Machine Learning CS60050
Assignment 1 Report

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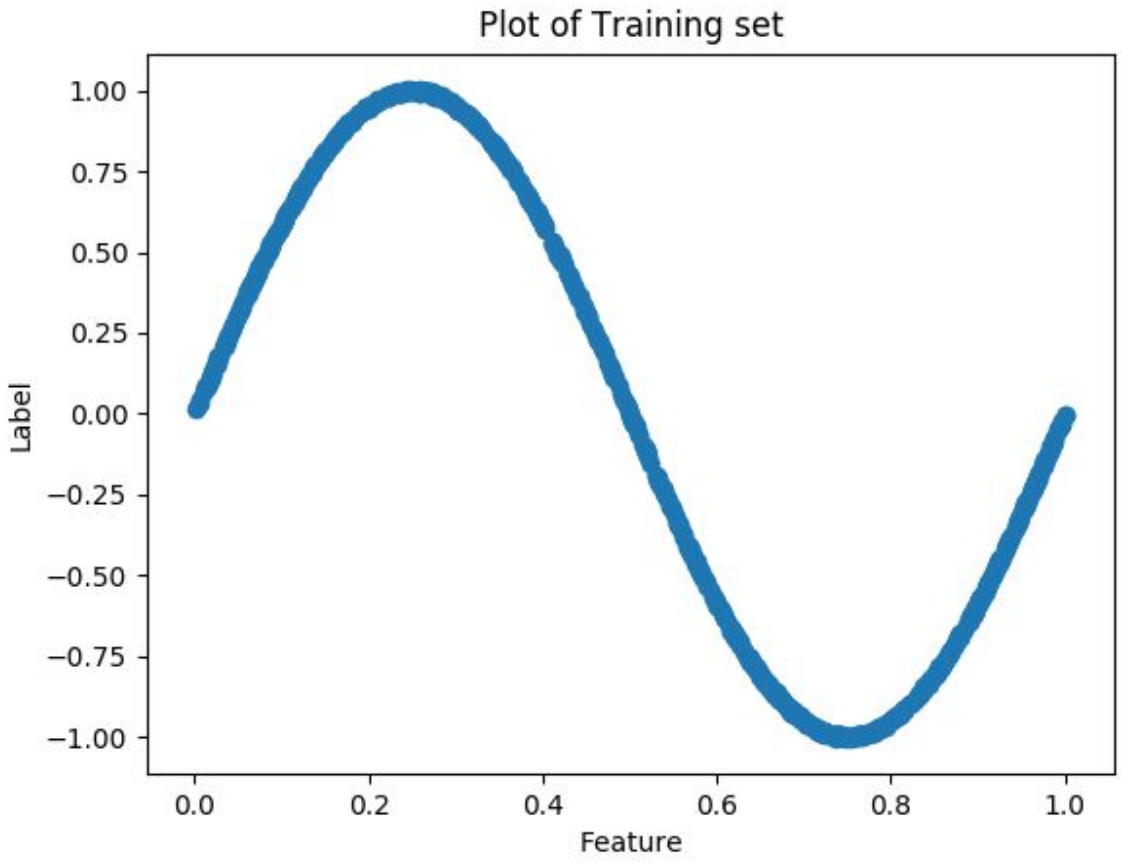
Part1

