```
% Import data
data_HW3 = readtable("Top 100 Genes.xlsx","ReadRowNames",true);
```

```
% Inspect table
head(data_HW3,5)
```

```
ans = 5×101 table
```

...

	A_23_P342744	A_24_P246891	A_23_P24535	A_23_P75362	A_32_P76399
1 GENE_SYMBOL	'LIX1L'	'NEU4'	'TTC12'	'IFITM10'	'EIF3L'
2 GENE_NAME	'Lix1 homolog...	'sialidase 4'	'tetratricope...	'interferon i...	'eukaryotic t...
3 GSM1912920	'-0.0999'	'-0.96104'	'0.28358'	'-0.31814'	'-0.26628'
4 GSM1912921	'1.0914'	'1.6402'	'-1.4203'	'-0.54017'	'-0.089449'
5 GSM1912922	'-0.37438'	'1.7162'	'0.17951'	'0.75482'	'0.4971'

```
test_patients = readcell("Patient IDs - Test Set.xlsx");
train_patients = readcell("Patient IDs - Training Set.xlsx");
```

```
% Using readmatrix correctly loads data as class "double"
%data_HW3_2 = readmatrix("Top 100 Genes & Rand 15 Patients.xlsx");
```

```
% Create new X and Y matrices (have to convert class if using readtable)
Xtrain = str2double(data_HW3{train_patients, 1:100});
Xtest = str2double(data_HW3{test_patients, 1:100});

Ytrain = table2array(data_HW3(train_patients, end));
Ytest = table2array(data_HW3(test_patients, end));
```

Multi-linear Regression using Hold-out Validation

Normal Regression

```
% Find correlation of all 100 genes and then extract data for top 15 genes
r_100 = corr(Xtrain,Ytrain);
[r_15,index_15] = maxk(abs(r_100),15);

% Create new training and test predictor data sets with top 15 genes
Xtrain_15 = Xtrain(:,index_15);
Xtest_15 = Xtest(:,index_15);

mdl = fitlm(Xtrain_15,Ytrain)
```

```
mdl = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9 + x10 + x11 + x12 + x13 + x14 + x15
```

```
Estimated Coefficients:
                   Estimate      SE        tStat        pValue  
                   ________    ______    _________    __________

    (Intercept)     627.65     54.797       11.454    2.7843e-12
    x1               163.8     175.67      0.93244       0.35881
    x2             -31.076     115.96     -0.26799       0.79061
    x3             -1.6132     93.205    -0.017308       0.98631
    x4               -4.73      140.2    -0.033738       0.97332
    x5              252.87     152.73       1.6557       0.10857
    x6              134.88     119.03       1.1332       0.26641
    x7             -56.536     128.64      -0.4395       0.66356
    x8              107.58     63.946       1.6824       0.10322
    x9              145.38     70.929       2.0497      0.049532
    x10             141.14       51.1        2.762     0.0098648
    x11             177.62     122.02       1.4556       0.15623
    x12            -276.22      212.1      -1.3023       0.20306
    x13            -19.133     92.052     -0.20785        0.8368
    x14            -257.19     123.27      -2.0864      0.045844
    x15             48.972     119.86      0.40858       0.68585


Number of observations: 45, Error degrees of freedom: 29
Root Mean Squared Error: 212
R-squared: 0.718,  Adjusted R-Squared: 0.572
F-statistic vs. constant model: 4.92, p-value = 0.00012
```

```
Ypred_norm = predict(mdl,Xtest_15);
r_norm = corr(Ytest,Ypred_norm)
```

```
r_norm = 0.0816
```

```
r2_norm = r_norm^2
```

```
r2_norm = 0.0067
```

```
RMSE = sqrt(mean((Ypred_norm-Ytest).^2))
```

```
RMSE = 359.6592
```

```
avg_error = mean(abs(Ypred_norm-Ytest))
```

```
avg_error = 296.3538
```

Lasso Regression

```
[B1, Fit] = lasso(Xtrain_15,Ytrain,'CV',5);
B1_coeff = B1(:,Fit.Index1SE)
```

```
B1_coeff = 15×1
  143.2955
         0
   15.2578
         0
   28.6057
    3.0056
         0
   34.1621
   38.1426
   30.7815
```

