PA1report

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1 CSE574 - Programming Assignment 1 Report

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1.1 Part 1 - Linear Regression

1.1.1 Problem 1 - Linear Regression with Direct Minimization

Output:
RMSE without intercept on train data - 138.20
RMSE with intercept on train data - 46.77
RMSE without intercept on test data - 326.76
RMSE with intercept on test data - 60.89

From the results above, we can see the root mean square error drops significantly when the train data has intercept term.
We can say that the training data with intercept term is more accurate. Therefore, the training data with intercept term is much better.

1.1.2 Problem 2 - Linear Regression with Gradient Descent

Output:
Gradient Descent Linear Regression RMSE on train data - 47.99
Gradient Descent Linear Regression RMSE on test data - 54.95

Comparing Gradient Decent for Linear Regression Learning and Direct Minimization by computing their root mean square error(RMSE) (46.77 on training data and 60.89 on test data), we find that, these two methods have overall similar performance. On the training data, the direct minimization method has a slightly lower RMSE, while on the test data, gradient descent based method has a relatively much lower RMSE. Also, since the gradient descent method is computationally less complex than the other one, we would say gradient descent method is better in this context.

1.2 Part 2 - Linear Classification

1.2.1 Problem 3 - Perceptron using Gradient Descent

Output:
Perceptron Accuracy on train data - 0.84
Perceptron Accuracy on test data - 0.84

The perceptron accuracy is very high(much greater than 50%) and their performance on both training data and testing data are the same(or almost the same to be general)

1.2.2 Problem 4 - Logistic Regression Using Newton's Method

Output:
Logistic Regression Accuracy on train data - 0.84
Logistic Regression Accuracy on test data - 0.86

After using Newton's Method, the accuracy on training data is 0.84, and the accuracy on test data is 0.86. The accuracy is also very high. And comparing to Perceptron classifier, the accuracy of testing data is higher when using Logistic Regression

1.2.3 Problem 5 - Support Vector Machines Using Gradient Descent

Output:
SVM Accuracy on train data - 0.85
SVM Accuracy on test data - 0.86

SVM accuracy changes every time since we are optimizing T times over ramdom data sample. The result accuracy is overall good. Since it verifies a lot, it may even behavior better than Logistic Regression(over 0.86). But most of the time accuracies for training data and test data stay around 0.8 to 0.85

1.2.4 Problem 6 - Plotting decision boundaries

Output:

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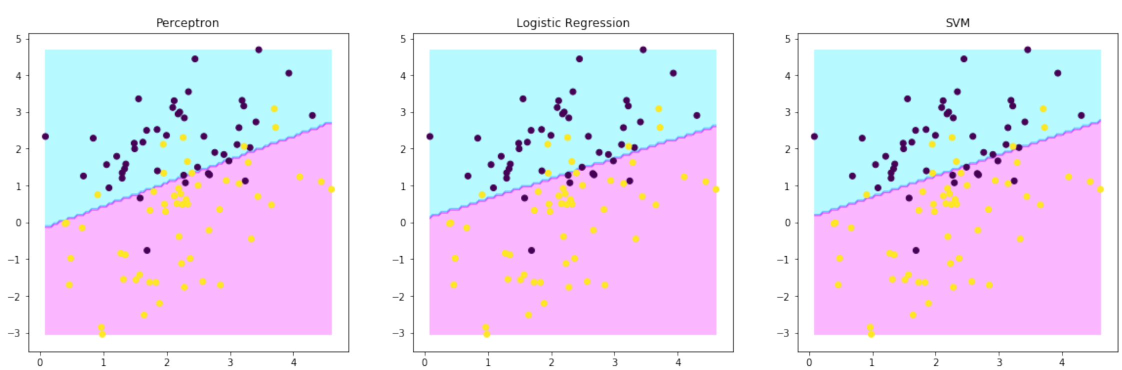

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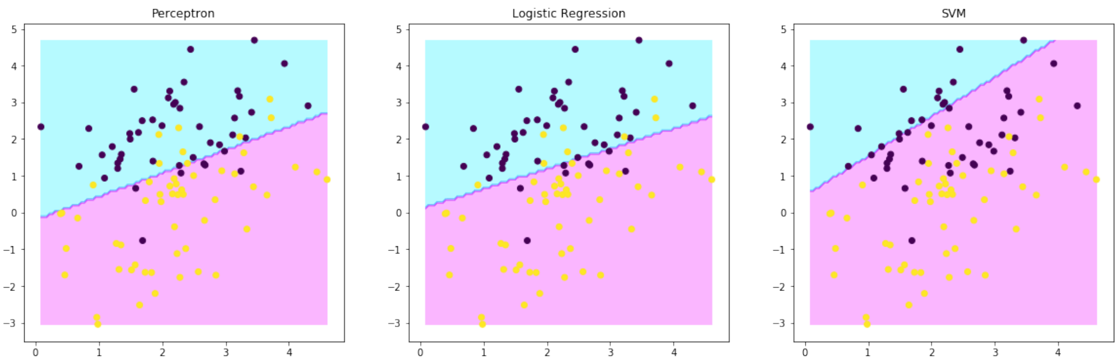

We put two sets of result plot here to compare the behaivor of three classifiers. As we can see that these three classifiers can have very close performances(set 1). However, the randomness property of SVM usually make SVM unstable. As we mentioned above, randomness sometimes can make it perform even better than Percentron and Logistic Regression, but that does not happen a lot. Furthermore, when we compare two accuracy sets on Perceptron and Logistic Regression, we find that the Logistic Regression has better performence on test data(0.86 vs. 0.84). Including all factors we have talked above, we think Logistic Regression is the best classifier.