

# IML Term project

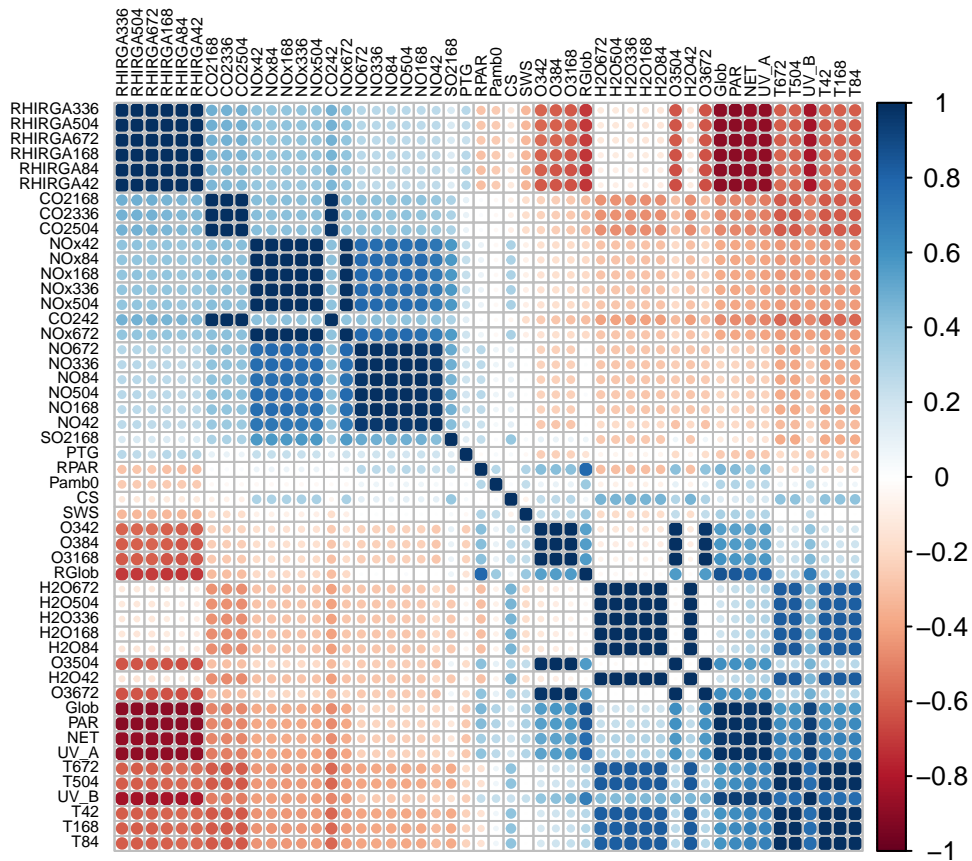
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## Preprocessing data

### 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 (H2O)

	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
## N0x168.mean
##      7
## [1] 6.960544
## H20168.mean
##      3
```

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

```
##      (Intercept)      C02168.mean      C02168.std      H20168.mean      H20168.std
## -1.760990e+01 -7.706613e-02  1.707145e-01 -7.413117e-01 -2.982764e-01
##      N0168.mean      N0168.std      03168.mean      03168.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
##      S02168.mean      S02168.std      SWS.mean      SWS.std
## -1.942375e+00  2.594570e+00  5.644814e-02  1.811580e-02
```

Hence we keep the following parameters

```
## [1] "C02168.mean"      "C02168.std"      "H20168.mean"      "H20168.std"
## [5] "N0168.mean"      "N0168.std"      "03168.mean"      "03168.std"
## [9] "Pamb0.mean"      "Pamb0.std"      "PTG.mean"      "PTG.std"
## [13] "RHIRGA168.mean"  "RHIRGA168.std"  "S02168.mean"      "S02168.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

### Testing classifiers as they are

#### Naive Bayes

Accuracy			Perplexity		
train	test	CV	train	test	CV
0.8448276	0.7801724	0.8146552	30.86972	82.21584	152.8545

