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CS 613 - Assignment 2 report

PART-1 [Theory Part]

Data, M =

$$\begin{bmatrix} -2 & 1 \\ -5 & -4 \\ -3 & 1 \\ 0 & 3 \\ -8 & 11 \\ -2 & 5 \\ 1 & 0 \\ 5 & -1 \\ -1 & -3 \\ 6 & 1 \end{bmatrix}$$

X =

$$\begin{bmatrix} -2 \\ -5 \\ -3 \\ 0 \\ -8 \\ -2 \\ 1 \\ 5 \\ -1 \\ 6 \end{bmatrix}$$

Y =

$$\begin{bmatrix} 1 \\ -4 \\ 1 \\ 3 \\ 11 \\ 5 \\ 0 \\ -1 \\ -3 \\ 1 \end{bmatrix}$$

Mean,

$$\mu = -0.9 \tag{1}$$

Standard Deviation,

$$\sigma = 4.2282 \tag{2}$$

X - Standardized =

$$\begin{bmatrix} -0.2602 \\ -0.9697 \\ -0.4967 \\ 0.2129 \\ -1.6792 \\ -0.2602 \\ 0.44937 \\ 1.3954 \\ -0.0237 \\ 1.6319 \end{bmatrix}$$

Adding Bias Feature to X =

$$\begin{bmatrix} 1 & -0.2602 \\ 1 & -0.9697 \\ 1 & -0.4967 \\ 1 & 0.2129 \\ 1 & -1.6792 \\ 1 & -0.2602 \\ 1 & 0.44937 \\ 1 & 1.3954 \\ 1 & -0.0237 \\ 1 & 1.6319 \end{bmatrix}$$

$X^T * X =$

$$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ -0.2602 & -0.9697 & -0.4967 & 0.2129 & -1.6792 & -0.2602 & 0.44937 & 1.3954 & -0.0237 & 1.6319 \end{bmatrix} \times \begin{bmatrix} 1 & -0.2602 \\ 1 & -0.9697 \\ 1 & -0.4967 \\ 1 & 0.2129 \\ 1 & -1.6792 \\ 1 & -0.2602 \\ 1 & 0.44937 \\ 1 & 1.3954 \\ 1 & -0.0237 \\ 1 & 1.6319 \end{bmatrix}$$

$$= \begin{bmatrix} 10 & 6.6613e-16 \\ 6.6613e-16 & 9 \end{bmatrix}$$

$(X^T * X)^{-1} =$

$$\begin{bmatrix} 0.10 & -7.4015e-18 \\ -7.4015e-18 & 0.11 \end{bmatrix}$$

$(\mathrm{X}^{\mathrm{T}} * \mathrm{X})^{-1} * \mathrm{X}^{\mathrm{T}} =$

$$\begin{bmatrix} 0.10 & 0 \\ 0 & 0.11 \end{bmatrix} \times \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ -0.2602 & -0.9697 & -0.4967 & 0.2129 & -1.6792 & -0.2602 & 0.44937 & 1.3954 & -0.0237 & 1.6319 \end{bmatrix}$$

$$= \begin{bmatrix} 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 \\ -0.0289 & -0.1077 & -0.0552 & 0.0237 & -0.1866 & -0.0289 & 0.0499 & 0.1550 & -0.0026 & 0.1813 \end{bmatrix}$$

$$Parameters, \theta = ((X^{\mathrm{T}} * X)^{-1} * X^{\mathrm{T}}) * Y \tag{3}$$

$$= \begin{bmatrix} 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 \\ -0.0289 & -0.1077 & -0.0552 & 0.0237 & -0.1866 & -0.0289 & 0.0499 & 0.1550 & -0.0026 & 0.1813 \end{bmatrix} \times \begin{bmatrix} 1 \\ -4 \\ 1 \\ 3 \\ 11 \\ 5 \\ 0 \\ -1 \\ -3 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1.400000 \\ -1.74489 \end{bmatrix}$$

Final Model:

$$\hat{Y} = \theta_0 + \theta_1 x_{:,1} \tag{4}$$

$$\hat{Y} = 1.4 + -1.74489 * x_{:,1} \tag{5}$$

PART-2 [Simple Closed Form Linear Regression]

Final Model:

$$\hat{Y} = \theta_0 + \theta_1 x_{:,1} \tag{6}$$

$$\hat{Y} = 3425.5667 + 846.9475 * x_{:,1} + -369.2202 * x_{:,2} \tag{7}$$

Test RMSE:

$$R.M.S.E = 853.38058 \tag{8}$$

PART-3 [S-Folds Closed Form Linear Regression, K=5]

Overall Test RMSE:

$$R.M.S.E = 634.8167 \tag{9}$$

PART-4 [Locally Weighted Closed Form Linear Regression]

