IML Term project

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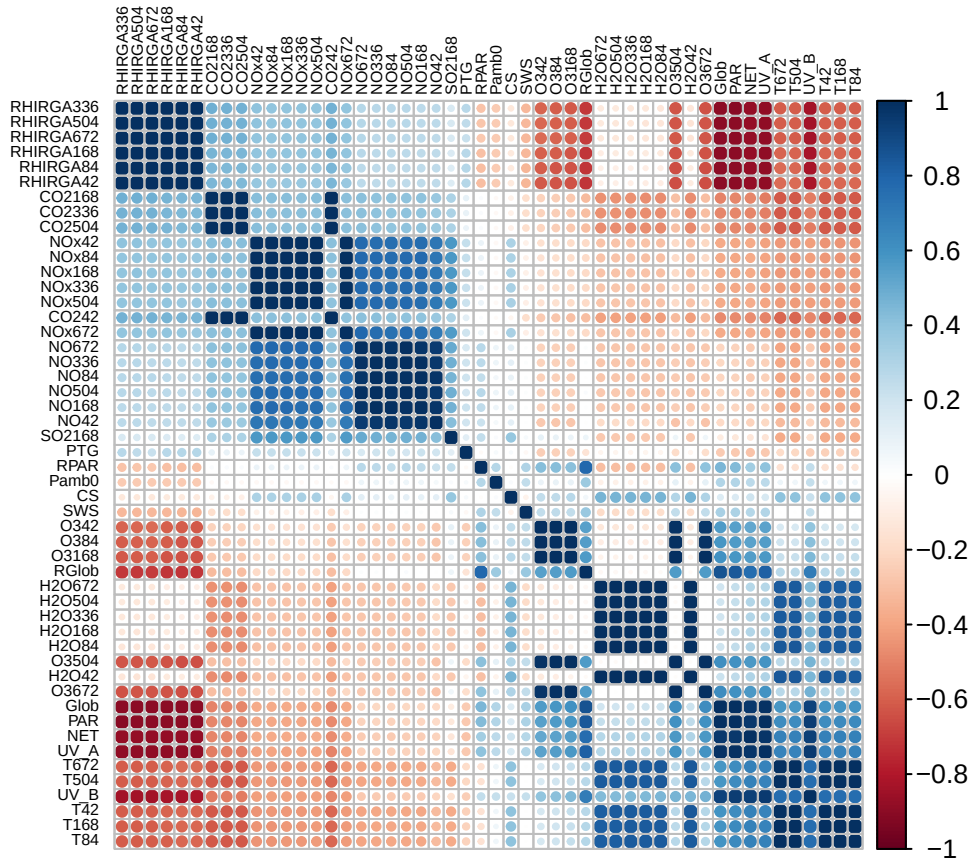
Preprocessing data

Correlation

Looking at the correlation matrix as it was presented in the solutions to Exercise set 1, it is clear that the measurements of the same thing at different heights correlate, as do some of the radiation-related parameters.



Correlation between measurements at different heights

Looking at the numeric values, we see that the measurements at different heights have strong positive correlation.

Table 1: Correlation (CO2)

	CO2168	CO2336	CO242	CO2504
CO2168	1.0000000	0.9996891	0.9939228	0.9988868
CO2336	0.9996891	1.0000000	0.9928568	0.9996424
CO242	0.9939228	0.9928568	1.0000000	0.9910311
CO2504	0.9988868	0.9996424	0.9910311	1.0000000

Table 2: Correlation (H20)

	H2O168	H2O336	H2O42	H2O504	H2O672	H2O84
H2O168	1.0000000	0.9998966	0.9997062	0.9997158	0.9994631	0.9998894
H2O336	0.9998966	1.0000000	0.9993506	0.9999302	0.9997498	0.9996330
H2O42	0.9997062	0.9993506	1.0000000	0.9990202	0.9986416	0.9999330
H2O504	0.9997158	0.9999302	0.9990202	1.0000000	0.9998589	0.9993631
H2O672	0.9994631	0.9997498	0.9986416	0.9998589	1.0000000	0.9990316
H2O84	0.9998894	0.9996330	0.9999330	0.9993631	0.9990316	1.0000000

Table 3: Correlation (NO)

	NO168	NO336	NO42	NO504	NO672	NO84
NO168	1.0000000	0.9942106	0.9729234	0.9888394	0.9787201	0.9955792
NO336	0.9942106	1.0000000	0.9681760	0.9962470	0.9889000	0.9912906
NO42	0.9729234	0.9681760	1.0000000	0.9648354	0.9580581	0.9766436
NO504	0.9888394	0.9962470	0.9648354	1.0000000	0.9947569	0.9859003
NO672	0.9787201	0.9889000	0.9580581	0.9947569	1.0000000	0.9766069
NO84	0.9955792	0.9912906	0.9766436	0.9859003	0.9766069	1.0000000

Table 4: Correlation (NOx)

