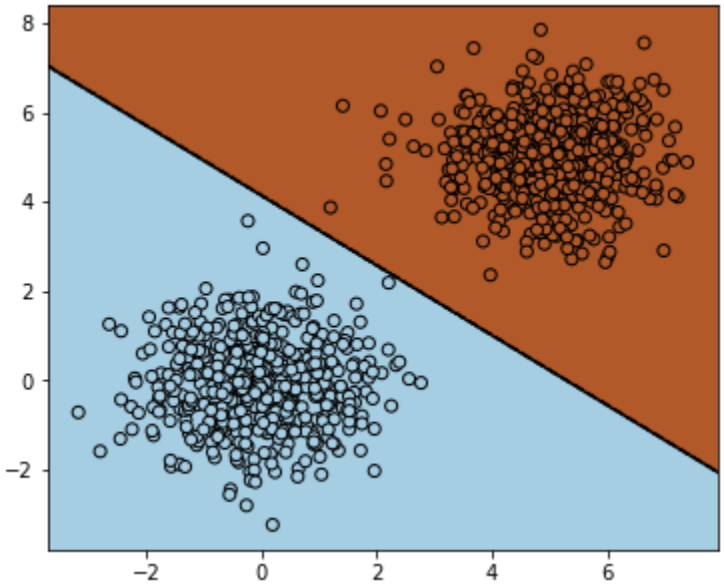
Logistic Regression



Naive Bayes Classifier



Perceptron

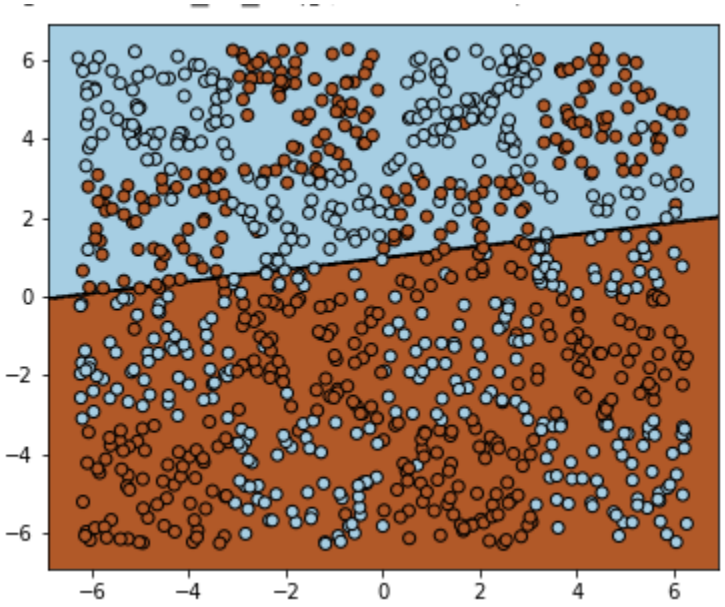


Observations

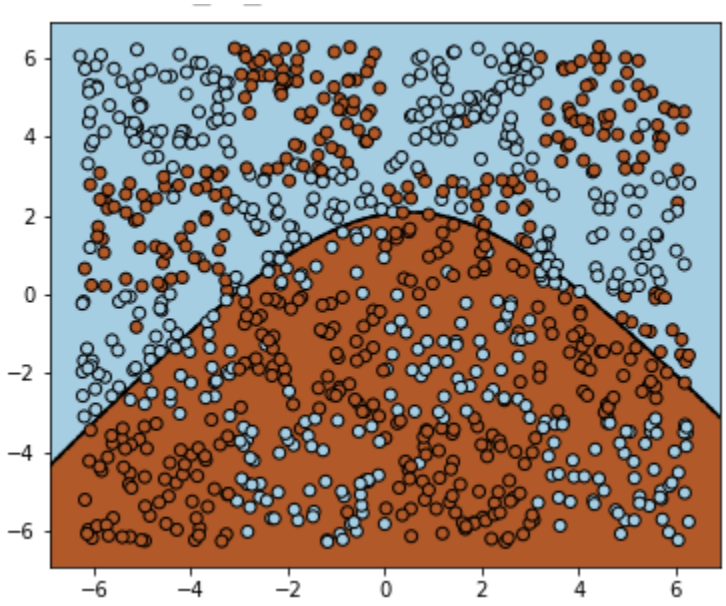
- All the models classified all the points in the dataset correctly.
- Logistic Regression and Perceptron classified the points by approximating a linear function. Whereas Naive Bayes Classifier classified the points by approximating a gaussian function, it can be observed that the separator of Naive Bayes Classifier is curved and not perfectly linear as in the case of Logistic Regression and Perceptron.

For Dataset 2

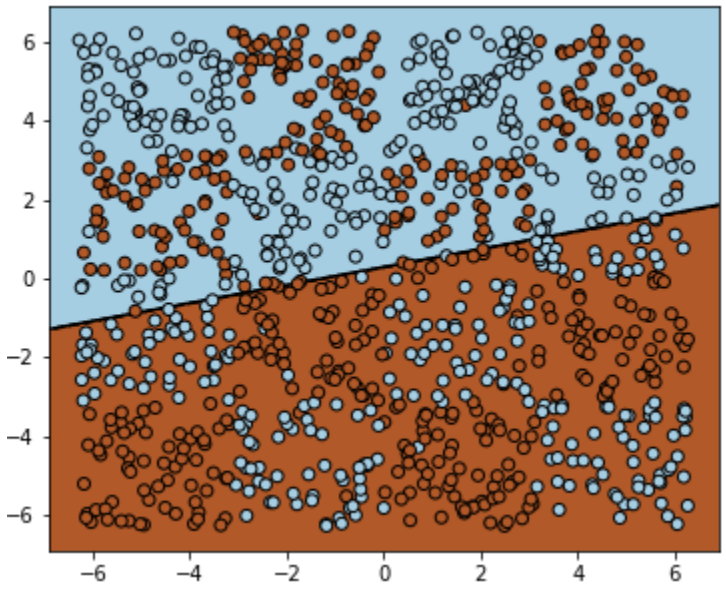
Logistic Regression



Naive Bayes Classifier



Perceptron



Observations

- None of the models classified all the points in the dataset correctly.
- The gaussian function approximate found by the Naive Bayes Classifier can be easily seen from the plot but yet it did not classify all the points correctly as the dataset has a chess board structure of labels.
- Logistic Regression and Perceptron, as they only try to approximate using linear function, failed miserably as there are many points which are mis classified given the structure of the dataset is chess board kind.

Linear Separability

A perceptron is guaranteed to converge if the data is linearly separable.

For Dataset 1

Train Dataset is linearly separable as the perceptron algorithm converges on the dataset, because the accuracy score is close to 1.

For Dataset 2

Train Dataset is not linearly separable as the perceptron algorithm did not converge on the dataset after 100 iterations because the accuracy score is not close to 1.

For Dataset 3

Train Dataset is not linearly separable as the perceptron algorithm did not converge on the dataset after 500 iterations because the accuracy score is not close to 1.