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Group 30

CSE474 Introduction to Machine Learning

Programming Assignment 2

Classification and Regression

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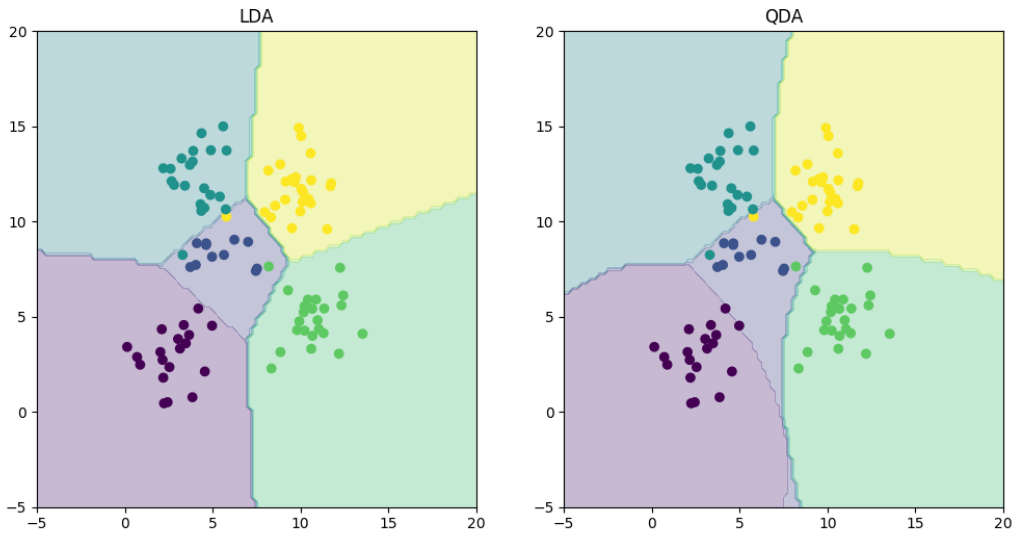
Problem 1: Gaussian Discriminators



LDA Accuracy = 0.97
QDA Accuracy = 0.96

The reason why there are difference between LDA and QDA is because LDA is linear and is only learning and testing a single d*d covariance matrix while QDA is quadratic and is learning a list od d*d covariance matrixes.

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Problem 2: Linear Regression

MSE using OLE

	without intercept	with intercept
Training Data	19099.44684457	2187.16029493
Test Data	106775.36155512	3707.84018132

MSE with intercept is better since lesser Mean Square Error is better. MSE with intercept in both test data and training data has a lower value than MSE without intercept. Therefore, we choose MSE with intercept is better.