	NOx168	NOx336	NOx42	NOx504	NOx672	NOx84
NOx168	1.0000000	0.9988830	0.9966528	0.9966839	0.9946312	0.9996773
NOx336	0.9988830	1.0000000	0.9953287	0.9986298	0.9973042	0.9984147
NOx42	0.9966528	0.9953287	1.0000000	0.9931515	0.9913512	0.9968910
NOx504	0.9966839	0.9986298	0.9931515	1.0000000	0.9987762	0.9961637
NOx672	0.9946312	0.9973042	0.9913512	0.9987762	1.0000000	0.9940603
NOx84	0.9996773	0.9984147	0.9968910	0.9961637	0.9940603	1.0000000

Table 5: Correlation (O3)

	O3168	O342	O3504	O3672	O384
O3168	1.0000000	0.9955292	0.9954429	0.9918052	0.9986470
O342	0.9955292	1.0000000	0.9843062	0.9789921	0.9987926
O3504	0.9954429	0.9843062	1.0000000	0.9989553	0.9904563
O3672	0.9918052	0.9789921	0.9989553	1.0000000	0.9857437
O384	0.9986470	0.9987926	0.9904563	0.9857437	1.0000000

Table 6: Correlation (RHIRGA)

	RHIRGA168	RHIRGA336	RHIRGA42	RHIRGA504	RHIRGA672	RHIRGA84
RHIRGA168	1.0000000	0.9992464	0.9972212	0.9981986	0.9957488	0.9989197
RHIRGA336	0.9992464	1.0000000	0.9950372	0.9994052	0.9973122	0.9970893
RHIRGA42	0.9972212	0.9950372	1.0000000	0.9931951	0.9902415	0.9991006
RHIRGA504	0.9981986	0.9994052	0.9931951	1.0000000	0.9987544	0.9955233
RHIRGA672	0.9957488	0.9973122	0.9902415	0.9987544	1.0000000	0.9927423
RHIRGA84	0.9989197	0.9970893	0.9991006	0.9955233	0.9927423	1.0000000

Table 7: Correlation (T)

	T168	T42	T504	T672	T84
T168	1.0000000	0.9997396	0.9997239	0.9993168	0.9999172
T42	0.9997396	1.0000000	0.9993129	0.9987827	0.9998980
T504	0.9997239	0.9993129	1.0000000	0.9998644	0.9995274
T672	0.9993168	0.9987827	0.9998644	1.0000000	0.9990504
T84	0.9999172	0.9998980	0.9995274	0.9990504	1.0000000

Measurement heights

The measurement height 16.8m is the only one with all measurements. Because of this and the correlation between the measurements at different heights, we choose to discard measurements from heights other than 16.8m.

Table 8: Measurements at different heights: What measurements have been done at particular heights?

dm.42	dm.84	dm.168	dm.336	dm.504	dm.672
CO242	NA	CO2168	CO2336	CO2504	NA
H2O42	H2O84	H2O168	H2O336	H2O504	NA
NO42	NO84	NO168	NO336	NO504	NO672
NOx42	NOx84	NOx168	NOx336	NOx504	NOx672
O342	O384	O3168	NA	O3504	O3672
RHIRGA42	RHIRGA84	RHIRGA168	RHIRGA336	RHIRGA504	RHIRGA672
NA	NA	SO2168	NA	NA	NA
T42	T84	T168	NA	T504	T672

vif

```
## Loading required package: carData

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 3003.667

## PAR.std
##      18

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 1612.928

## UV_A.std
##       30

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 237.7665

## Glob.std
##        4

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 168.3538

## UV_B.std
##       28

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 94.19929

## RPAR.mean
##        21

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] 45.30109

## NET.std
##       6
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] 12.3017
```

```
## RGlob.std
##        16
```

```
## [1] 11.65981
```

```
## CS.mean
##      21
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] 7.342582
```

```
## NOx168.mean
##           7
```

```
## [1] 6.960544
```

```
## H2O168.mean
##           3
```

Runnig vif() over several variables in the 16.8m-restricted dataset, we come up to the following collection of coefficients

```
##    (Intercept)    CO2168.mean     CO2168.std    H2O168.mean     H2O168.std
##  -1.760990e+01  -7.706613e-02   1.707145e-01  -7.413117e-01  -2.982764e-01
##     NO168.mean      NO168.std     O3168.mean      O3168.std     Pamb0.mean
##  -5.767996e+00   4.915288e+00   8.270660e-03   3.630687e-04   2.079041e-03
##      Pamb0.std       PTG.mean        PTG.std RHIRGA168.mean  RHIRGA168.std
##   5.275777e-01  -3.373216e+01   1.954975e+01  -6.657638e-02   1.851450e-01
##    SO2168.mean     SO2168.std       SWS.mean        SWS.std
##  -1.942375e+00   2.594570e+00   5.644814e-02   1.811580e-02
```

