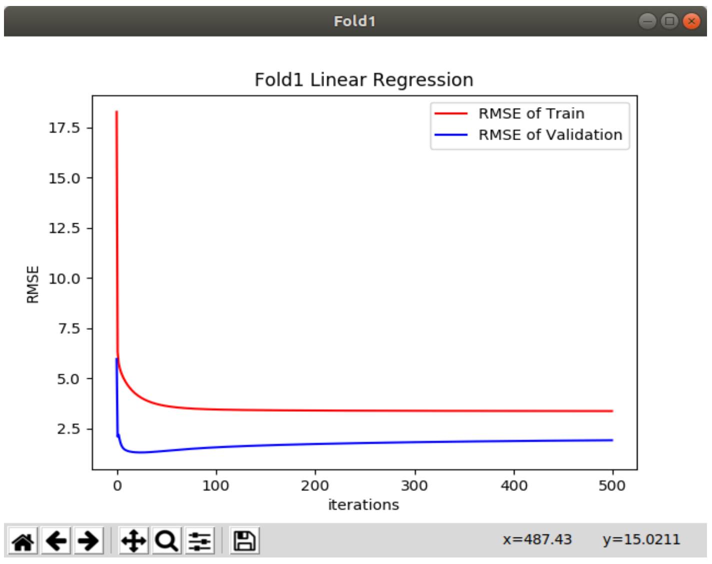
ML Assignment-1
Observations and Report

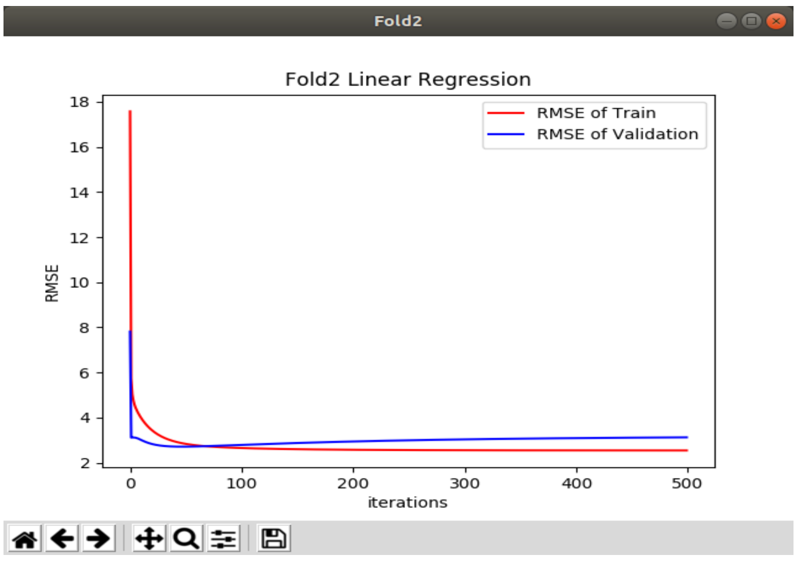
1.

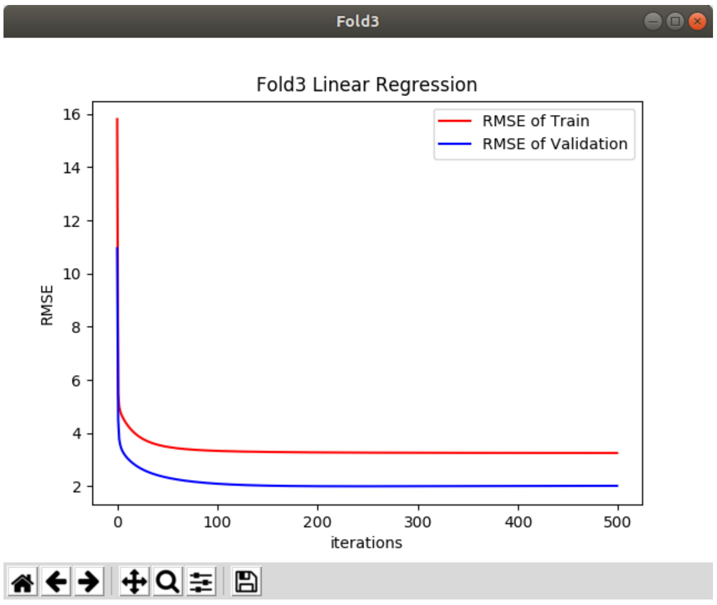
I. Linear Regression Gradient Descent:

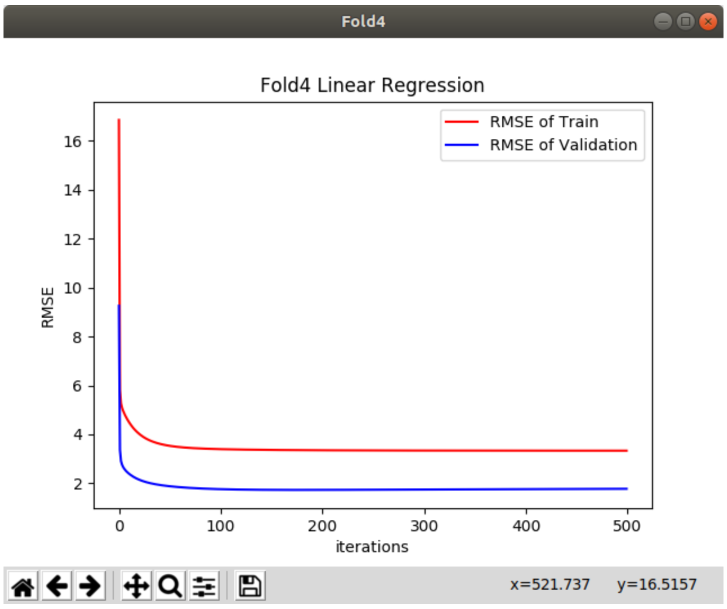
- Initially load the data from dataset like features(Input examples) and output(actual values- column MV).
- Initialised a theta(coefficient) vector to zeroes and features into X.
- Calculated theta values for each iteration on each 5-folds on using Gradient Descent.
- Calculated RMSE values for each iteration on each 5-folds on both training and validation set and stored in list and ploted graph.
- Observed that for each iteration RMSE values are decreasing i.e., Gradient descent is converging.
- Plotted graphs for each fold, RMSE and Standard deviation.
- Now applied Regularization on that set for both L1(Lasso) Regression and L2(Ridge) Regression and plotted the graphs for both.

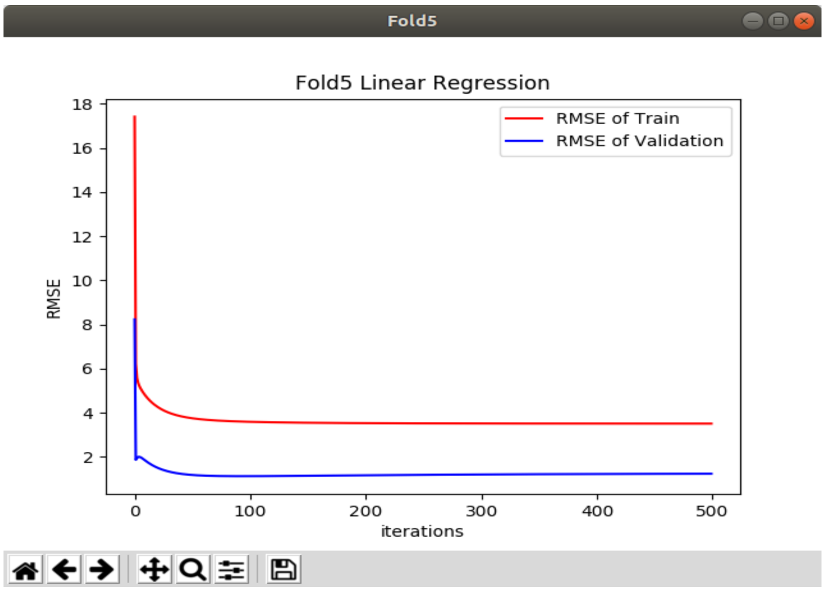
The RMSE values plotted for each training set over each iteration until the error has converged:



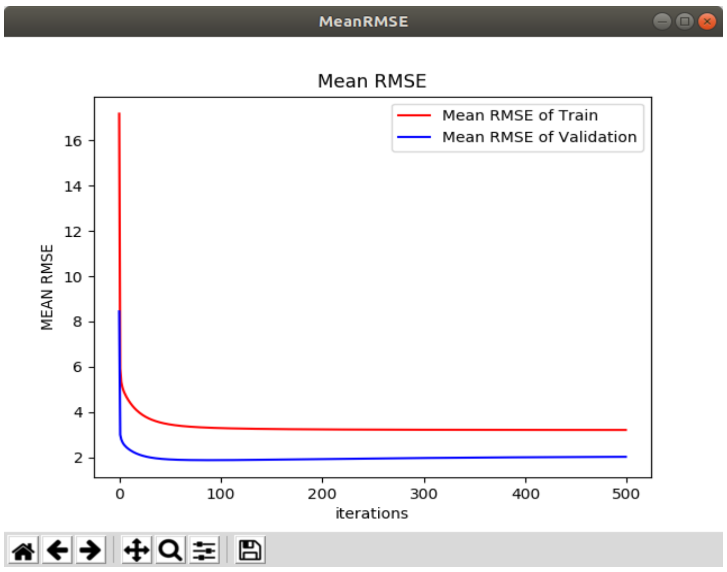


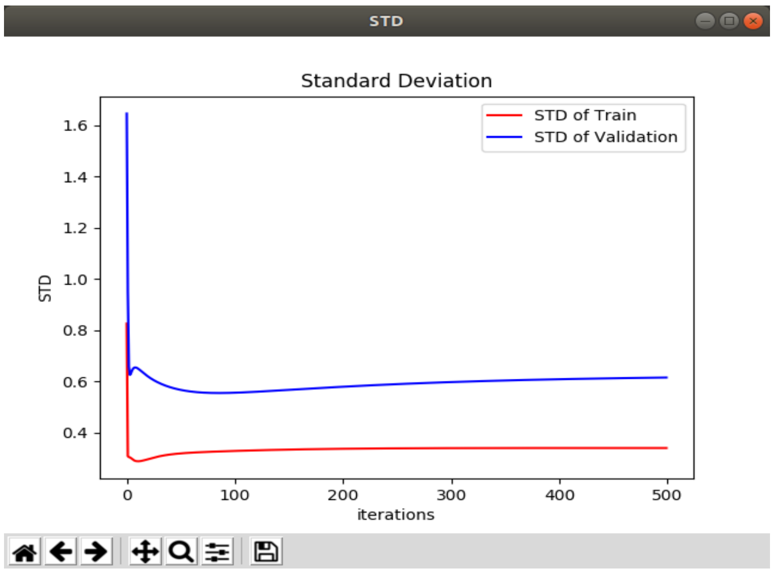

Fold3
Fold3 Linear Regression
RMSE of Train
RMSE of Validation
RMSE
iterations
16
14
12
10
8
6
4
2
0
100
200
300
400
500


Fold4
Fold4 Linear Regression
RMSE of Train
RMSE of Validation
RMSE
iterations
x=521.737 y=16.5157
16
14
12
10
8
6
4
2
0
100
200
300
400
500