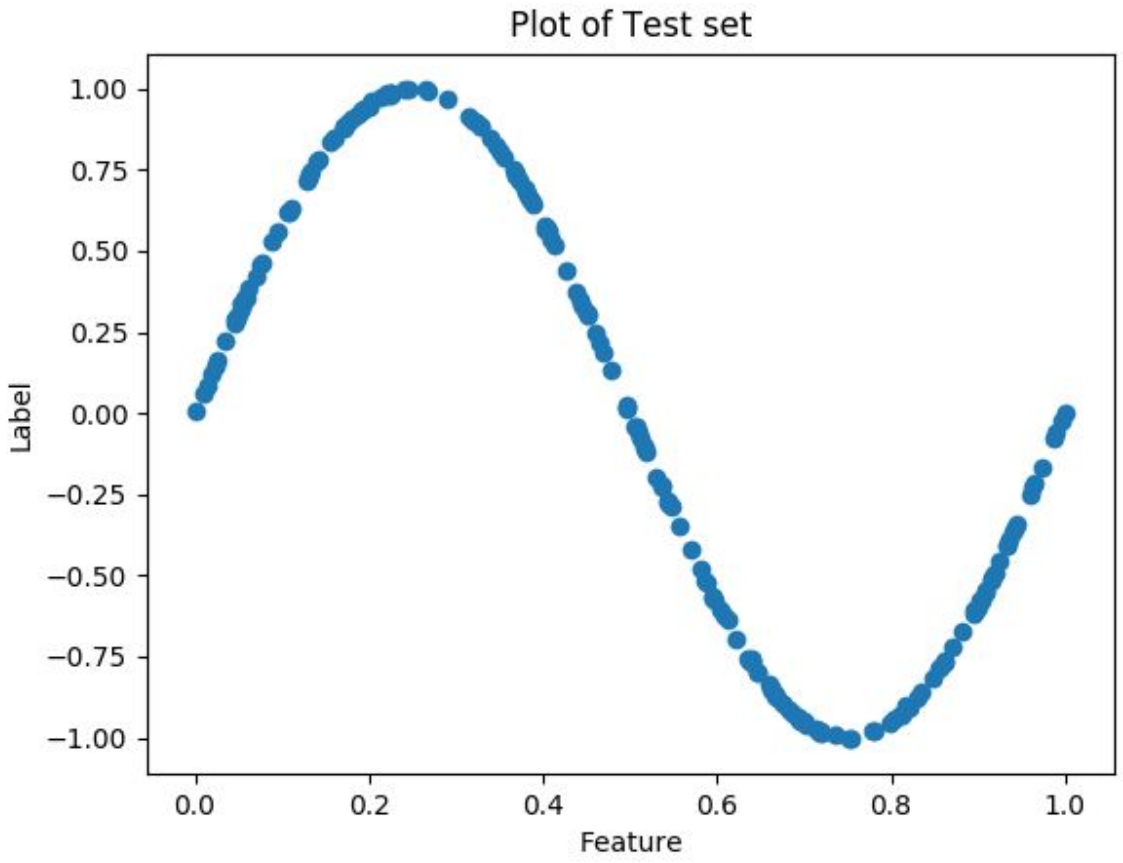
a)

The training set plot is saved as trainset.png and the test set plot as testset.png.

This is the plot of the training set



This is the plot of Test set



b)

The coefficients all equations obtained are saved in the .txt files labeled para1deg.txt, para2deg.txt and so on to be used in part2. The iteration stop criteria used is that absolute difference between current and previous error is less than 0.00000001.

Degree 1 parameters:
[9.160862573335669667e-01, -1.855147527446064259e+00]

Degree 2 parameters
[9.7374307187658870 61e-01, -2.2009538199544609 33e+00,
3.4051652786970609 82e-01]

Degree 3 parameters
[-7.6710870463102251 44e-02, 1.0506476175989318 38e+01,
-3.1223422760134507 57e+01, 2.0910097319424689 74e+01]

Degree 4 parameters
[8.2269157978968207 59e-02, 7.1927591396496577 40e+00,
-1.5708213818613540 27e+01,-3.8591368774082961 40e+00,
1.2609492256853767 96e+01]

Degree 5 parameters
[1.8559211517783294 48e-01, 5.5405538316254698 83e+00,
-1.0842730013035152 94e+01,-4.0265151613464755 80e+00,
2.0202634736046367 61e+00,7.5742341152976813 13e+00]

