In the name of God

Computational Intelligence Ex1 Report

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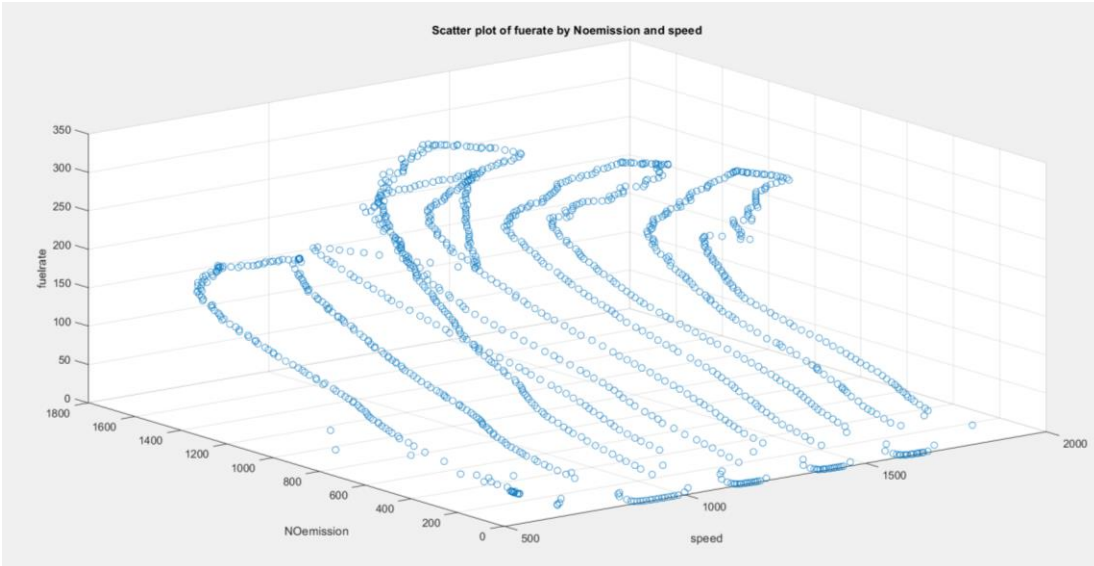
Part a)



Part b and c)

In this part with use of **fitml** function, do the linear regression with coefficients like below:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

I put the results of my regression fit that shows the estimation of coefficients of above equation and MSE of train and validation data in blew:

```
Linear regression model:
    y ~ 1 + x1 + x2

Estimated Coefficients:
                   Estimate       SE         tStat       pValue
                   ________    _________    _______    __________

    (Intercept)    -63.475        9.6931    -6.5484    1.1286e-10
    x1             0.05189     0.0063823     8.1303    1.9575e-15
    x2             0.14591     0.0047731      30.57    7.5593e-131


Number of observations: 700, Error degrees of freedom: 697
Root Mean Squared Error: 59
R-squared: 0.584,  Adjusted R-Squared: 0.583
F-statistic vs. constant model: 489, p-value = 1.87e-133

MSE_tarin_data =

   3.4647e+03


MSE_validation_data =

   3.6694e+03
```

Part d)

In this part as we know from logistic regression, we have an equation as the below form:

$$y = \frac{Y}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2}}$$

If we get the ln of the above equation, we have:

$$\ln\left(\frac{Y - y}{y}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

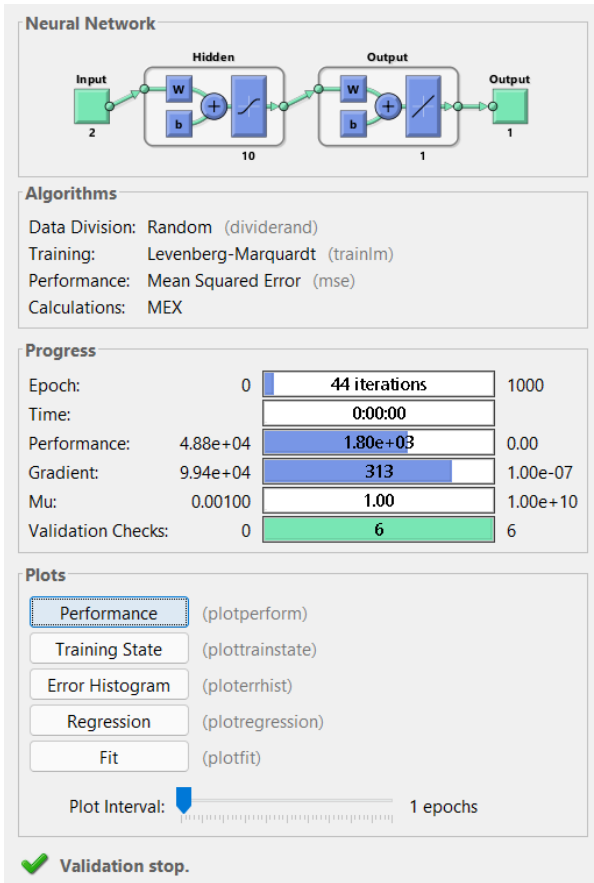
Now we do the simple multiple linear regression like the previous part. I put the coefficients and MSEs of both train and validation data in below:

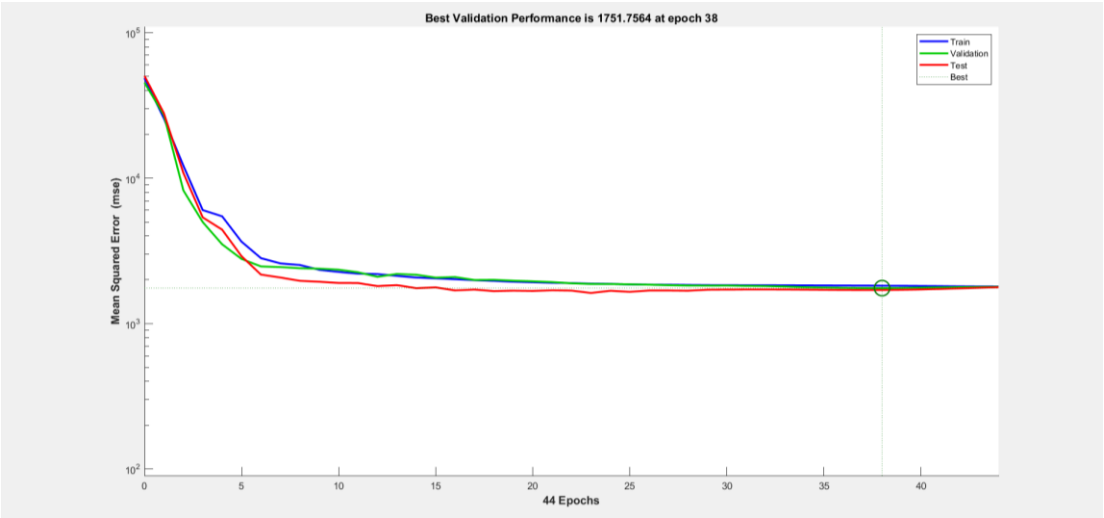
```
Linear regression model:
    y ~ 1 + x1 + x2

Estimated Coefficients:
                   Estimate        SE         tStat       pValue
                   ________    _________    ______    __________

    (Intercept)      -4.7504      0.20489   -23.185    1.3688e-88
    x1             0.0010087   0.00013491     7.477    2.2911e-13
    x2             0.0032414   0.00010089    32.127   1.1901e-139


Number of observations: 700, Error degrees of freedom: 697
Root Mean Squared Error: 1.25
R-squared: 0.605,  Adjusted R-Squared: 0.604
F-statistic vs. constant model: 533, p-value = 3.05e-141

MSE_train_data_log =

   2.8126e+04


MSE_validation_data_log =

   2.7982e+04
```

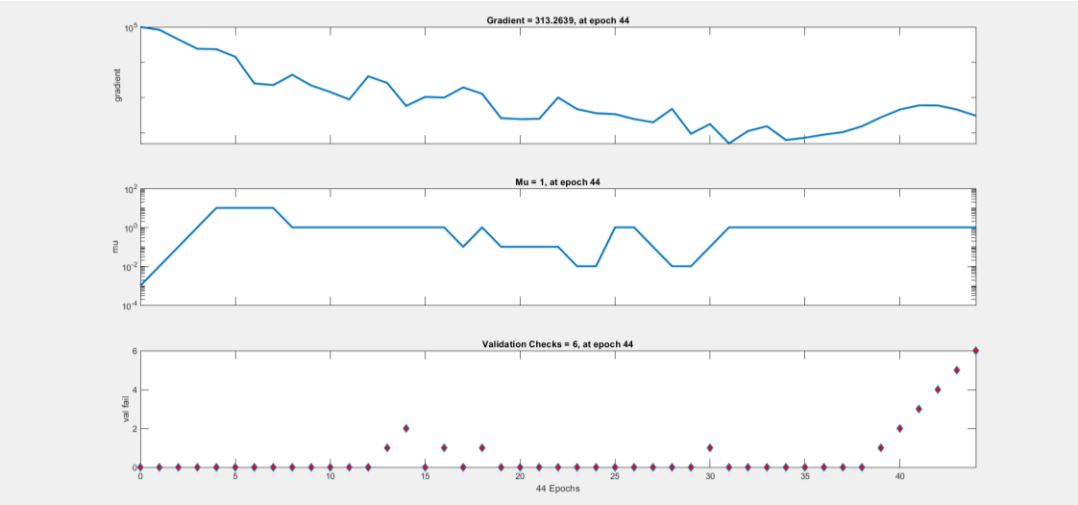
Part e)

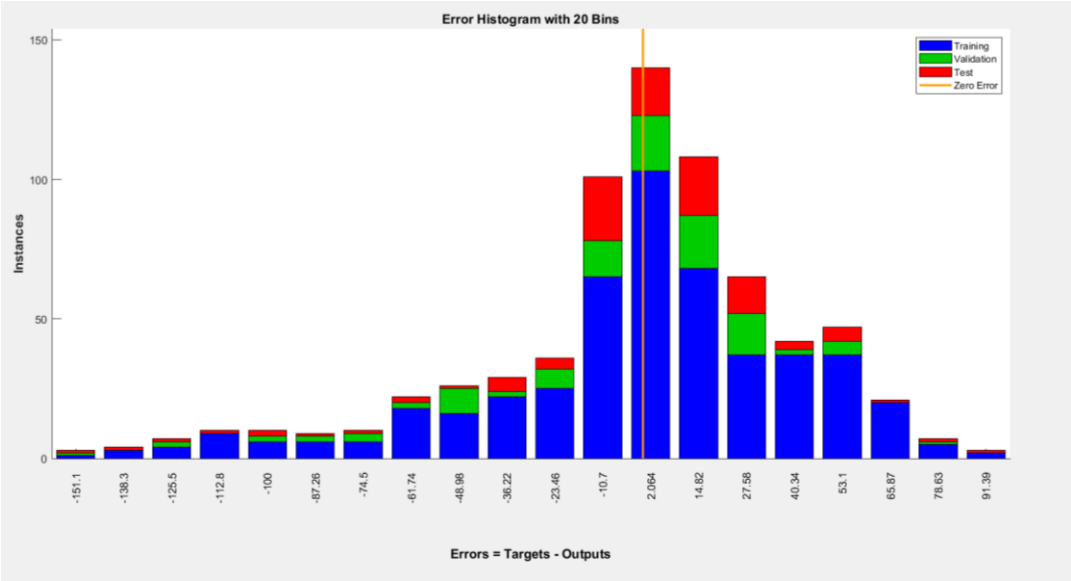
I tried simulation with 10,100,200 and 1000 hidden layers and put the simulation results in below:

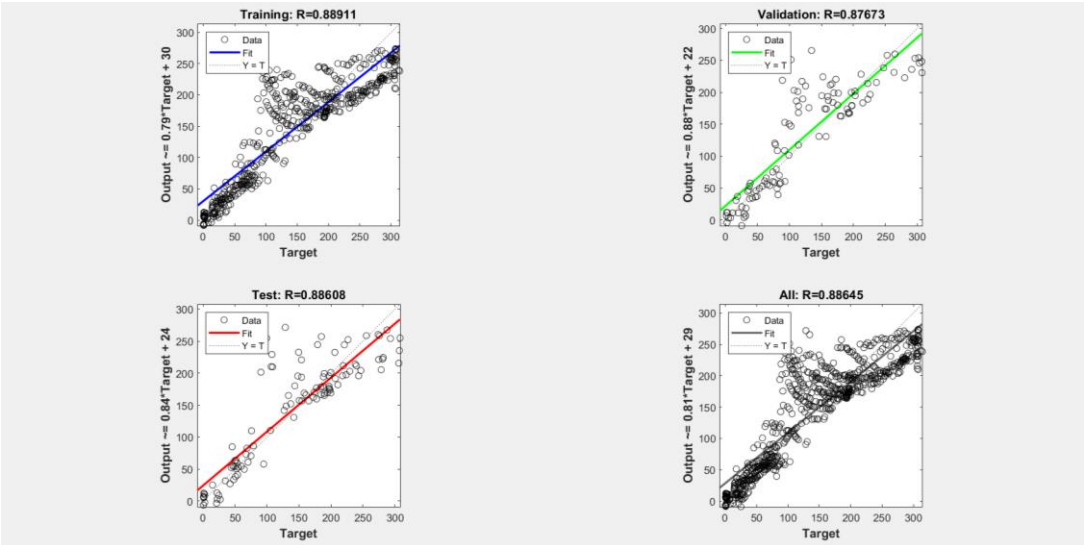
Hidden Layers = 10



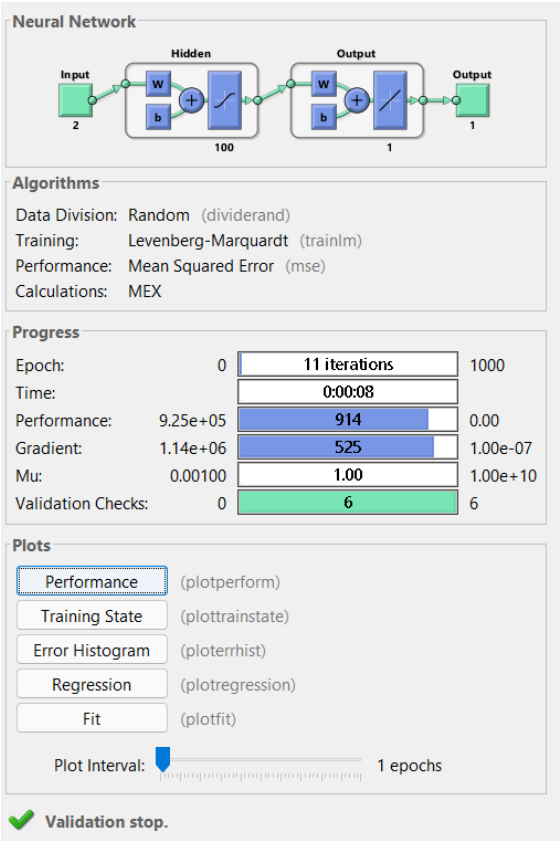


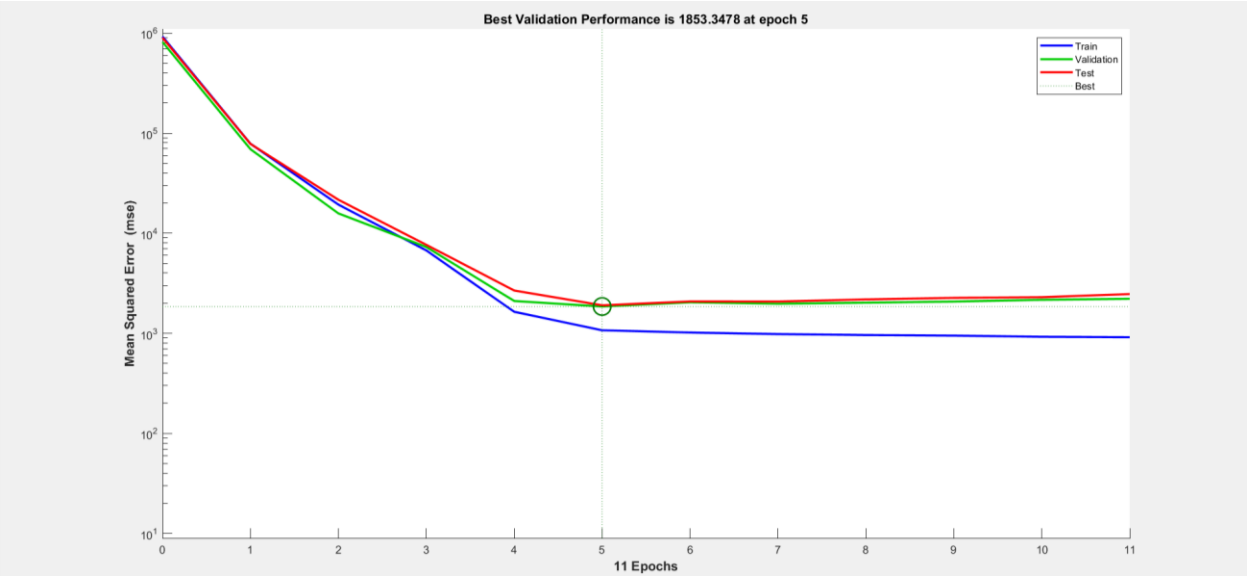

Gradient = 313.2639, at epoch 44
gradient
Mu = 1, at epoch 44
mu
Validation Checks = 6, at epoch 44
val fail
44 Epochs