⋮

```
B1_intercept = Fit.Intercept(Fit.Index1SE)
```

```
B1_intercept = 599.6518
```

```
Ypred_lasso = Xtest_15 * B1_coeff + B1_intercept;

r_lasso = corr(Ypred_lasso,Ytest)
```

```
r_lasso = 0.1174
```

```
r2_lasso =  r_lasso^2
```

```
r2_lasso = 0.0138
```

```
RMSE_lasso = sqrt(mean((Ypred_lasso-Ytest).^2))
```

```
RMSE_lasso = 314.1729
```

```
avg_error_lasso = mean(abs(Ypred_lasso-Ytest))
```

```
avg_error_lasso = 257.2454
```

Stepwise Regression

```
[B2,~,~,~,stats] = stepwisefit(Xtrain_15,Ytrain);
```

```
Initial columns included: none
Step 1, added column 1, p=3.57549e-06
Step 2, added column 10, p=0.000962066
Step 3, added column 15, p=0.0485883
Final columns included:  1 10 15
    'Coeff'       'Std.Err.'    'Status'    'P'
    [393.7172]    [ 90.9898]    'In'        [9.4619e-05]
    [ -0.3560]    [ 99.5721]    'Out'       [    0.9972]
    [ 64.4157]    [ 69.1039]    'Out'       [    0.3568]
    [ 52.2210]    [ 64.1681]    'Out'       [    0.4206]
    [ 43.3180]    [ 90.0316]    'Out'       [    0.6330]
    [ 42.2050]    [ 67.8657]    'Out'       [    0.5375]
    [ 29.5171]    [ 95.3956]    'Out'       [    0.7586]
    [ 74.9424]    [ 55.4607]    'Out'       [    0.1842]
    [100.5944]    [ 53.7852]    'Out'       [    0.0688]
    [ 65.2065]    [ 31.8982]    'In'        [    0.0474]
    [131.6148]    [ 87.8463]    'Out'       [    0.1419]
    [  5.7396]    [ 88.2548]    'Out'       [    0.9485]
    [ 88.5513]    [ 70.0971]    'Out'       [    0.2138]
    [-38.5347]    [ 82.3811]    'Out'       [    0.6425]
    [149.7515]    [ 73.6695]    'In'        [    0.0486]
```

```
Ypred_step = Xtest_15(:,[1,10,15])*B2([1,10,15]) + stats.intercept;
r_stepwise = corr(Ypred_step,Ytest)
```

```
r_stepwise = 0.1894
```

```
r2_stepwise =  r_stepwise^2
```

```
r2_stepwise = 0.0359
```

```
RMSE_stepwise = sqrt(mean((Ypred_step-Ytest).^2))
```

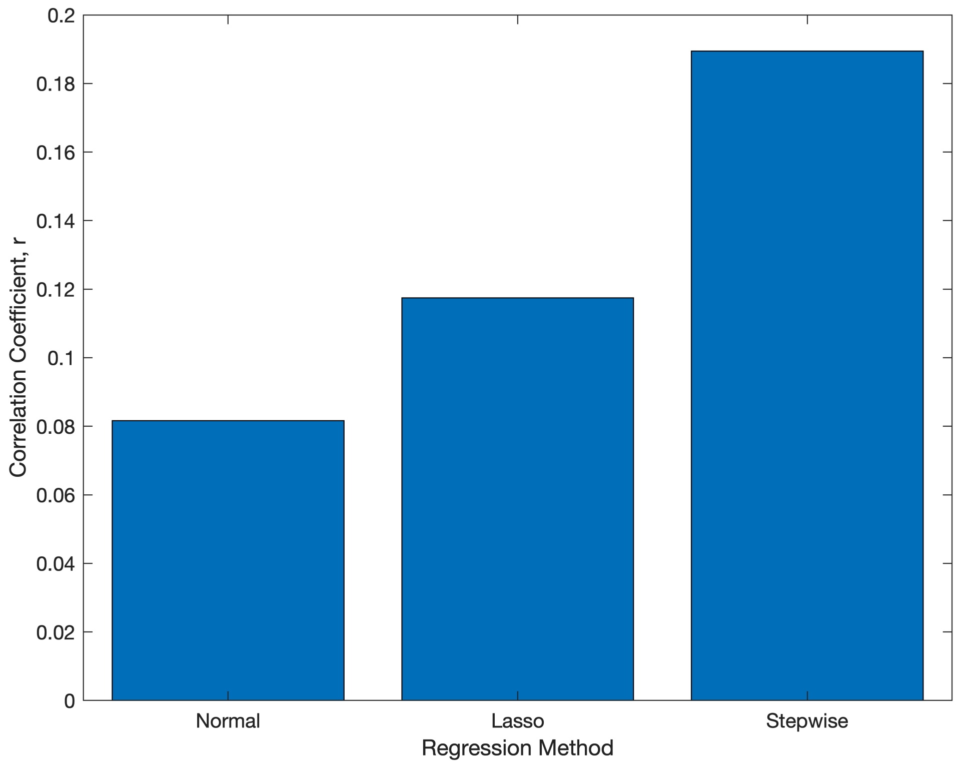
```
RMSE_stepwise = 347.2721
```

```
avg_error_stepwise = mean(abs(Ypred_step-Ytest))
```