Degree 6 parameters
[7.3006447119546263 87e-02, 7.2118094130971286 40e+00,
-1.5756737561267954 11e+01, -1.9651135049035792 78e+00,
6.1048734909108048 90e+00, 7.4915913762548482 78e+00,
-2.8336241195812745 81e+00]

Degree 7 parameters
[3.3535910378634306 57e-02, 7.6610896846217046 98e+00,
-1.6197730088030862 56e+01, -3.3707210670857707 95e+00,
5.8557779619581085 13e+00,9.2427581849090056 92e+00,
2.4894389228576576 66e+00,-5.5193397494960105 83e+00]

Degree 8 parameters
[3.5718615333908056 15e-02, 7.4698291407773549 37e+00,

-1.4915136636024779 90e+01, -4.7230047913012587 20e+00,
4.2168469017281466 90e+00, 8.2974914073969792 13e+00,
6.1808324017163167 60e+00,-6.3429413710337290 14e-01,
-5.8379724055673545 28e+00]

Degree 9 Parameters
[5.5997214114923893 34e-02, 7.0715833500925358 02e+00,
-1.3478463000074469 85e+01, -5.2093751738348350 60e+00,
2.9965273951570989 83e+00, 5.8294307183606175 47e+00,
6.2927040304466013 15e+00, 4.3219075407415390 44e+00,
-1.6894753335997778 62e+00,-6.1926817169425287 80e+00]

Squared Error on test set
Degree 1 equation : 9.553047026982150469e-02
Degree 2 equation : 9.579849786630653674e-02
Degree 3 equation : 3.248852208697320266e-03
Degree 4 equation : 4.661570718049655622e-03
Degree 5 equation : 8.650413318205520119e-03
Degree 6 equation : 4.575871866849035713e-03
Degree 7 equation : 2.336083023418762672e-03
Degree 8 equation : 1.412402863748173565e-03
Degree 9 equation : 1.22726006598750674e-03

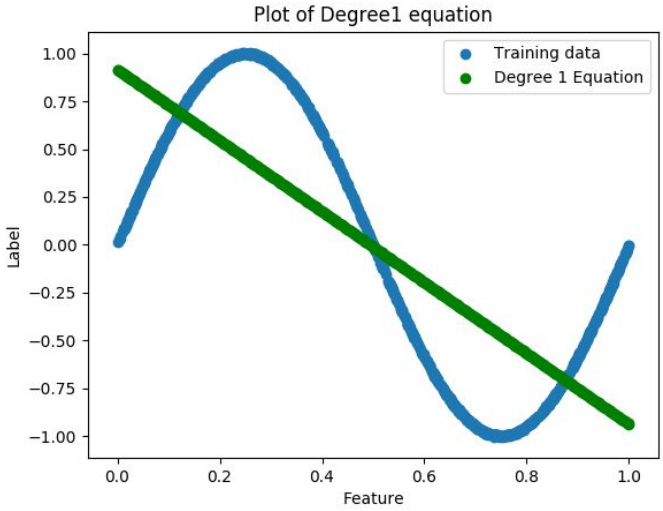
Degree 9 equation is observed to have the minimum squared error on test set and Degree 2 equation is observed to have the maximum squared error on test set.

Part 2

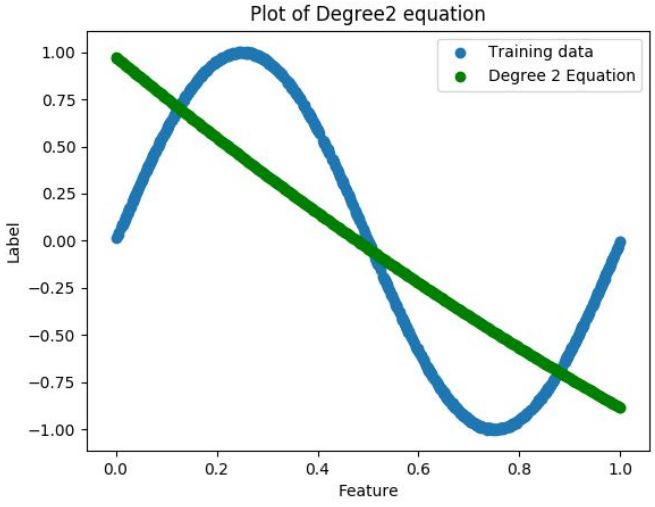
a)