Test RMSE:

$$R.M.S.E = 321.4794 \tag{10}$$

PART-5 [Batch Gradient Descent Linear Regression]

Final Model:

$$\hat{Y} = \theta_0 + \theta_1 x_{:,1} \tag{11}$$

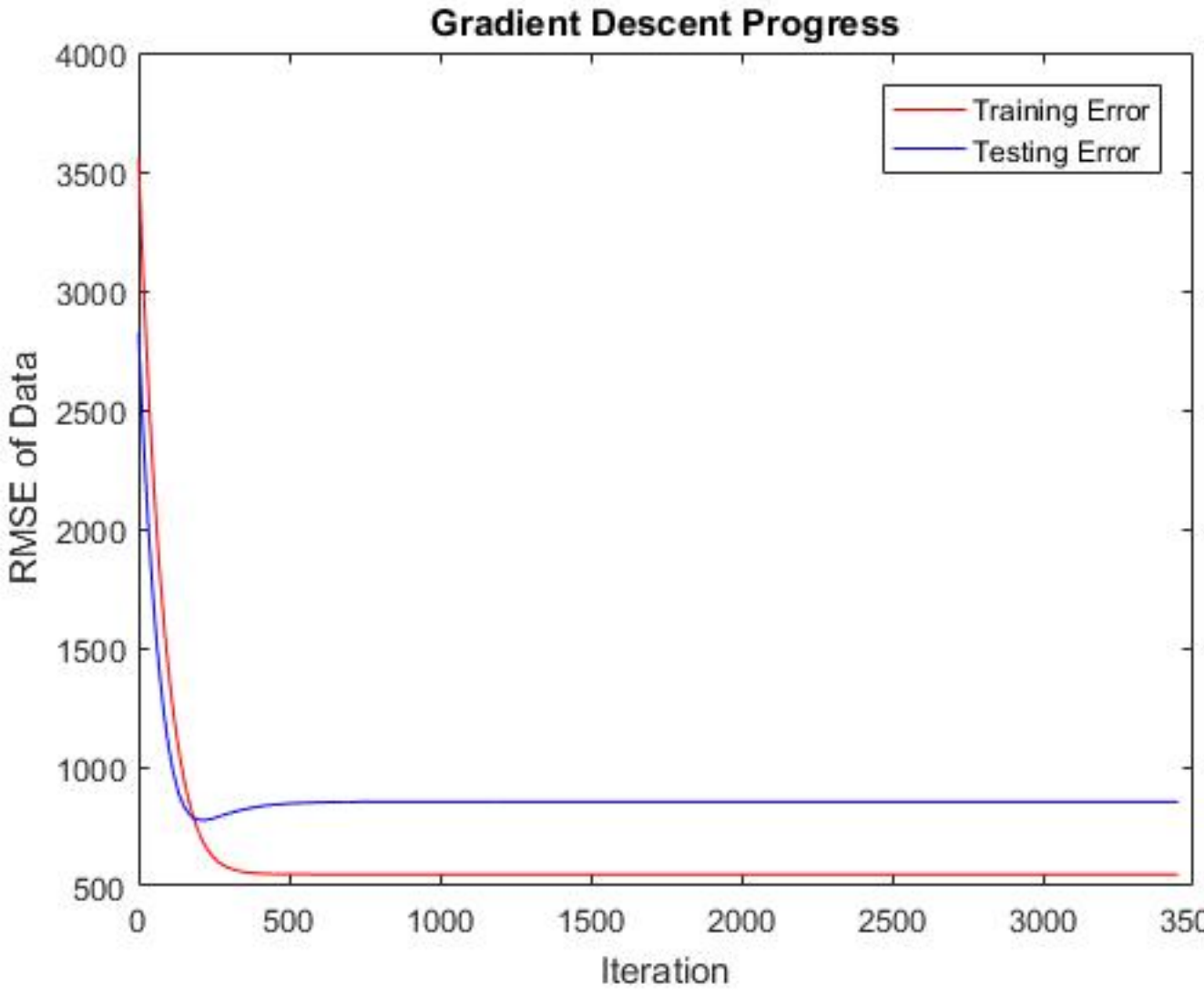
$$\hat{Y} = 3425.5667 + 846.9475 * x_{:,1} + -369.2202 * x_{:,2} \tag{12}$$

Final Test RMSE:

$$R.M.S.E = 853.38058 \tag{13}$$

Final Train RMSE:

$$R.M.S.E = 548.97236 \tag{14}$$


Gradient Descent Progress
Training Error
Testing Error
RMSE of Data
Iteration
4000
3500
3000
2500
2000
1500
1000
500
0
500
1000
1500
2000
2500
3000
3500