Hence we keep the following parameters

```
##  [1] "CO2168.mean"    "CO2168.std"     "H2O168.mean"    "H2O168.std"
##  [5] "NO168.mean"     "NO168.std"      "O3168.mean"     "O3168.std"
##  [9] "Pamb0.mean"     "Pamb0.std"      "PTG.mean"       "PTG.std"
## [13] "RHIRGA168.mean" "RHIRGA168.std"  "SO2168.mean"    "SO2168.std"
## [17] "SWS.mean"       "SWS.std"        "class2"
```

PCA

PCA for all three versions of data

```
##   [1] 0.3981163 0.5569929 0.6835814 0.7260025 0.7598939 0.7874098 0.8125596
##   [8] 0.8346002 0.8530532 0.8686838 0.8821772 0.8942397 0.9051217 0.9157874
##  [15] 0.9248316 0.9336262 0.9417328 0.9485561 0.9553166 0.9611454 0.9668515
##  [22] 0.9712230 0.9745869 0.9776303 0.9801121 0.9824840 0.9844354 0.9860310
##  [29] 0.9875789 0.9890640 0.9904694 0.9917631 0.9928400 0.9936991 0.9943712
##  [36] 0.9949925 0.9955783 0.9961134 0.9966184 0.9970703 0.9975005 0.9978140
##  [43] 0.9980826 0.9982829 0.9984779 0.9986491 0.9987938 0.9989157 0.9990305
##  [50] 0.9991350 0.9992267 0.9993091 0.9993894 0.9994606 0.9995292 0.9995878
##  [57] 0.9996377 0.9996800 0.9997150 0.9997457 0.9997746 0.9997990 0.9998221
##  [64] 0.9998437 0.9998622 0.9998783 0.9998934 0.9999073 0.9999197 0.9999320
##  [71] 0.9999411 0.9999493 0.9999558 0.9999620 0.9999667 0.9999708 0.9999743
##  [78] 0.9999775 0.9999805 0.9999832 0.9999855 0.9999876 0.9999893 0.9999910
##  [85] 0.9999926 0.9999940 0.9999952 0.9999962 0.9999970 0.9999978 0.9999985
```

```
##  [92] 0.9999990 0.9999993 0.9999995 0.9999997 0.9999998 0.9999999 0.9999999
##  [99] 1.0000000 1.0000000
```

```
##  [1] 0.4309861 0.5575522 0.6537154 0.7007490 0.7412151 0.7770282 0.8055799
##  [8] 0.8313561 0.8543780 0.8745338 0.8925758 0.9081481 0.9224718 0.9346085
## [15] 0.9446046 0.9531742 0.9611388 0.9675212 0.9735814 0.9786998 0.9835213
## [22] 0.9872826 0.9901902 0.9927185 0.9946737 0.9964706 0.9978635 0.9986532
## [29] 0.9990837 0.9994036 0.9996349 0.9998353 0.9999258 0.9999871 0.9999948
## [36] 1.0000000
```

```
##  [1] 0.2592587 0.4142654 0.5355777 0.6267689 0.6891652 0.7479272 0.7955438
##  [8] 0.8334548 0.8637669 0.8919822 0.9138447 0.9314743 0.9476770 0.9617142
## [15] 0.9737523 0.9840080 0.9930149 1.0000000
```

Classifiers

Naive Bayes, LDA and QDA on the original data, 168-data and the PCA'd versions of these data sets

Naive Bayes

Accuracy				Perplexity			
train	test	CV	LOOCV	train	test	CV	LOOCV
0.8448276	0.7801724	0.8146552	0.8125	30.86972	82.21584	152.8545	166.084

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.7823276	0.7823276	36.25527	40.74978

Using PCA on the original and the 16.8m-dataset.

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.7564655	0.7564655	12.14968	12.57788

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.7823276	0.7823276	36.25527	40.74978

LDA

On the original dataset and the 16.8m-dataset.

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.875	0.8814655	1.683712	1.579626

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.887931	0.8922414	1.329679	1.32923

Using PCA on the original and the 16.8m-dataset.

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.8706897	0.8706897	1.364454	1.368989

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.875	0.875	1.391006	1.391656

QDA

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.8448276	0.8383621	2979.474	3793.874

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.8556034	0.8534483	7.745819	6.34633

Using PCA on the original and the 16.8m-dataset.

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.8426724	0.8383621	2.06776	2.034851