The coefficients obtained in previous part are used to plot the different degree equations taking 500 equidistant points. The plots are saved as degree1.png, degree2.png and so on.

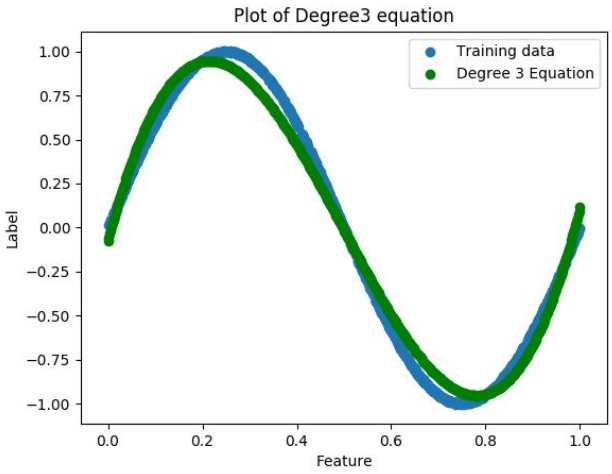
Plot of Degree 1 equation



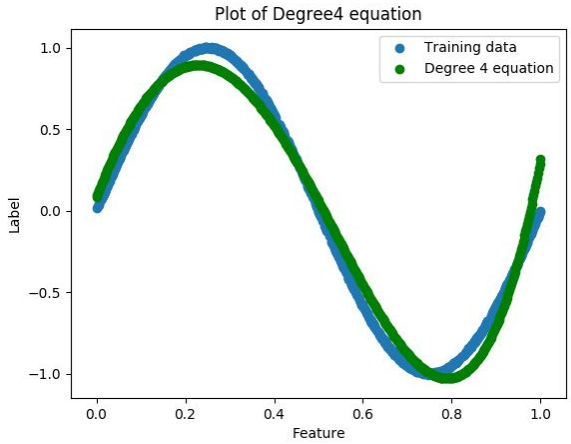
Plot of Degree 2 equation



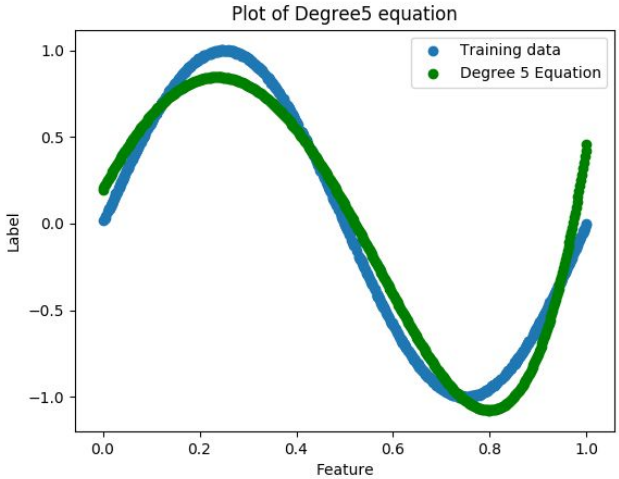
Plot of Degree 3 equation



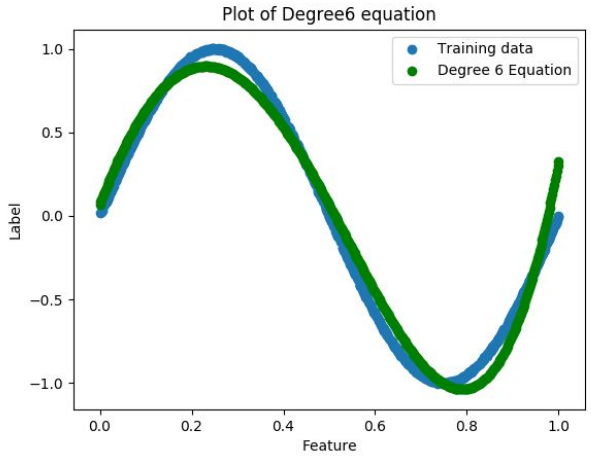