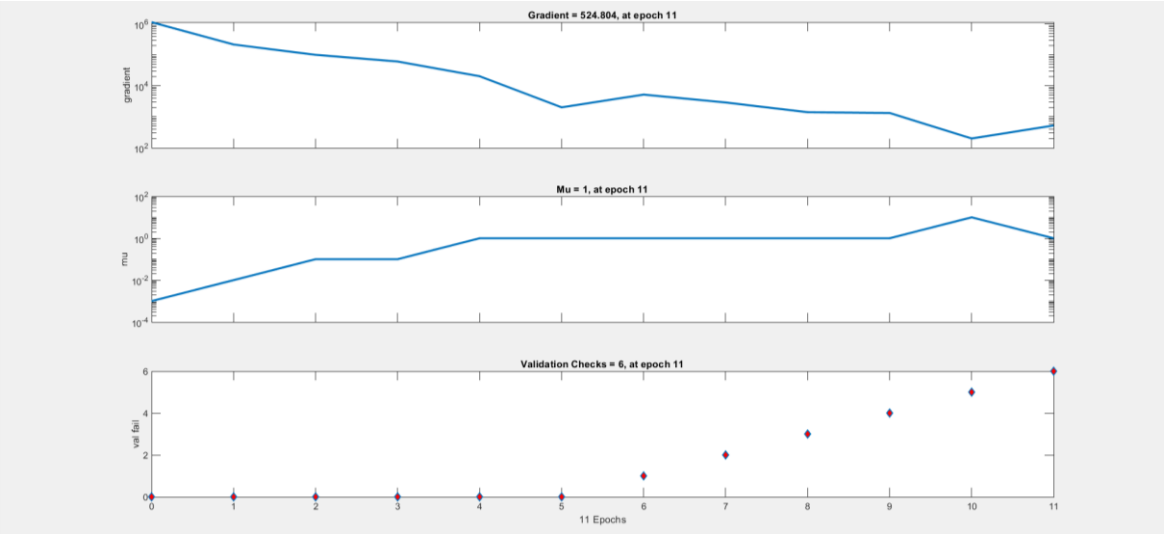

Error Histogram with 20 Bins
Training
Validation
Test
Zero Error
Instances
-151.1
-138.3
-125.5
-112.8
-100
-87.26
-74.5
-61.74
-48.98
-36.22
-23.46
-10.7
2.064
14.82
27.58
40.34
53.1
65.87
78.63
91.39
Errors = Targets - Outputs

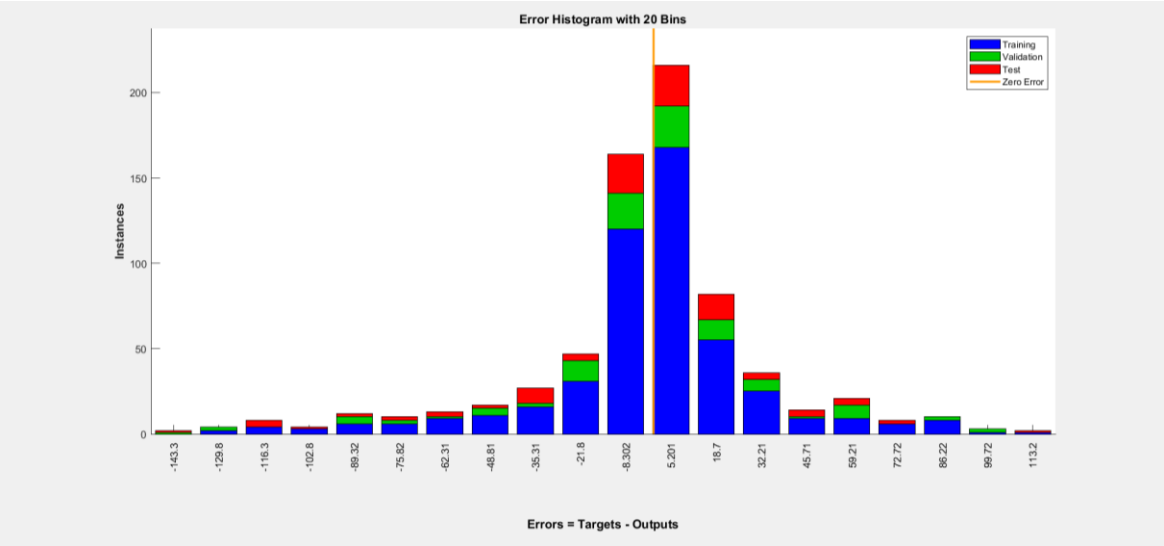

Training: R=0.88911
Output ~= 0.79*Target + 30
Validation: R=0.87673
Output ~= 0.88*Target + 22
Test: R=0.88608
Output ~= 0.84*Target + 24
All: R=0.88645
Output ~= 0.81*Target + 29
Data
Fit
Y = T
Target