Accuracy		Perplexity	
CV	LOOCV	CV	LOOCV
0.8340517	0.8383621	2.024616	2.038691

Multiple classes

Naive Bayes on the npf-dataset

```
## [1] 0.5064655
```

LDA on the npf.168-dataset

```
## [1] 0.6443966
```

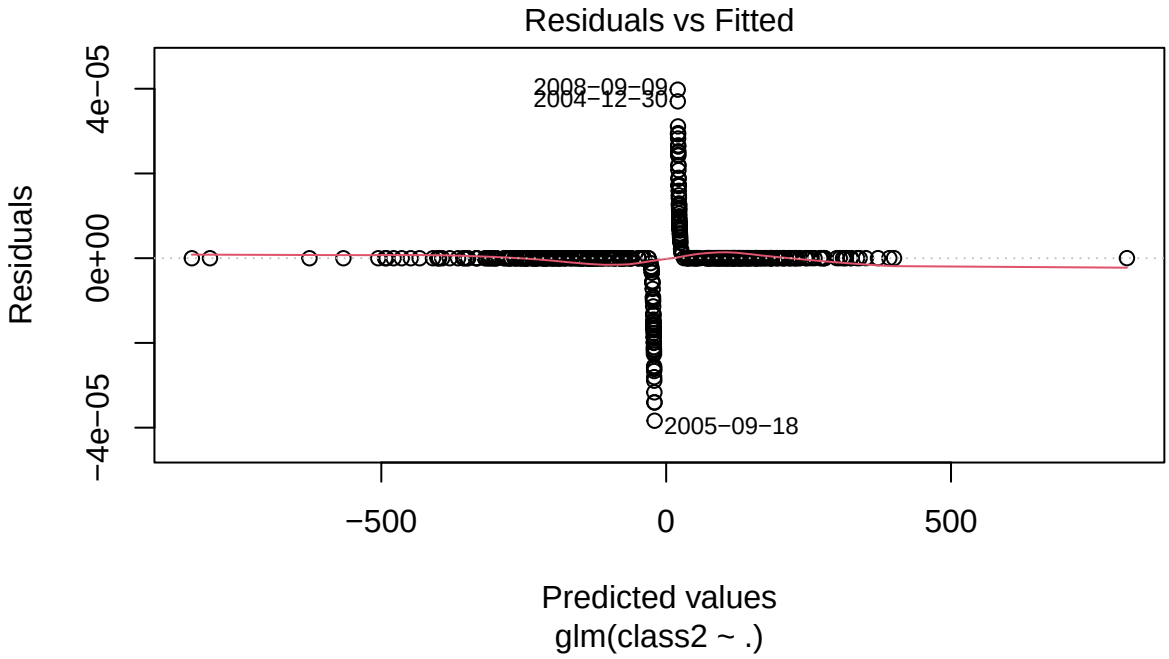
QDA on the npf.pca-dataset

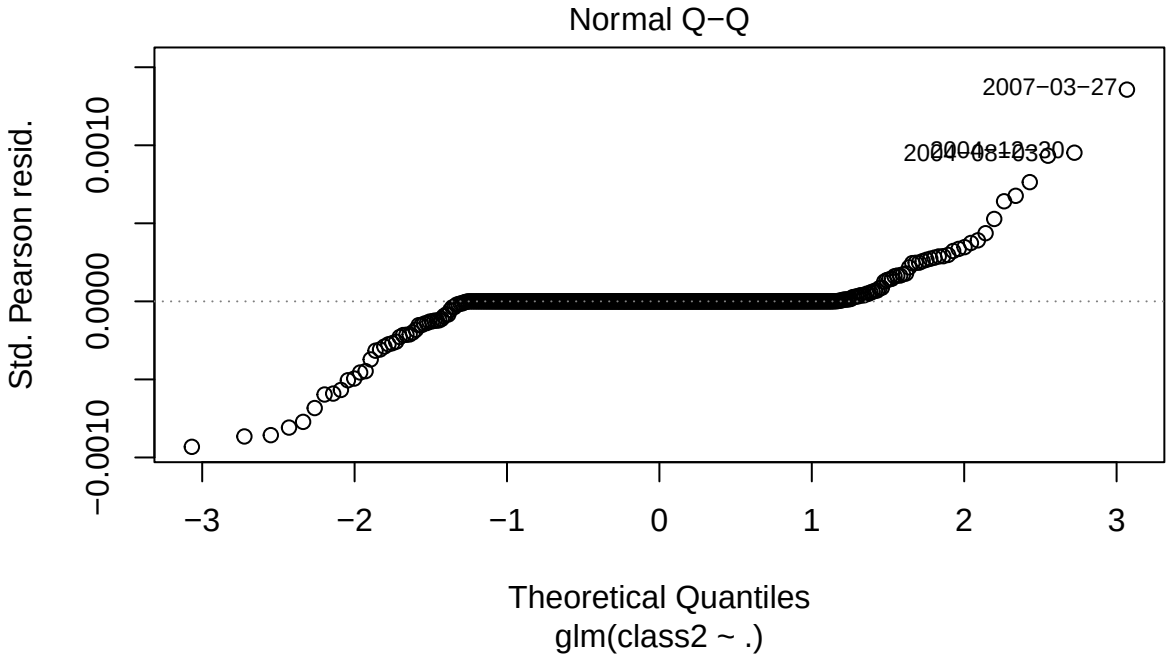