Plot of Degree 4 equation



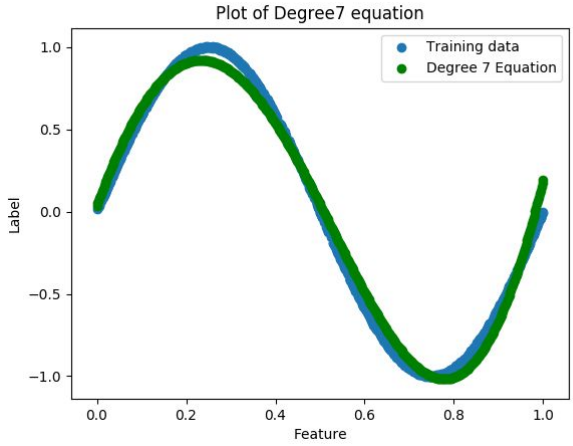
Plot of Degree 5 equation



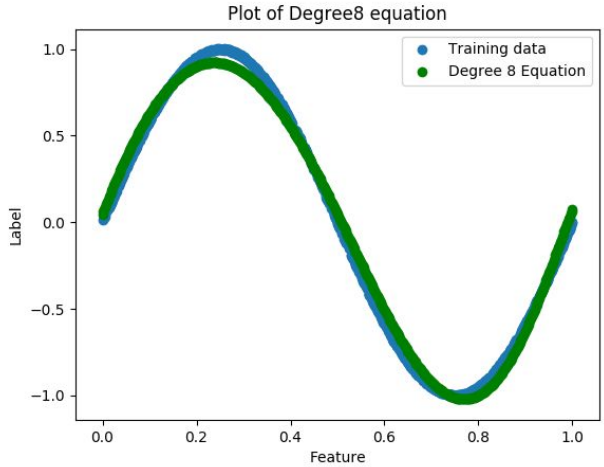
Plot of Degree 6 equation



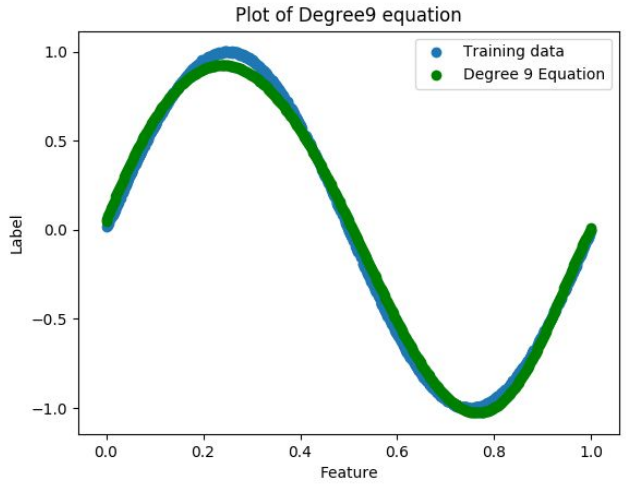
Plot of Degree 7 equation



Plot of Degree 8 equation



Plot of Degree 9 equation



b)

The squared error on training set are stored in trainingerror.txt file and squared error on test set are stored in testerror.txt file.