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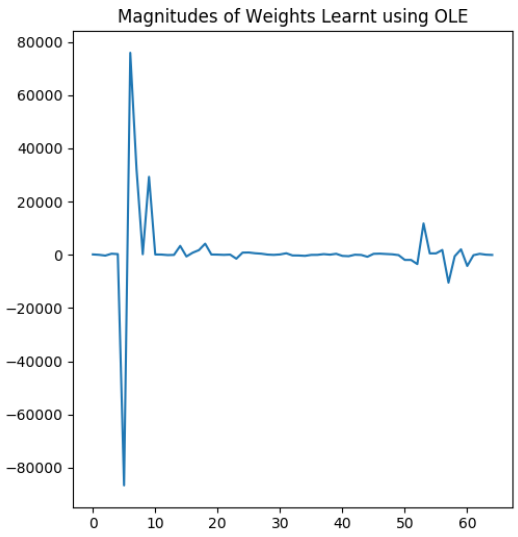
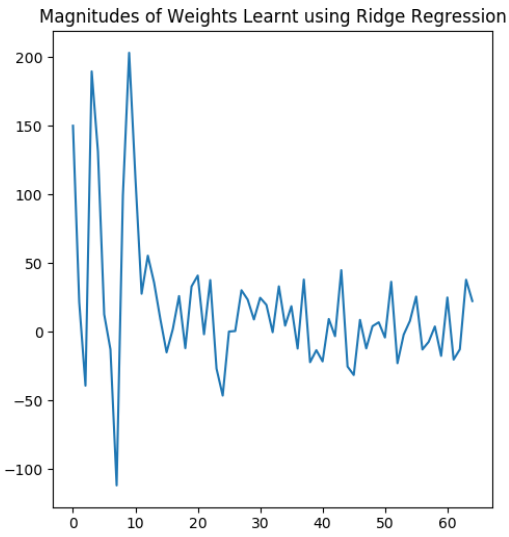
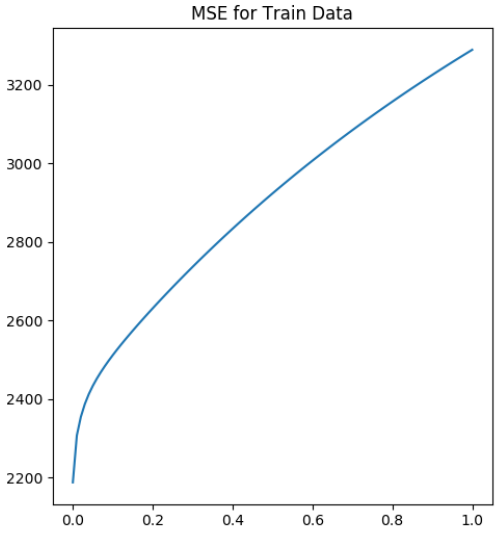
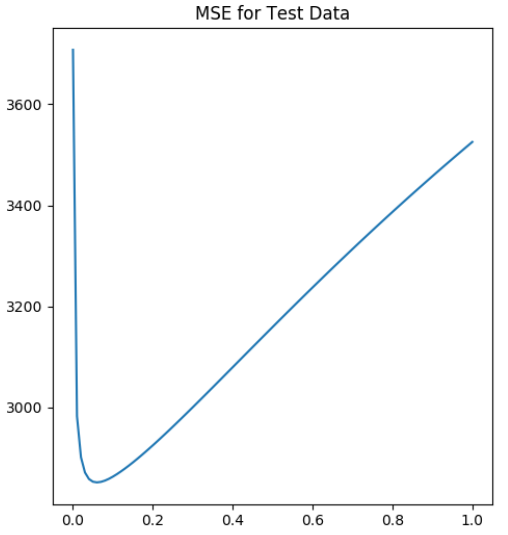
Problem 3: Ridge Regression Learning





- The magnitudes of the weights for OLE are way larger than for Ridge Regression because the regularization term does not favor high weights.
-





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MSE using OLE

	without intercept	with intercept
Training Data	19099.44684457	2187.16029493
Test Data	106775.36155512	3707.84018132

MSE using Ridge Regression (using optimal lambda = 0.06)

	Training Data	Test Data
with intercept	2851.33021344	2451.52849064

- The optimal value for lambda is 0.06 since this value minimizes our MSE for the data.
- When comparing OLE vs Ridge Regression for Training and Test Data the MSE for Ridge Regression is significantly lower than OLE therefore Ridge Regression is the preffered way to learn weights for this data set.

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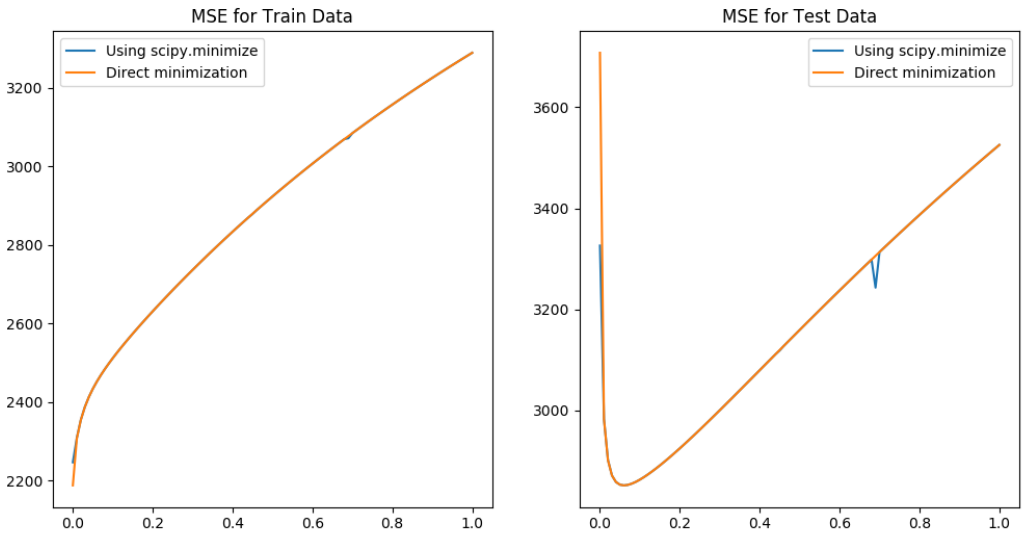
Problem 4: Using Gradient Descent



