PSYC 560

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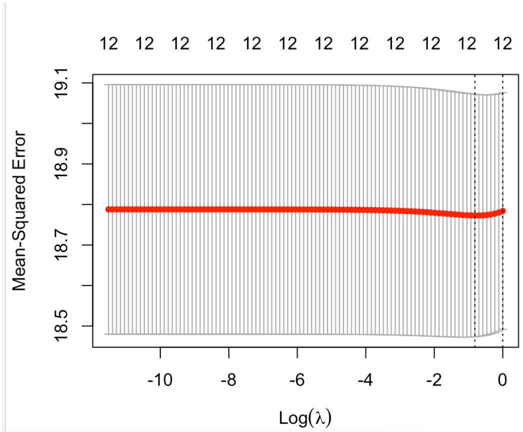
Assignment #3: Shrinkage and Data Reduction Methods

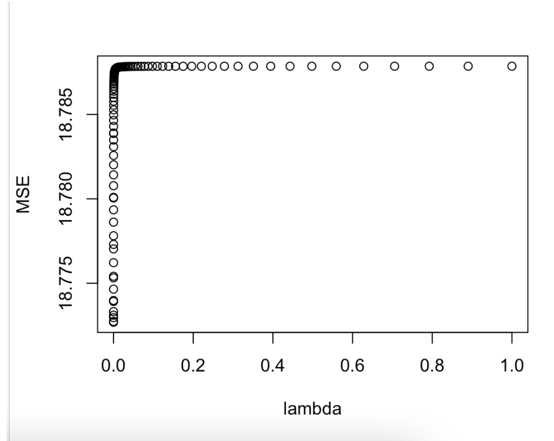
[Q1] The data file **mobilephone2_training.csv** is part of large European survey data for mobile phone customers. It includes the following variables:

Suppose that you are interested in predicting the duration of remaining a customer (dura24) using 12 predictors (variables 2 – 12).

1. dura24: the duration of remaining a customer in the past 24 months
2. age
3. Ssound: satisfaction with sound quality (1 - 10)
4. Sglob: satisfaction with overall network functioning (1 - 10)
5. Svmail: satisfaction with voicemail (1 - 10)
6. Sinfor: satisfaction with information (1 - 10)
7. Sprice: satisfaction on price (1 - 10)
8. Spromo: satisfaction on promotion (1 - 10)
9. Sadver: satisfaction with the advertisement (1 - 10)
10. Sperson: satisfaction with the salesperson (1 - 10)
11. Simage: satisfaction on company image (1 - 10)
12. Sglobal: global satisfaction (1 – 10)
13. Lintent: intention of loyalty (1 - 10)

(1) Apply a series of ridge regression to the data, considering 100 candidate values of the tuning parameter λ within the interval [10-5, 1]. Based on 10-fold cross validation, plot all MSE values against the candidate values of λ and choose the optimal λ value. Given the chosen λ value, re-run a ridge regression for the data and report its coefficient estimates. (2 points)