```
## [1] 0.5991379
```

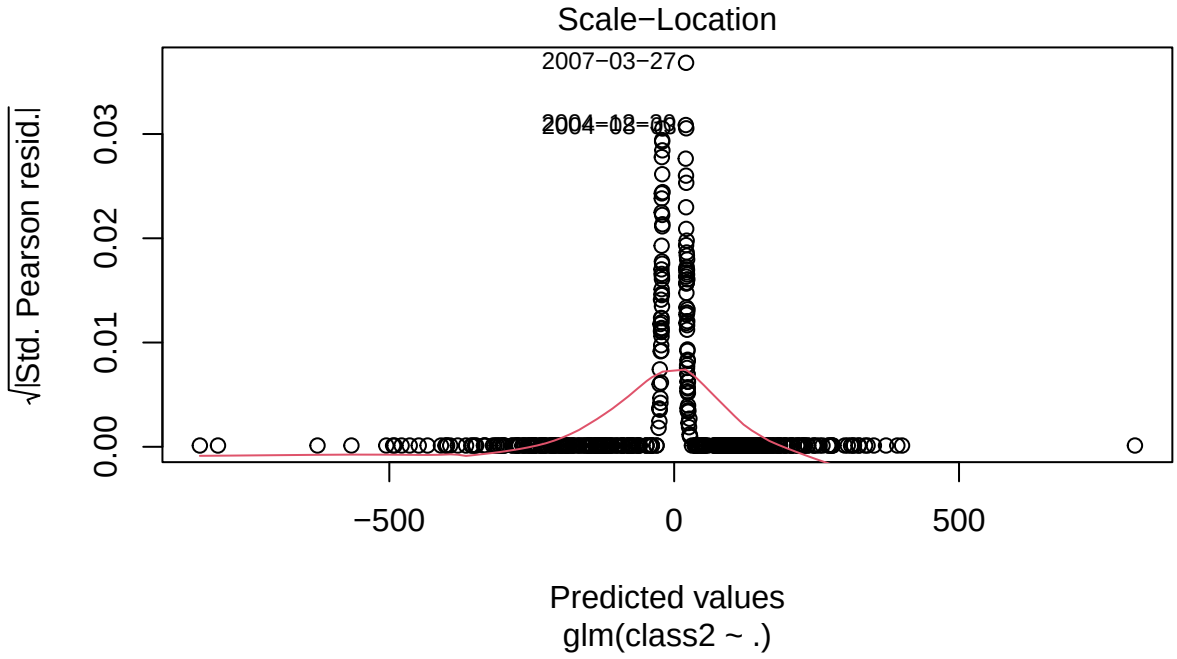
QDA on the npf.168.pca-dataset

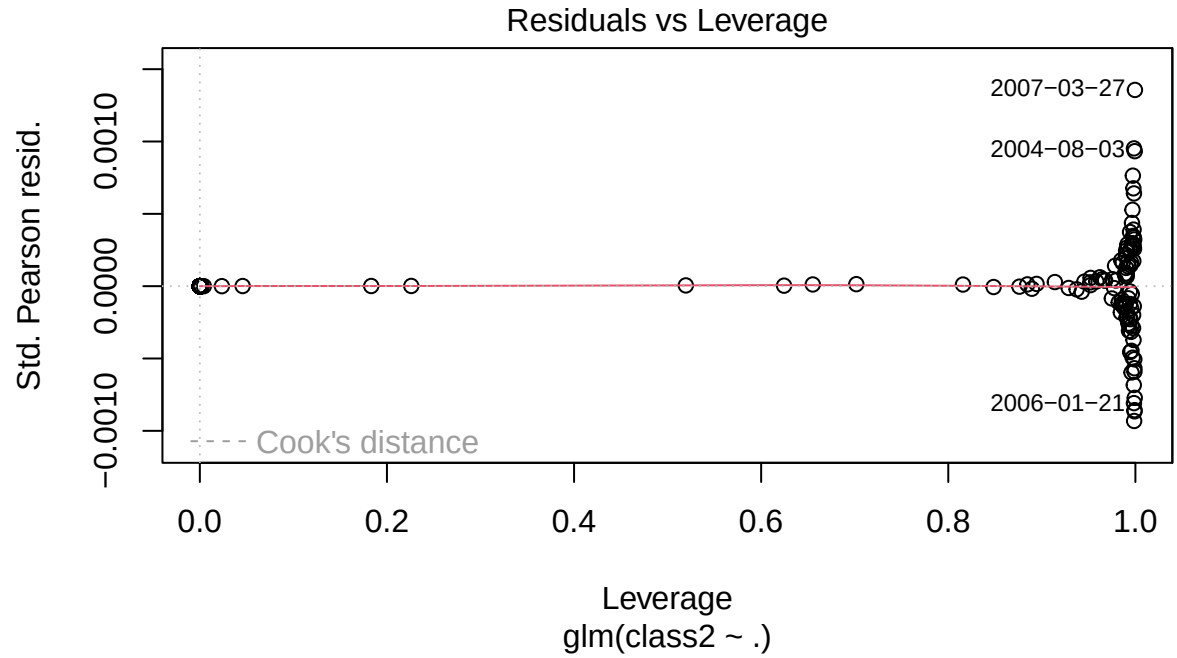
```
## [1] 0.5948276
```

GLM


Residuals vs Fitted
Residuals
4e−05
0e+00
−4e−05
2008−09−09
2004−12−30
2005−09−18
−500
0
500
Predicted values
glm(class2 ~ .)