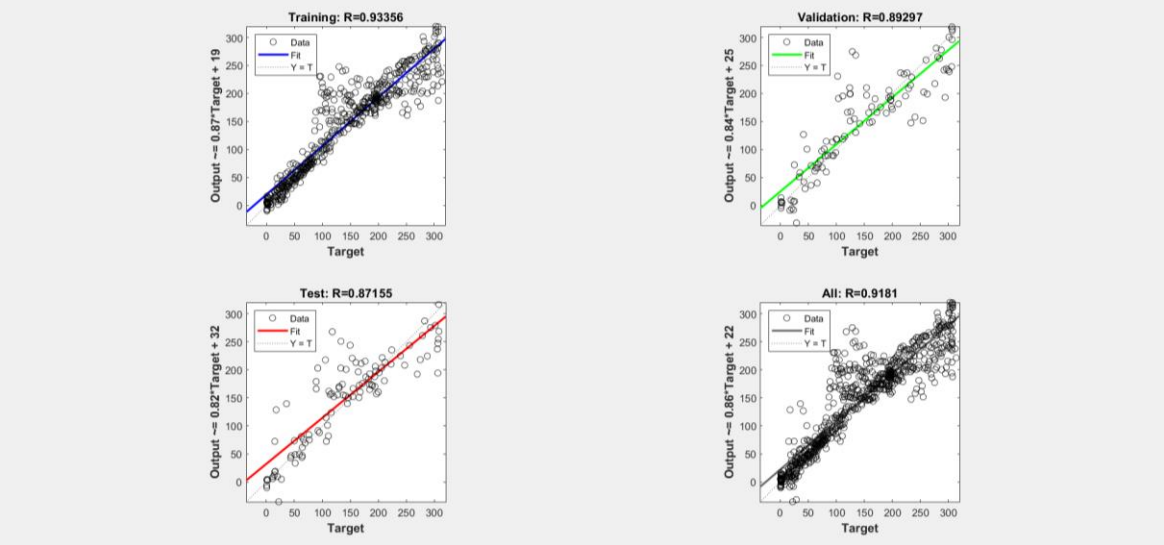
Hidden Layers = 100



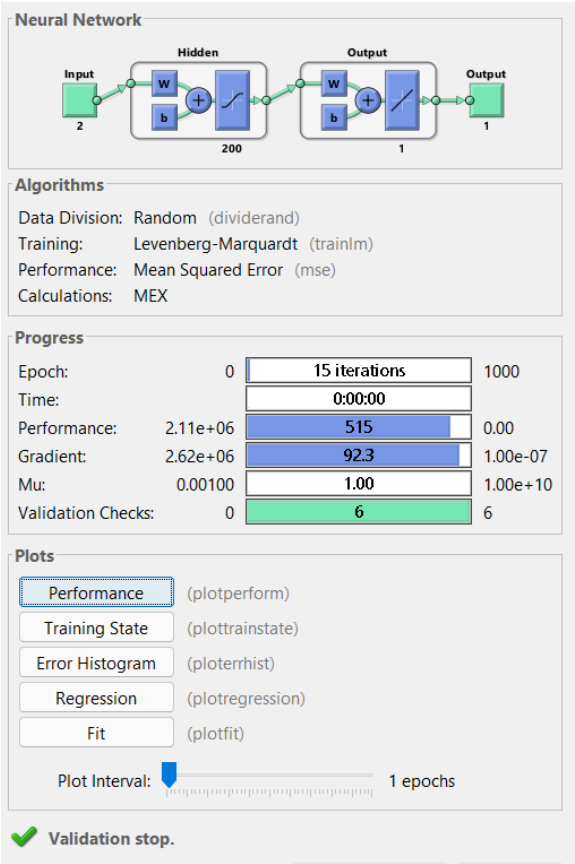


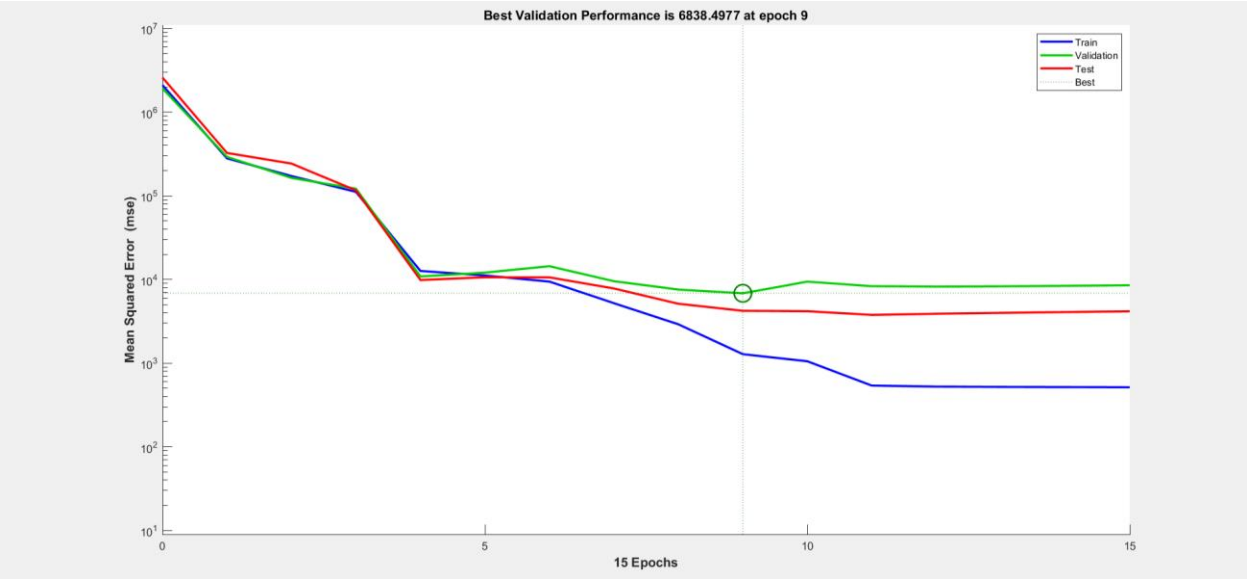

Gradient = 524.804, at epoch 11
gradient
Mu = 1, at epoch 11
mu
Validation Checks = 6, at epoch 11
val fail
11 Epochs