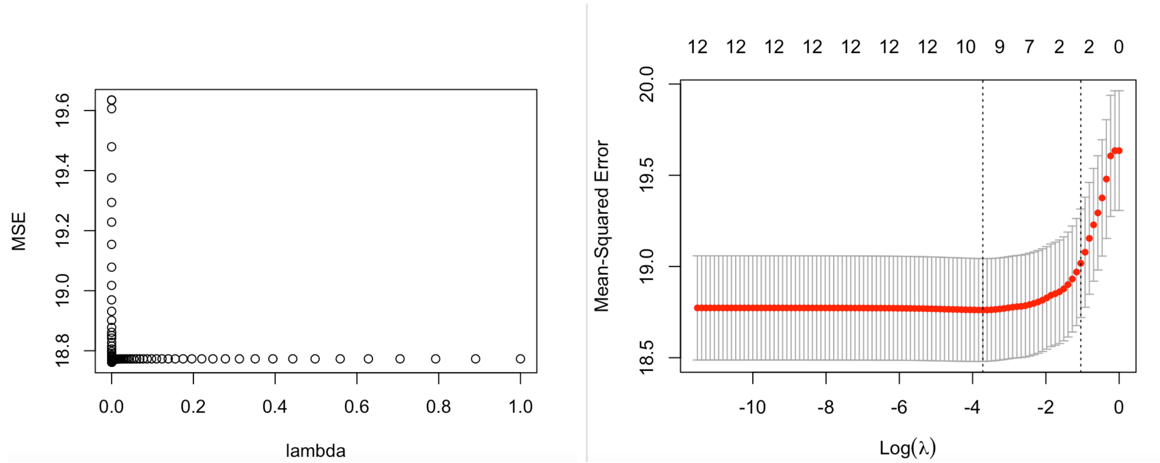


At seed = 42, we generate a sequence of 100 values from 10^-5 to 1, and we find the optimal lambda = 0.4430621 based on 10-fold cross validation, then we re-run the ridge regression using lambda = 0.4430621, then we get the coefficient estimates as follows:

```
                     s0
(Intercept) 15.343174382
age          0.066382545
ssound       0.055948175
sglob        0.080414500
svmail      -0.005857497
sinfor       0.061046521
sprice       0.024152055
spromo       0.048993454
sadver      -0.106313829
sperson     -0.073973560
simage      -0.153642246
sglobal     -0.023394492
lintent      0.198328487
```

(2) Apply a series of the lasso to the data, considering 100 candidate values of the tunning parameter λ within the interval [10-5, 1]. Based on 10-fold cross validation, plot all MSE values against the candidate values of λ and choose the optimal λ value. Given the chosen λ value,

re-run the lasso for the data and report its coefficient estimates. (2 points)



At seed = 42, we generate a sequence of 100 values from 10^-5 to 1, and we find the optimal lambda = 0.2420128 based on 10-fold cross validation, then we re-run the lasso regression using lambda = 0.2420128, then we get the coefficient estimates as follows:

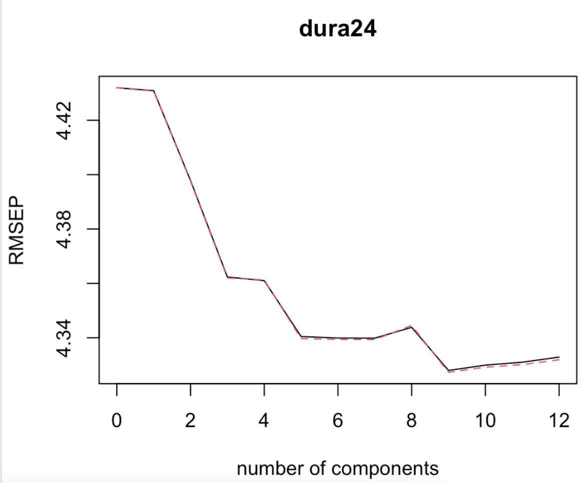
```
                      s0
(Intercept) 15.299091281
age          0.070929659
ssound       0.043658908
sglob        0.070234621
svmail       .
sinfor       0.041688576
sprice       0.002682897
spromo       0.040784117
sadver      -0.088932598
sperson     -0.068532178
simage      -0.162160281
sglobal      .
lintent      0.209719283
```

(3) Apply a principal component regression to the data and choose the number of components that minimizes the cross-validated RMSE. Plot the RMSE values against the number of components. Also, describe how much variance of the predictors and the response the chosen number of components explain (2 points)

```
> summary(pcr.fit)
Data: 	X dimension: 3000 12
	Y dimension: 3000 1
Fit method: svdpc
Number of components considered: 12

VALIDATION: RMSEP
Cross-validated using 10 random segments.
       (Intercept)  1 comps  2 comps  3 comps  4 comps  5 comps  6 comps  7 comps  8 comps  9 comps
CV           4.432    4.431    4.399    4.366    4.364    4.344    4.345    4.348    4.349    4.335
adjCV        4.432    4.431    4.398    4.365    4.364    4.343    4.344    4.347    4.349    4.334
       10 comps  11 comps  12 comps
CV        4.336     4.337     4.338
adjCV     4.335     4.336     4.337

TRAINING: % variance explained
        1 comps  2 comps  3 comps  4 comps  5 comps  6 comps  7 comps  8 comps  9 comps  10 comps
X       38.2731   47.603   56.262   63.684   70.815   77.615   83.543   87.970   92.276    95.328
dura24   0.1165    1.674    3.311    3.399    4.386    4.452    4.475    4.493    5.139     5.142
        11 comps  12 comps
X         98.214   100.000
dura24     5.175     5.181
```