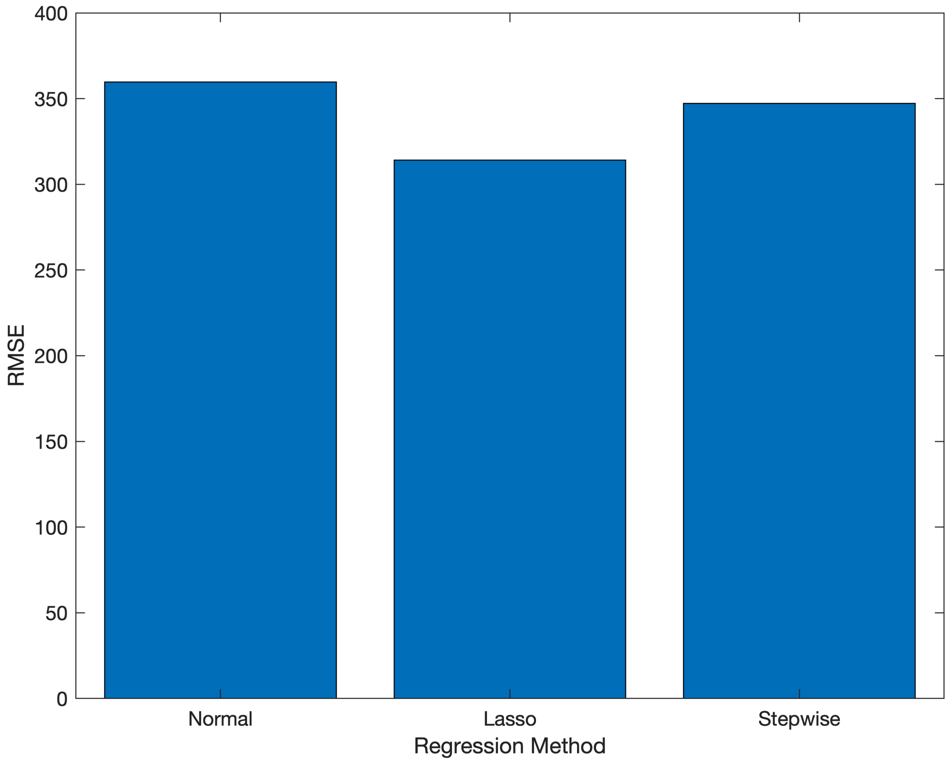
```
avg_error_stepwise = 281.9262
```

Compare Results of 3 Methods

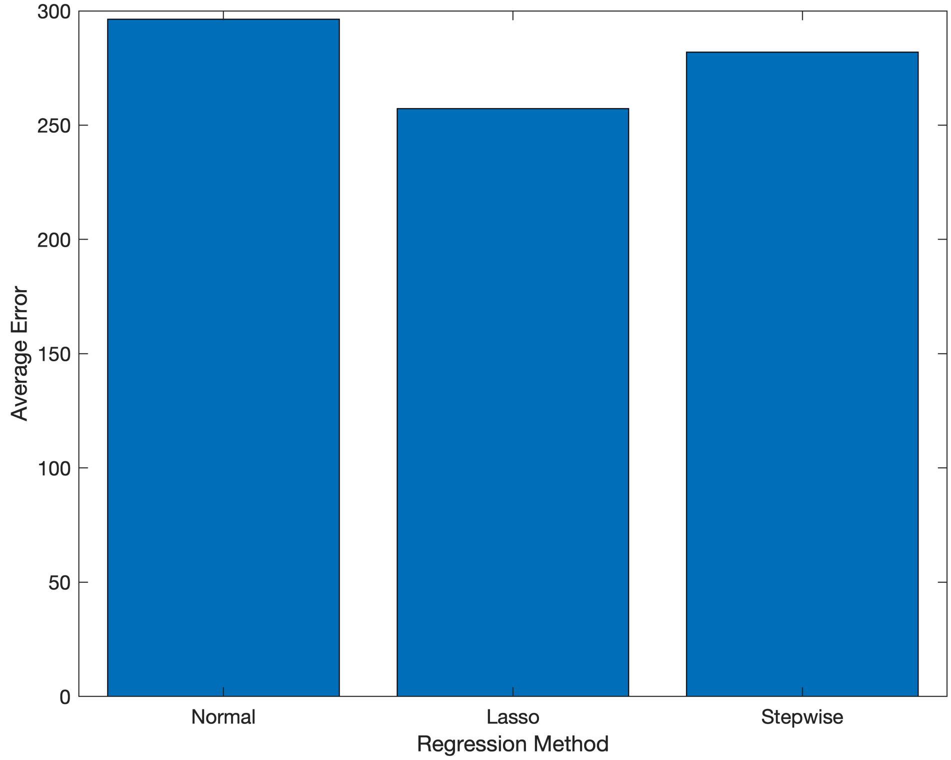
```
% Create labels for bar graphs
x = categorical({'Normal','Lasso','Stepwise'});
x = reordercats(x,{'Normal','Lasso','Stepwise'});

% Correlation bar graph
bar(x,[r_norm,r_lasso,r_stepwise])
xlabel("Regression Method")
ylabel("Correlation Coefficient, r")
```