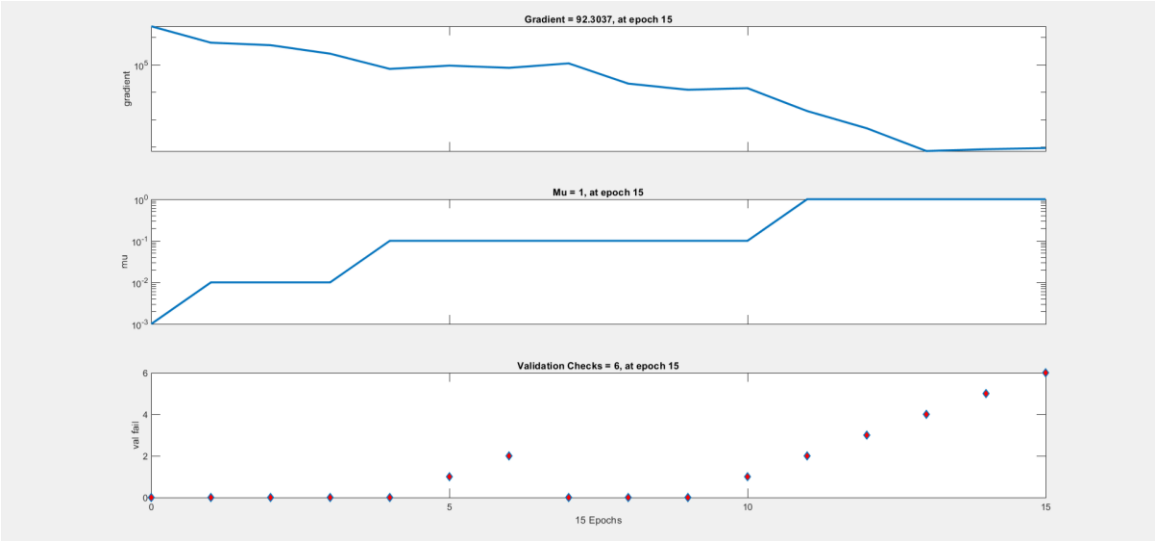

Error Histogram with 20 Bins
Training
Validation
Test
Zero Error
Instances
-143.3
-129.8
-116.3
-102.8
-89.32
-75.82
-62.31
-48.81
-35.31
-21.8
-8.302
5.201
18.7
32.21
45.71
59.21
72.72
86.22
99.72
113.2
Errors = Targets - Outputs

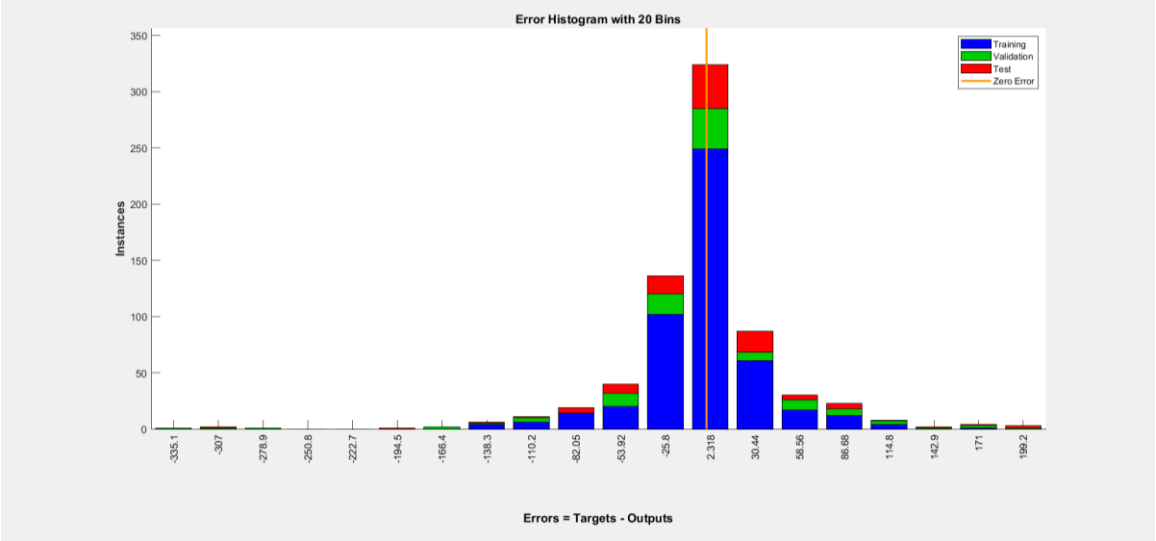

Training: R=0.93356
Output ~= 0.87*Target + 19
Validation: R=0.89297
Output ~= 0.84*Target + 25
Test: R=0.87155
Output ~= 0.82*Target + 32
All: R=0.9181
Output ~= 0.86*Target + 22
Data
Fit
Y = T
Target