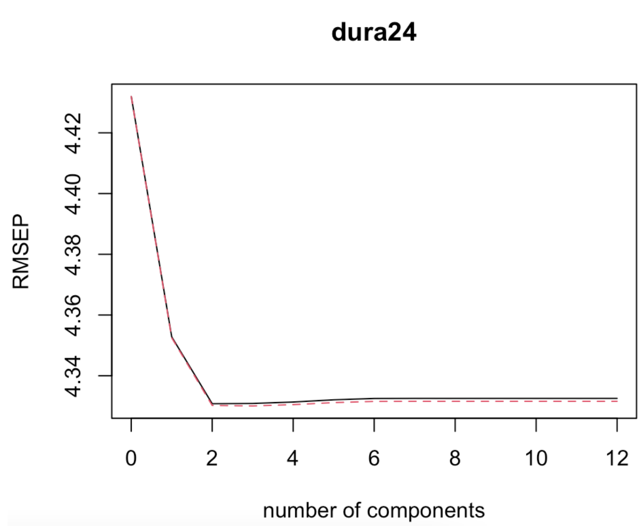
From the plot above, we can see that choosing 9 components will minimize the cross-validated RMSE. 92.276% variance of the predictors are explained by the 9 chosen components, 5.139% of variance of the response is explained by the 9 chosen components.

(4) Apply a partial least squares regression to the data and choose the number of components that minimizes the cross-validated RMSE. Plot the RMSE values against the number of components. Also, describe how much variance of the predictors and the response the chosen number of components explain (2 points)

```
> summary(plsr.fit)
Data: 	X dimension: 3000 12 
	Y dimension: 3000 1
Fit method: kernelpls
Number of components considered: 12

VALIDATION: RMSEP
Cross-validated using 10 random segments.
       (Intercept)  1 comps  2 comps  3 comps  4 comps  5 comps  6 comps  7 comps  8 comps  9 comps
CV           4.432    4.353    4.331    4.331    4.331    4.332    4.333    4.333    4.333    4.333
adjCV        4.432    4.352    4.330    4.330    4.330    4.331    4.332    4.332    4.332    4.332
       10 comps  11 comps  12 comps
CV        4.333     4.333     4.333
adjCV     4.332     4.332     4.332

TRAINING: % variance explained
        1 comps  2 comps  3 comps  4 comps  5 comps  6 comps  7 comps  8 comps  9 comps  10 comps
X        18.646   46.580   52.682    59.12   65.309   70.085   73.691   78.849   85.415    89.894
dura24    3.942    5.014    5.167     5.18    5.181    5.181    5.181    5.181    5.181     5.181
        11 comps  12 comps
X         95.466   100.000
dura24     5.181     5.181
```



We choose 2 components to minimize the cross-validated RMSE. 46.580% variance of the predictors are explained by the 2 chosen components, 5.014% of variance of the response is explained by the 2 chosen components.

[Q2] Using the estimated solutions obtained from the above four methods, report their MSE values in the test sample (**mobilephone2_test.csv)** and conclude which method appears to perform best in terms of the test MSE values (2 points).

Using the solutions obtained from ridge regression, lasso regression, principal component regression, and partial least squares regression, we find the MSE values in the test sample(**mobilephone2_test.csv)** as follows:

MSE_RIDGE: 19.74827

MSE_LASSO: 19.76836

MSE_PCR: 19.76372

MSE_PLSR: 19.81273

We conclude that the ridge regression appears to perform the best in terms of having the lowest test MSE value.