Group 50 Project 1 Report

Abhishek Kumar: 50419133, Utkarsh Kumar: 50419745

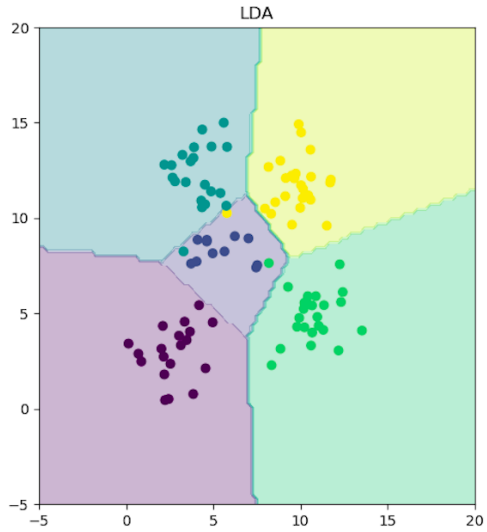

Figure 1. Discriminatory boundary for LDA

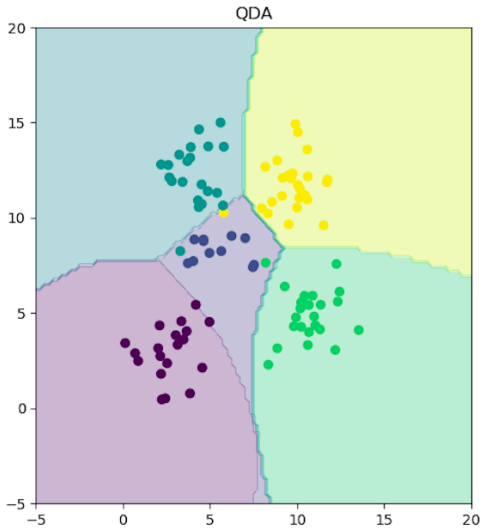

Figure 2. Discriminatory boundary for QDA

A. Experiment with Gaussian Discriminators

The following are the reported accuracy:

LDA Accuracy = 97%

QDA Accuracy = 96%

The plots for the boundaries have been shown for linear and quadratic discriminator. We have difference in the 2 boundaries because LDA separates/classifies values using a linear boundary and QDA separates/classifies values using a non linear boundary. This is because in QDA we get different covariance matrices for each group.

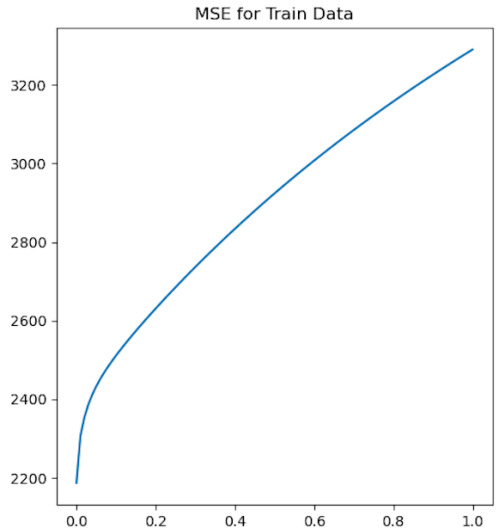

Figure 3. Ridge Regression training MSE v/s $\lambda[0, 1]$

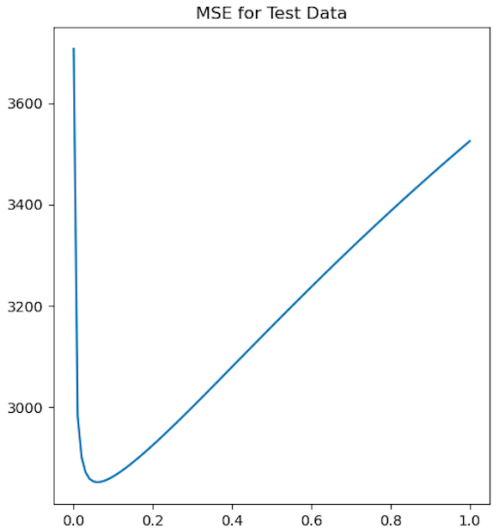

Figure 4. Ridge Regression training MSE v/s $\lambda[0, 1]$

Method	Train	Test
No Intercept	19,099	10,6775
With Intercept	2,187	3,707

Table 1. Results: Linear Regression

B. Experiment with Linear Regression

From the Table 1. shown, we can see that the model with intercept gives lower MSE values as compared to the model