Training set Squared error

Degree 1 equation: 9.96805416398770516 3e-02

Degree 2 equation: 9.91402201261563226 2e-02

Degree 3 equation: 3.23924243082965085 0e-03

Degree 4 equation: 4.60458403661523438 9e-03

Degree 5 equation: 8.45379076654621634 8e-03

Degree 6 equation: 4.52925497876387542 2e-03

Degree 7 equation: 2.34022910958788963 8e-03

Degree 8 equation: 1.43106922470061324 2e-03

Degree 9 equation: 1.23430969962590978 0e-03

Test set squared error

Degree 1 equation : 9.55304702698215046 9e-02

Degree 2 equation : 9.57984978663065367 4e-02

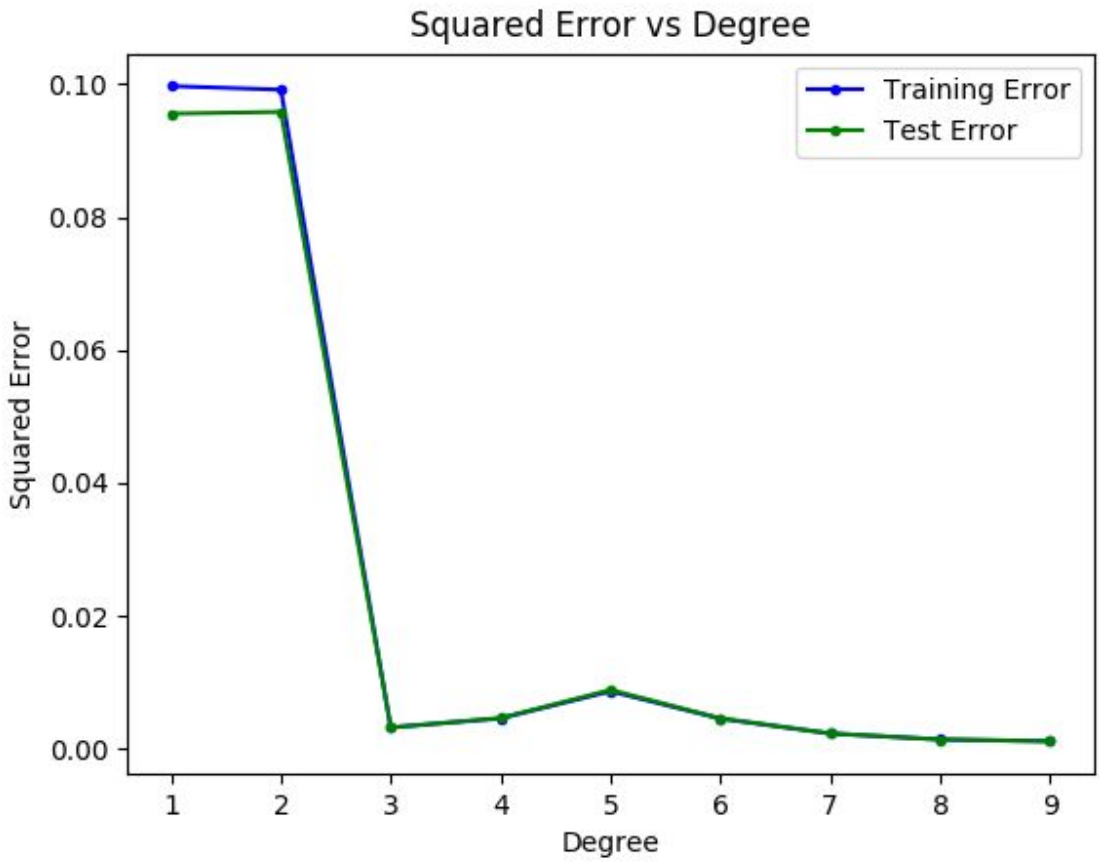
Degree 3 equation : 3.24885220869732026 6e-03