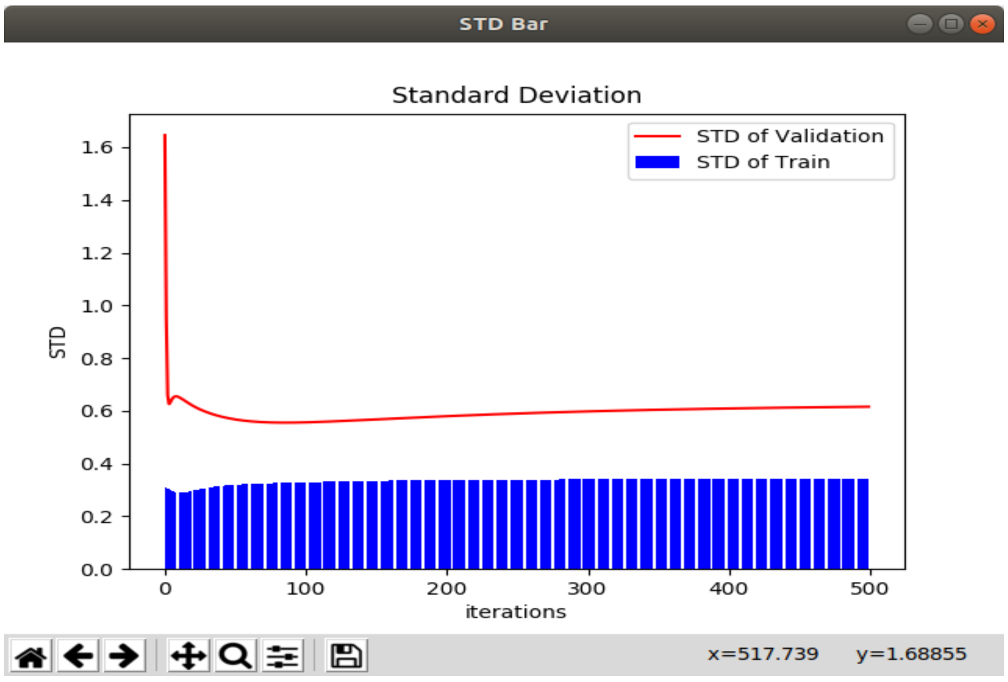

Fold5
Fold5 Linear Regression
RMSE of Train
RMSE of Validation
RMSE
iterations
18
16
14
12
10
8
6
4
2
0
100
200
300
400
500

Mean RMSE and Standard deviation:



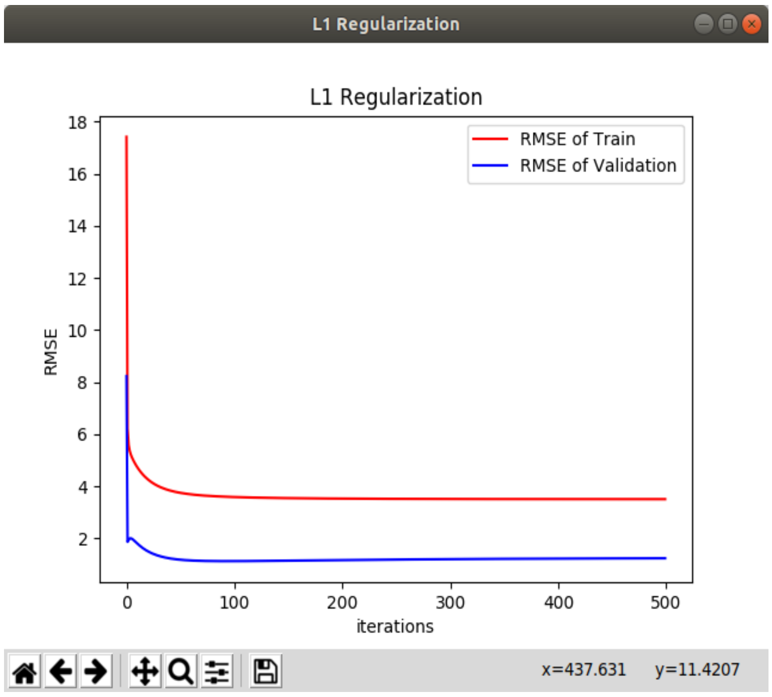


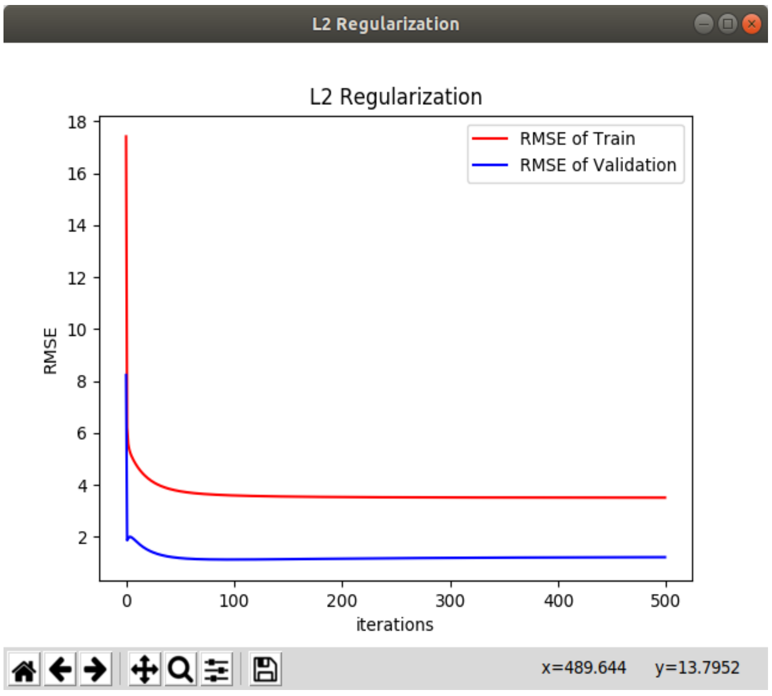
Graph using Bar



II. Regularization:

- The each 5- folds have been trained and by taking the best RMSE valued fold and trained the model using Hyperparameter(Lambda) by using L1 and L2 regularization and plotted the graphs for each regularization.





III.
No model is Overfitting and Underfitting but by using Regularization the error value is slight better than without Regularization model.

2.
I.
Logistic Regression using L2 Regularization:

- Implemented using Logistic regression in SKLEARN by solver='lbfgs'
- Here I implemented it using one vs rest like taking one class as '1' and others as '0' and giving trainImages and trainLabels its accuracy is reduced but accuracy of Test is high.

```
Class: 0
        TrainScore: 0.0037166666666666667
        Test score: 0.9922
Class: 1
        TrainScore: 0.20803333333333332
        Test score: 0.9933
Class: 2
        TrainScore: 0.09891666666666667
        Test score: 0.9802
Class: 3
        TrainScore: 0.09878333333333333
        Test score: 0.9761
Class: 4
        TrainScore: 0.0987
        Test score: 0.9834
Class: 5
        TrainScore: 0.09816666666666667
        Test score: 0.9779
Class: 6
        TrainScore: 0.09778333333333333
        Test score: 0.9846
Class: 7
        TrainScore: 0.09875
        Test score: 0.9833
Class: 8
        TrainScore: 0.09928333333333333
        Test score: 0.9464
Class: 9
        TrainScore: 0.0988
        Test score: 0.963
```

II.
Logistic Regression using L1 Regularization:

- Implemented using Logistic regression in SKLEARN by solver='liblinear'
- Here I implemented it using one vs rest like taking one class as '1' and others as '0' and giving trainImages and trainLabels its accuracy is reduced but accuracy of Test is high.

```
Class: 0
        Train Score: 0.0032
        Test Score: 0.9912
Class: 1
        Train Score: 0.20831666666666668
        Test Score: 0.9922
Class: 2
        Train Score: 0.09878333333333333
        Test Score: 0.9794
Class: 3
        Train Score: 0.09871666666666666
        Test Score: 0.9778
Class: 4
        Train Score: 0.09873333333333334
        Test Score: 0.9834
Class: 5
        Train Score: 0.09811666666666667
        Test Score: 0.9772
Class: 6
        Train Score: 0.09788333333333334
        Test Score: 0.9844
Class: 7
        Train Score: 0.09871666666666666
        Test Score: 0.9825
Class: 8
        Train Score: 0.0998
        Test Score: 0.961
Class: 9
        Train Score: 0.09878333333333333
        Test Score: 0.9672
```

III. For TestSet -the models neither overfit nor underfit since regularisation prevents such anomalies by introducing a hyper-parameter to regularise our prediction model. But for taking One vs Rest method the accuracy on TrainSet is less like Underfitting.