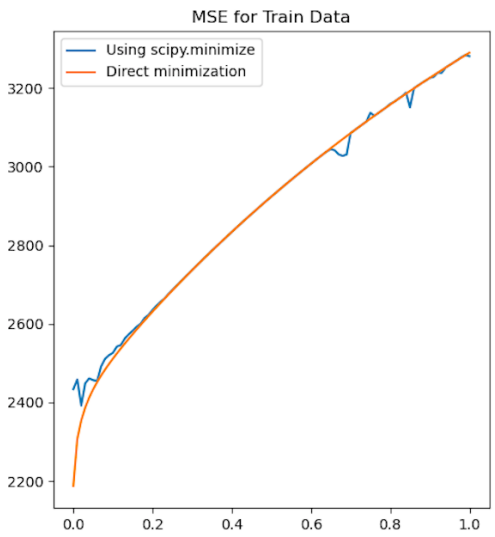

Figure 5. Ridge Regression Train: Direct v/s Gradient learning for $\lambda[0, 1]$

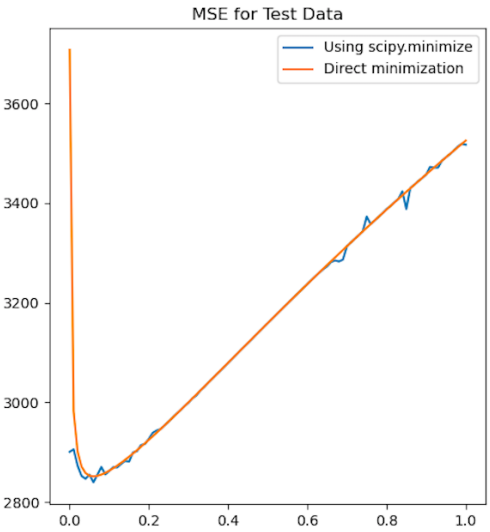

Figure 6. Ridge Regression Test: Direct v/s Gradient learning for $\lambda[0, 1]$

with no intercept. Hence the model with intercept is better.

C. Experiment with Ridge Regression

The training MSE is reported best for $\lambda = 0$ at 2187 Fig. 3 & Fig 4. show the training and testing MSE for ridge regression, for $\lambda[0, 1]$. The optimal value λ is chosen to be 0.06 as the testing error is minimum (MSE = 2851) for that value.

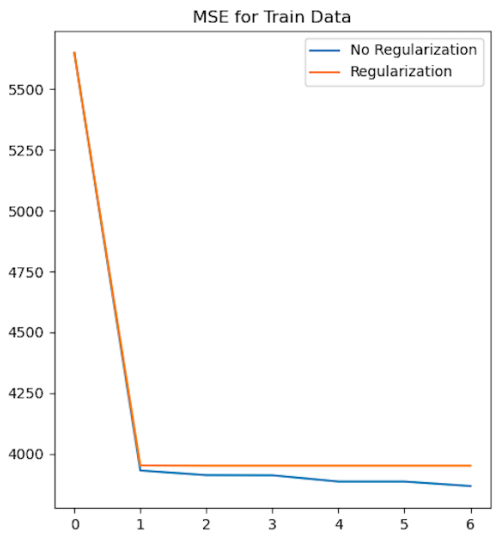

Figure 7. Training error for non-linear models for p=[0,6]

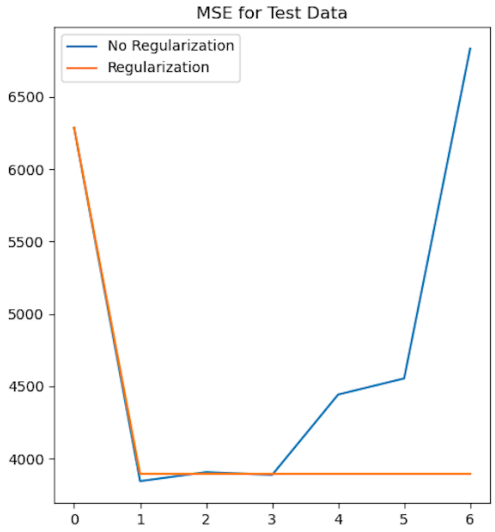

Figure 8. Testing error for non-linear models for p=[0,6]

D. Ridge Regression with Gradient Descent

In Fig. 5 & Fig 6. the error plots for gradient descent algorithms have been overlayed on the direct learning errors. With gradient descent, the optimal λ value doesnot change, however it does reduce the MSE from 2851 to 2839.

E. Non-Linear Regression

From Table 2, we can deduce that for a regularized setting we need model of 4th degree and for non-regularized setting, linear model is the most optimal model.

Method	MSE	p Value
No Regularization	3,845	1
Regularization	3,895	4

Table 2. Results: Non-Linear Regression

Method	MSE
Linear Regression	
No Intercept	10,6775
Intercept	3,707
Ridge Regression	λ=0.06
Analytical	2851
Gradient Descent	2839
Non-Linear Regression	
No Regularization	3,845
Regularization	3,895

Table 3. Selecting Optimal Model

F. Interpreting Results

We choose MSE on testing as the best estimate for the optimal model. Adding intercept greatly enhanced error loss. Ridge regression using gradient descent reached the most optimal value for the given dataset. Learning non-linear models doesnot further optimize the MSE on test. Therefore gradient descent based ridge regression is the best model for the given problem.