Degree 4 equation : 4.66157071804965562 2e-03

Degree 5 equation : 8.65041331820552011 9e-03

Degree 6 equation : 4.575871866849035713e-03
Degree 7 equation : 2.3360830234187626 72e-03
Degree 8 equation : 1.4124028637481735 65e-03
Degree 9 equation : 1.2272600659875066 74e-03

Plot of Error vs Degree of equation

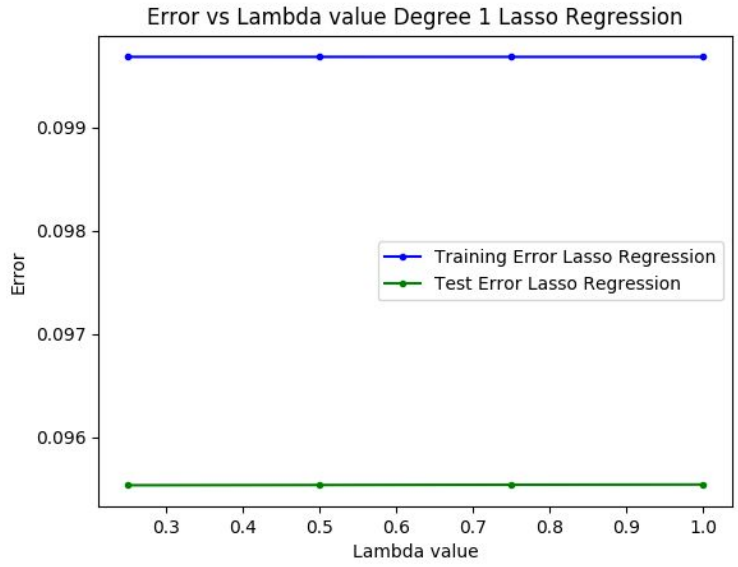


When n=9 we obtain the least squared error on the test set as well as training set hence it is most suitable for the dataset.

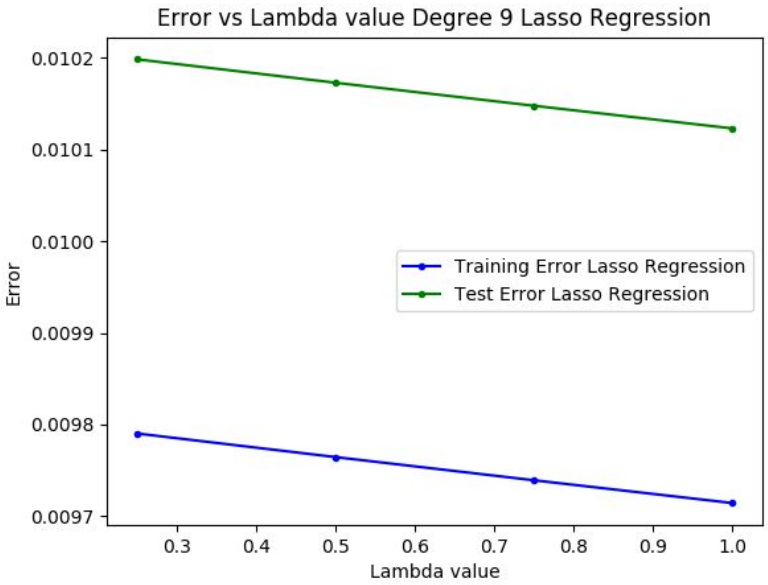
Part 3
Minimum training error from part 2 is Degree 9 equation
Maximum training error from part 2 is Degree 1 equation

A maximum of 100000 iterations have been performed. A lesser number of iterations might be performed if the iteration stop criteria is satisfied. The iteration stop criteria used is that absolute difference between current and previous error is less than 0.00000001.
The plots are saved as Degree 1 Lasso Regression.png, Degree 1 Ridge Regression.png, Degree 9 Lasso Regression.png , Degree 9 Ridge Regression.png