Normal Q−Q
Std. Pearson resid.
0.0010
0.0000
−0.0010
2007−03−27
−3
−2
−1
0
1
2
3
Theoretical Quantiles
glm(class2 ~ .)





GLM accuracy and perplexity.

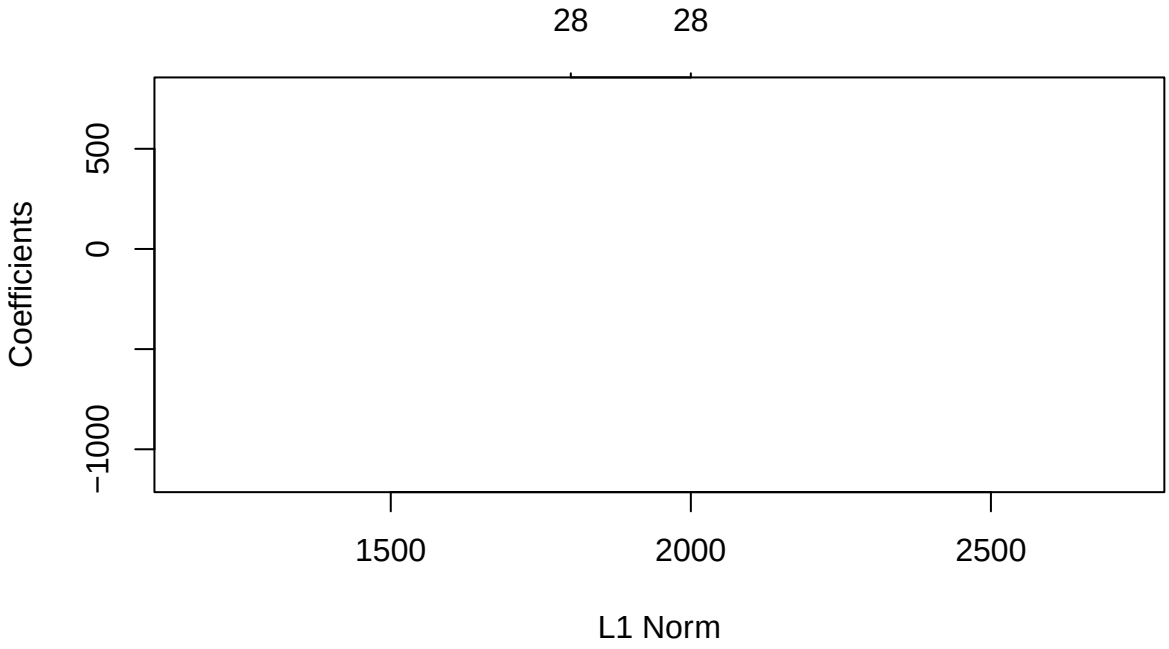
```
## [1] 1
```

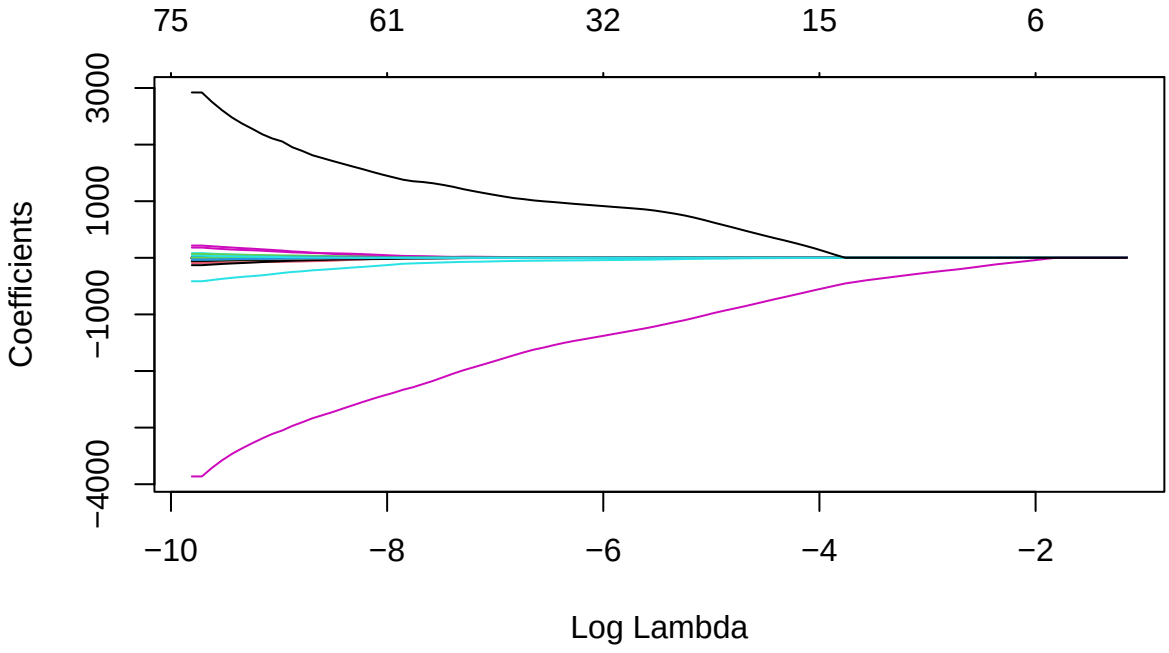
```
## [1] 0.3678794
```

Lasso / Ridge

```
## 101 x 1 sparse Matrix of class "dgCMatrix"
##                              s1
## (Intercept)     1.231858e+01
## CO2168.mean     .
## CO2168.std      .
## CO2336.mean     .
## CO2336.std      .
## CO242.mean     -2.197091e-02
## CO242.std       .
## CO2504.mean     .
## CO2504.std      .
## Glob.mean       .
## Glob.std        .
## H2O168.mean     .
## H2O168.std      .
## H2O336.mean    -9.874115e-03
## H2O336.std      .
## H2O42.mean      .
## H2O42.std       .
## H2O504.mean    -2.078462e-02
## H2O504.std      .
## H2O672.mean    -1.346224e-01
## H2O672.std      .
## H2O84.mean      .
## H2O84.std       .
## NET.mean        .
## NET.std         .
## NO168.mean      .
## NO168.std       .
## NO336.mean      .
## NO336.std       .
## NO42.mean       .
## NO42.std        .
## NO504.mean      .
## NO504.std       .
## NO672.mean      .
## NO672.std       .
## NO84.mean       .
## NO84.std        .
## NOx168.mean     .
## NOx168.std      .
## NOx336.mean     .
## NOx336.std      .
## NOx42.mean      .
## NOx42.std       .
## NOx504.mean     .
## NOx504.std      .
## NOx672.mean     .
## NOx672.std      .
## NOx84.mean      .
## NOx84.std       .
## O3168.mean      .
```