- It looks very similar to problem 3, its almost identical; however, the result from problem 4 is not as smooth as the result from problem 3.

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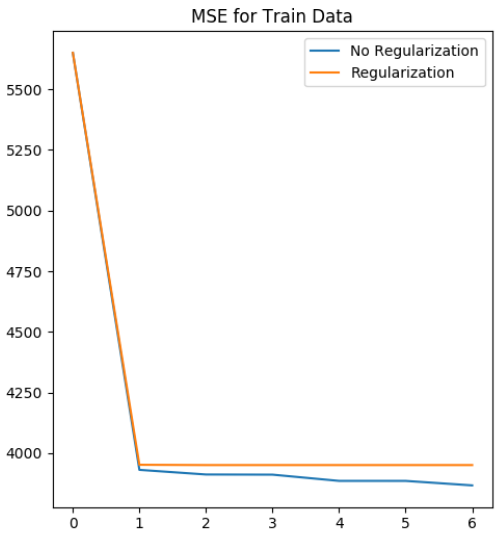
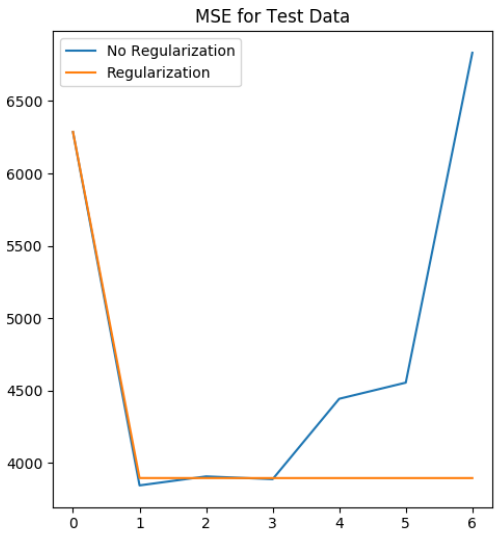
Problem 5: Non-linear Regression





Train Data:

p Lambda=0 Optimal Lambda

	0	1
0	6286.405	6286.882
1	3845.035	3895.856
2	3907.128	3895.584
3	3887.976	3895.583
4	4443.328	3895.583
5	4554.830	3895.583
6	6833.459	3895.583

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Test Data:

p Lambda=0 Optimal Lambda

	0	1
0	5650.711	5650.712
1	3930.915	3951.839
2	3911.840	3950.687
3	3911.189	3950.683
4	3885.473	3950.682
5	3885.407	3950.682
6	3866.883	3950.682

Train Data:
Lambda=0 is 3845.035 when p=1
Optimal Lambda is 3095.583 when p=6

Test Data
Lambda=0 is 3885.407 when p=5
Optimal Lambda is 3950.682 when p=6

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Problem 6

We can use MSE as a metric to compare OLE and Ridge Regression to weigh out the better approach.

OLE Regression:

MSE using OLE

	without intercept	with intercept
Training Data	19099.44684457	2187.16029493
Test Data	106775.36155512	3707.84018132

Ridge Regression:

MSE using Ridge Regression (using optimal lambda = 0.06)

	Training Data	Test Data
with intercept	2851.33021344	2451.52849064

Conclusion:

The metric that should be used to choose the best setting is MSE. We can see from our data that Ridge Regression and Gradient Descent for Ridge Regression produce significantly lower error in the general case than OLE.