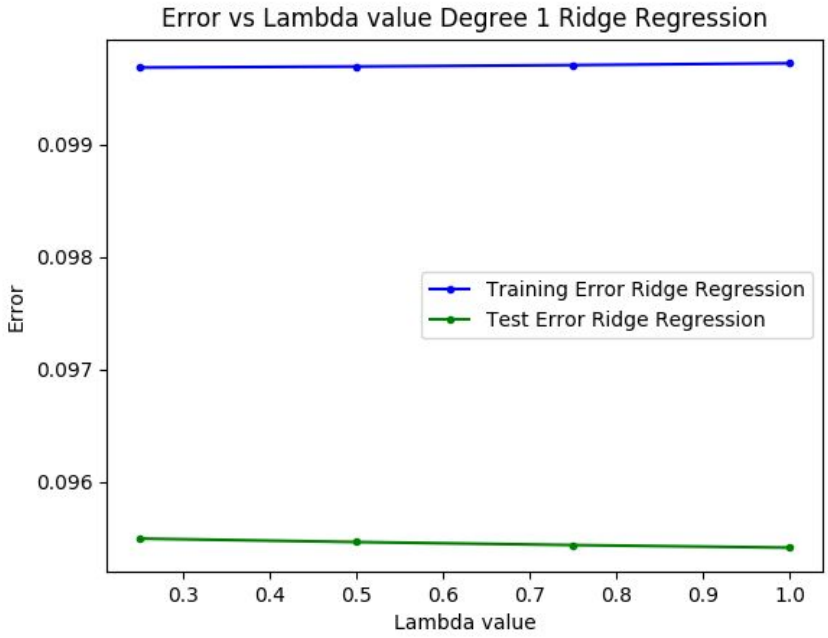
Degree 1 Lasso Regression Plot



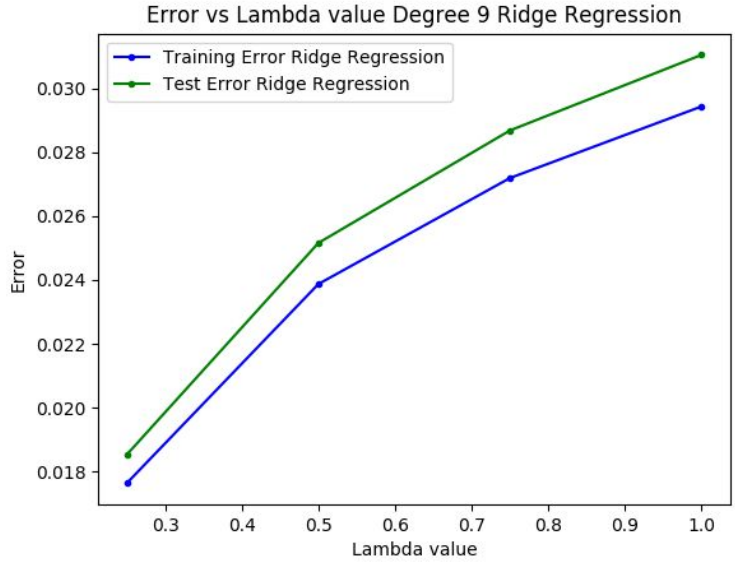
Degree 9 Lasso Regression Plot



Degree 1 Ridge Regression Plot



Degree 9 Ridge Regression Plot



The error observed in training and test set for Lasso regression for degree 9 equations is much lesser as compared to Ridge regression for degree 9 for all values of lambda for same maximum number of iterations.

The error observed in training and test set for ridge regression for degree 1 equations is similar as compared to lasso regression for degree 1 for all values of lambda.

For Lasso Regression error goes on decreasing with lambda for degree 9 equation
For Ridge Regression error goes on increasing with lambda for degree 9 equation
I would prefer Lasso Regression for this problem as the error given by equations obtained by it, on test and training set is much less than the error given by equations obtained by lasso regression for the same maximum number of iterations.