```
## O3168.std       .
## O342.mean       9.464717e-03
## O342.std        .
## O3504.mean      .
## O3504.std       .
## O3672.mean      2.096465e-02
## O3672.std       .
## O384.mean       .
## O384.std        .
## Pamb0.mean      .
## Pamb0.std       .
## PAR.mean        .
## PAR.std         .
## PTG.mean        .
## PTG.std         .
## RGlob.mean      6.385262e-03
## RGlob.std       .
## RHIRGA168.mean  .
## RHIRGA168.std   6.539972e-02
## RHIRGA336.mean -6.715760e-03
## RHIRGA336.std   .
## RHIRGA42.mean  -4.758290e-02
## RHIRGA42.std    .
## RHIRGA504.mean  .
## RHIRGA504.std   .
## RHIRGA672.mean  .
## RHIRGA672.std   .
## RHIRGA84.mean   .
## RHIRGA84.std    .
## RPAR.mean       .
## RPAR.std        .
## SO2168.mean     .
## SO2168.std      .
## SWS.mean        .
## SWS.std         .
## T168.mean       .
## T168.std        1.421411e-01
## T42.mean        .
## T42.std         .
## T504.mean       .
## T504.std        .
## T672.mean       .
## T672.std        .
## T84.mean        .
## T84.std         .
## UV_A.mean       .
## UV_A.std        .
## UV_B.mean       .
## UV_B.std        .
## CS.mean        -3.317112e+02
## CS.std          .
```