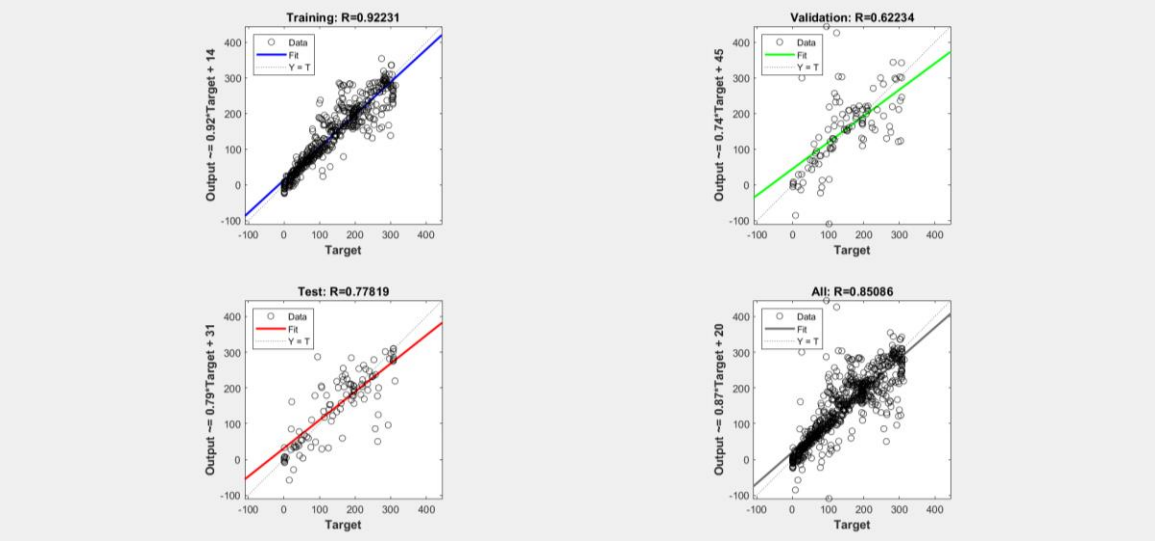
Hidden Layers = 200



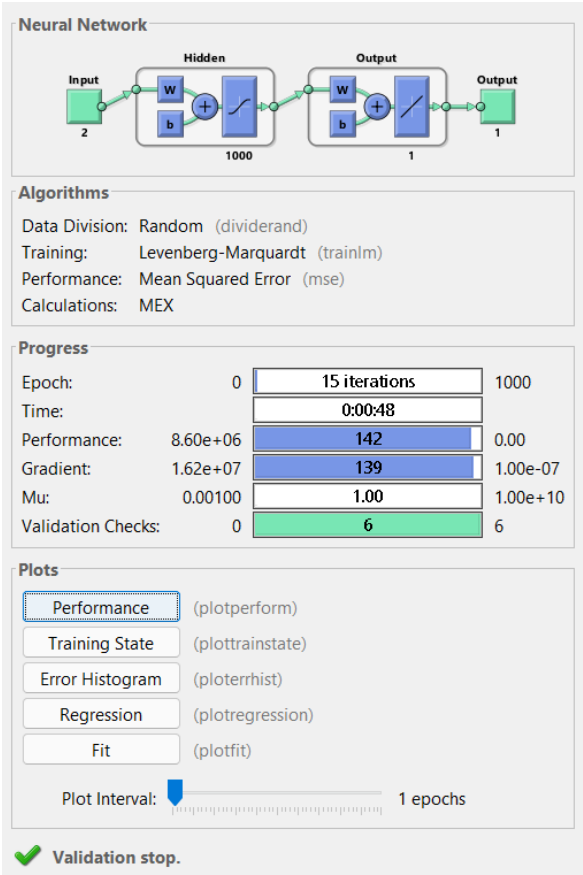


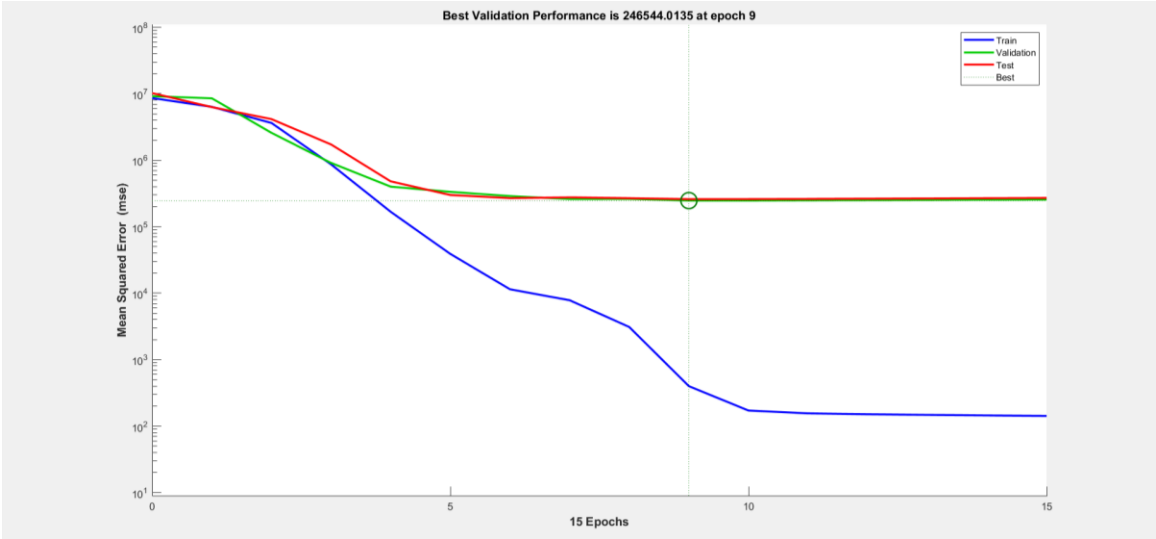

Gradient = 92.3037, at epoch 15
gradient
Mu = 1, at epoch 15
mu
Validation Checks = 6, at epoch 15
val fail
15 Epochs

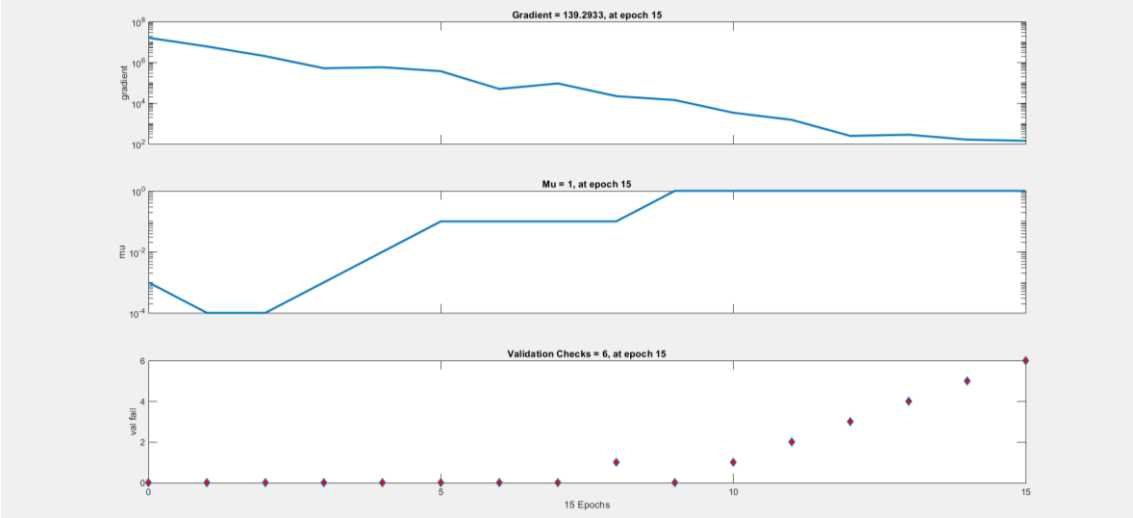

Error Histogram with 20 Bins
Training
Validation
Test
Zero Error
Instances
Errors = Targets - Outputs