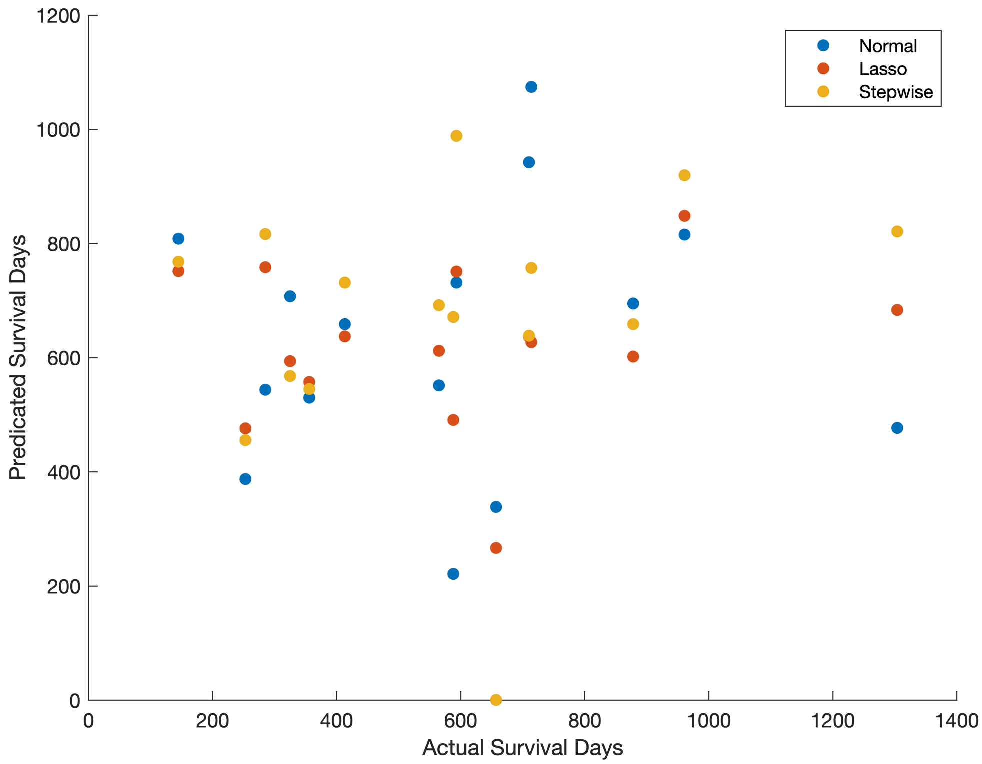

```
% RMSE bar graph
bar(x,[RMSE,RMSE_lasso,RMSE_stepwise])
xlabel("Regression Method")
ylabel("RMSE")
```




```
% Avg Error bar graph
bar(x,[avg_error,avg_error_lasso,avg_error_stepwise])
xlabel("Regression Method")
ylabel("Average Error")
```




```
scatter(Ytest,Ypred_norm,"filled")
xlabel("Actual Survival Days")
ylabel("Predicated Survival Days")
hold on
scatter(Ytest,Ypred_lasso,"filled")
hold on
scatter(Ytest,Ypred_step,"filled")
hold off
legend("Normal","Lasso","Stepwise")
```




```
boxplot(data_HW3.SurvivalDays)
```