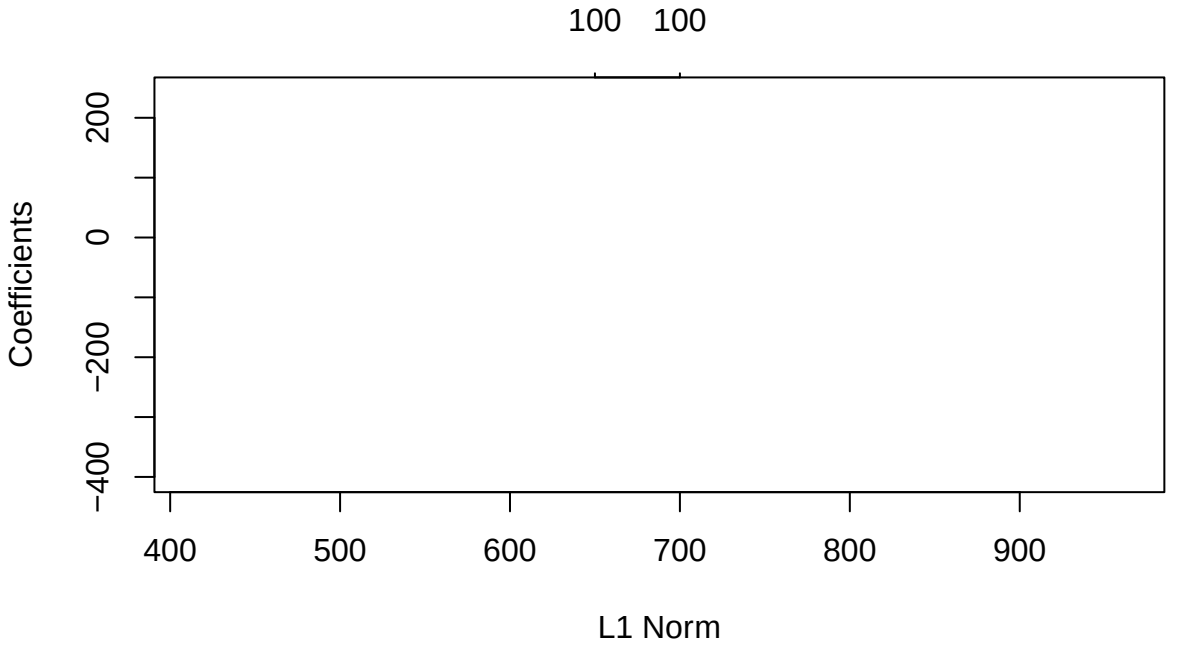


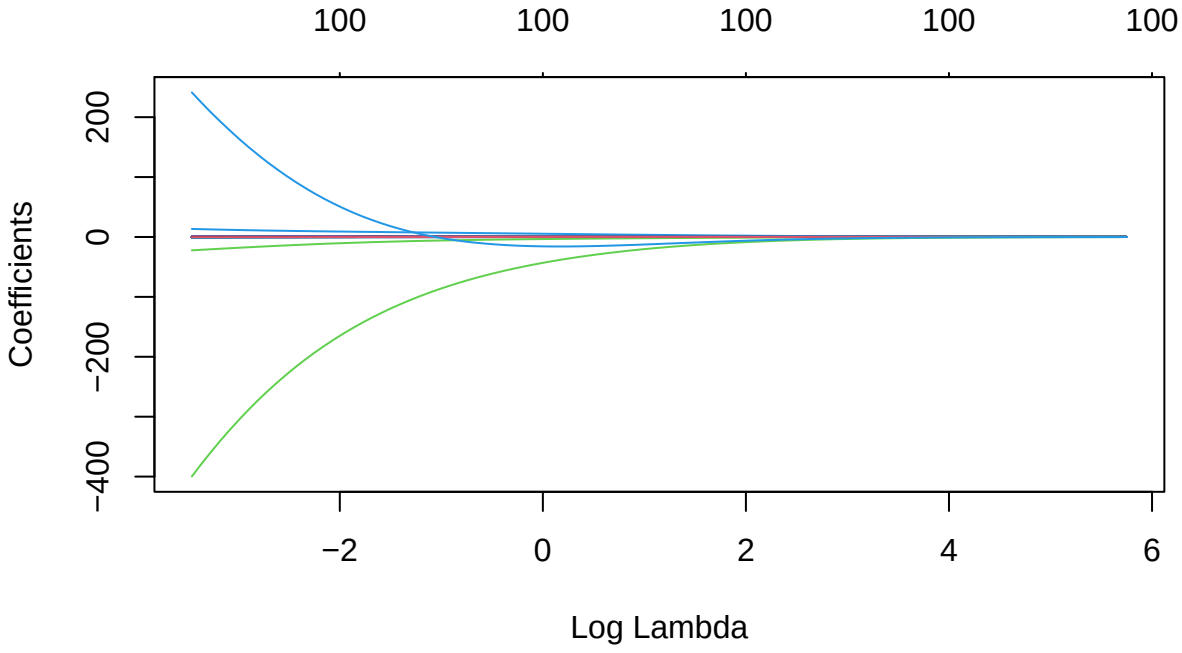


Lasso accuracy and perplexity.

```
## [1] 0.9202586
```

```
## [1] 0.4208642
```





Ridge accuracy and perplexity.

```
## [1] 0.9116379
```

```
## [1] 0.4304874
```

SVM

SVM accuracy and perplexity.

```
## [1] 0.8922414
```

```
## [1] 1.313228
```

Tree-based methods

```
## Distribution not specified, assuming bernoulli ...
```

```
## Distribution not specified, assuming bernoulli ...
```

Table 9: Tree-based methods, errors

	Dummy	RandomForest	GBM
train	0.4999814	0.2974802	2.5473612
test	0.5000557	0.6600307	3.0627817
CV	0.5034947	0.7062404	0.7062404
LOOCV	0.5021458	0.6250464	0.6250464

Table 10: Tree-based methods, classification accuracy

	Dummy	RandomForest	GBM
train	0	0	0
test	0	0	0
CV	0	0	0
LOOCV	0	0	0

Lasso (first version of final model)

```
## [1] 0.4978448
```

```
## [1] 1.292597
```

GLM (first version of actual model without usage of PCAs):

```
## [1] 0.8900862
```

```
## [1] 1.303646
```

SVM (first version of actual model)