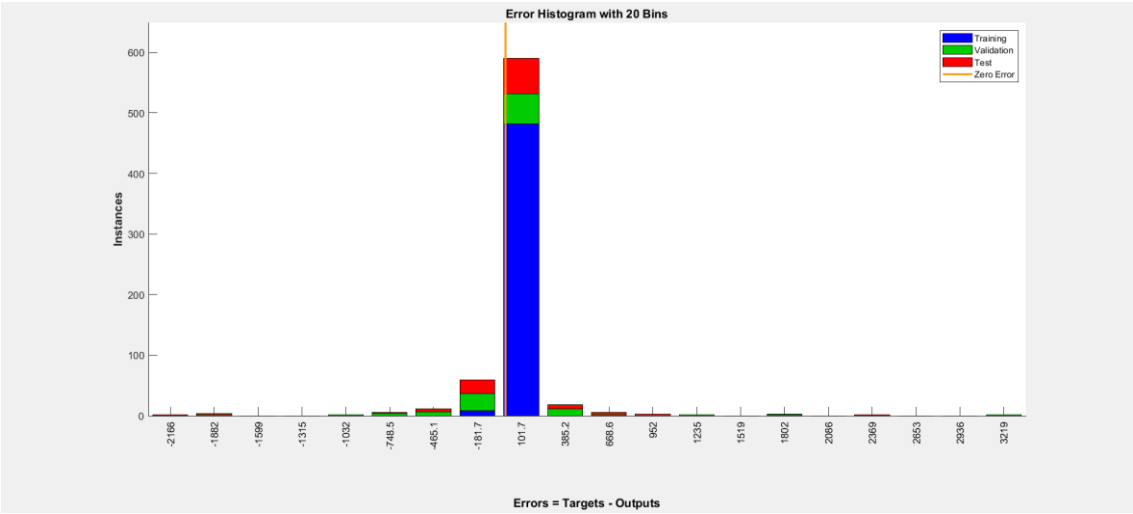

Training: R=0.92231
Output ~= 0.92*Target + 14
Validation: R=0.62234
Output ~= 0.74*Target + 45
Test: R=0.77819
Output ~= 0.79*Target + 31
All: R=0.85086
Output ~= 0.87*Target + 20
Data
Fit
Y = T
Target

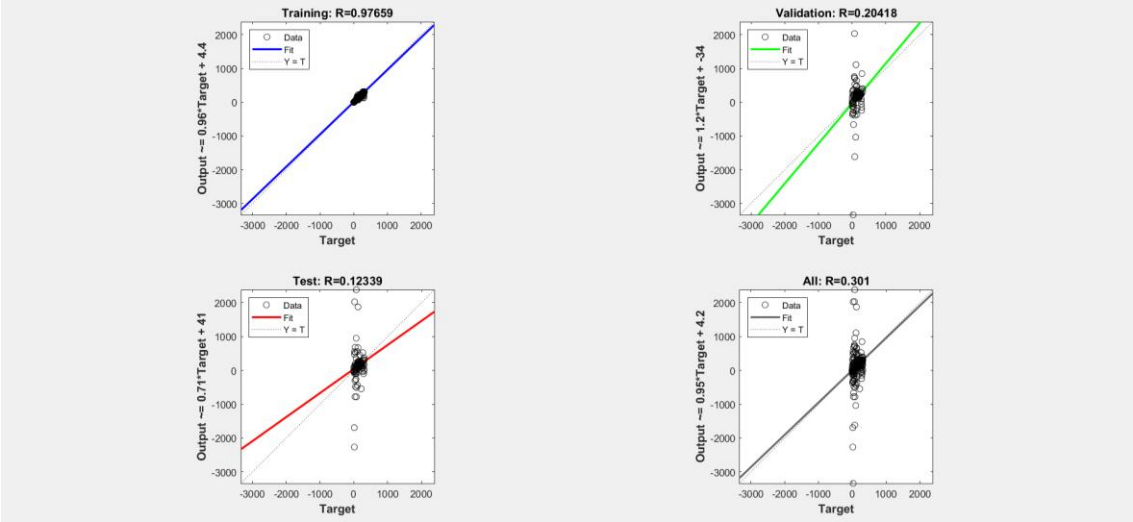
Hidden Layers = 1000






Gradient = 139.2933, at epoch 15
gradient
Mu = 1, at epoch 15
mu
Validation Checks = 6, at epoch 15
val fail
15 Epochs


Error Histogram with 20 Bins
Training
Validation
Test
Zero Error
Instances
Errors = Targets - Outputs


Training: R=0.97659
Output ~= 0.96*Target + 4.4
Validation: R=0.20418
Output ~= 1.2*Target + -34
Test: R=0.12339
Output ~= 0.71*Target + 41
All: R=0.301
Output ~= 0.95*Target + 4.2
Data
Fit
Y = T
Target

As I checked various values of hidden layers, I came to realize that a NN with 100 hidden layer gives us appropriate value of MSE. The MSEs of this NN with 100 of hidden layer is:

MSE_train_nn = 1.2347e+03

MSE_validation_nn = 2.12763+03

As we can see the MSE of our NN model is smaller than our regression and logistic model and MSE of our regression model is smaller than logistic model and this shows that the linear relation between our data is more and work even better than logistic model but our 10 hidden layer model estimate y better but it has more time and computational costs and can be appropriate for more complex relations.