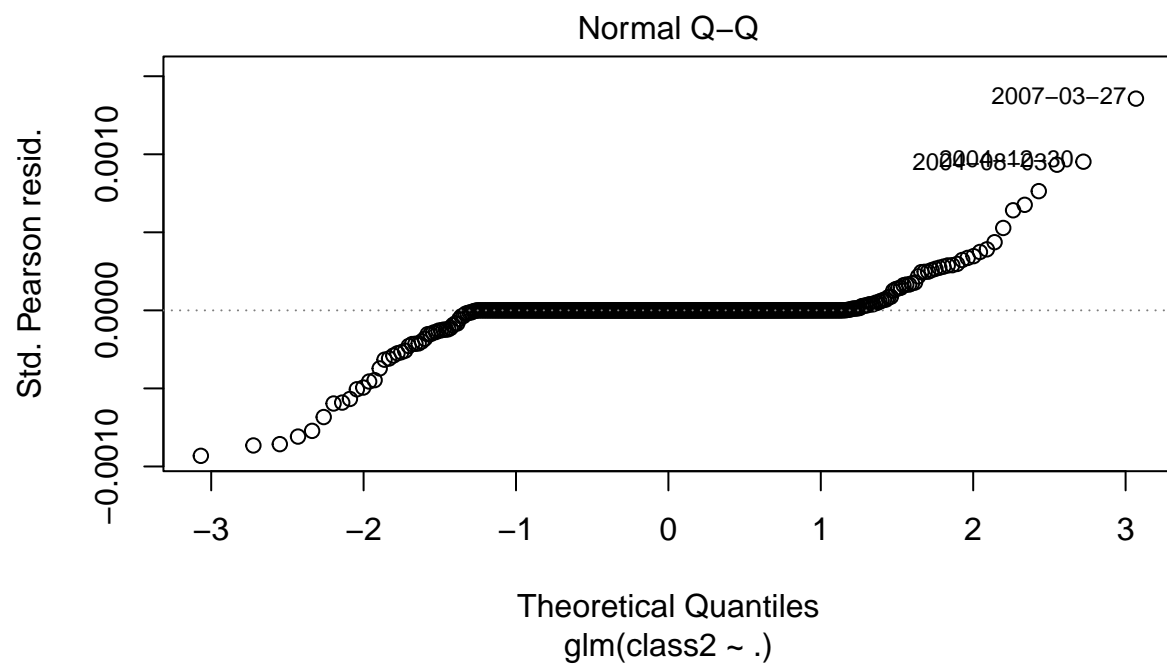
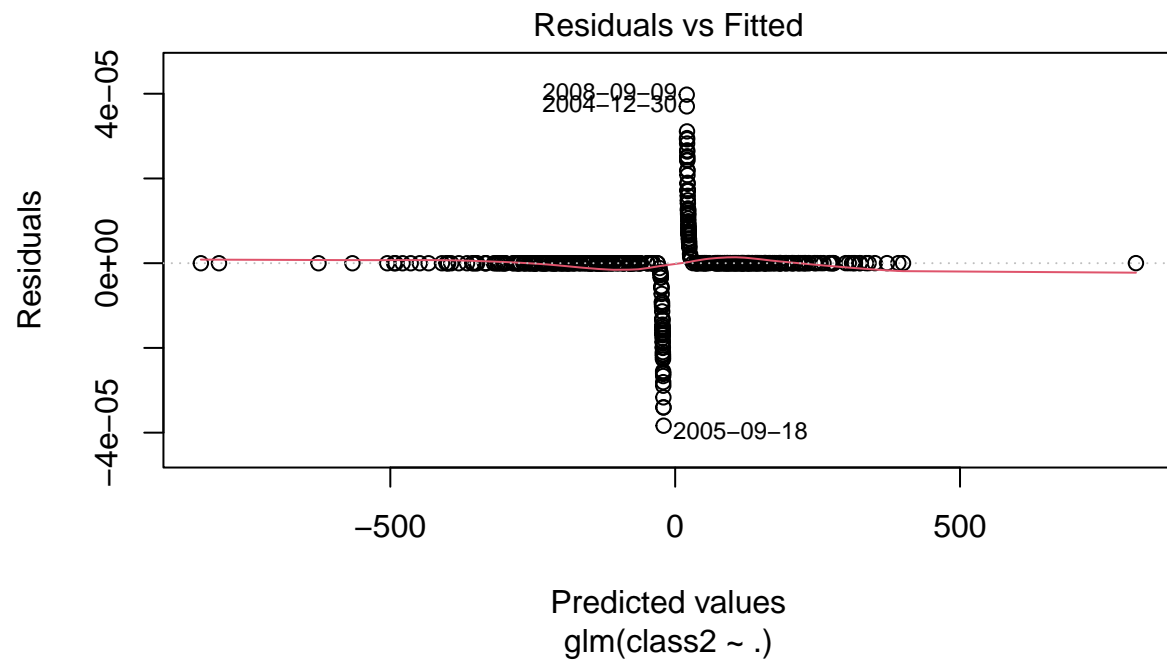
#### LDA

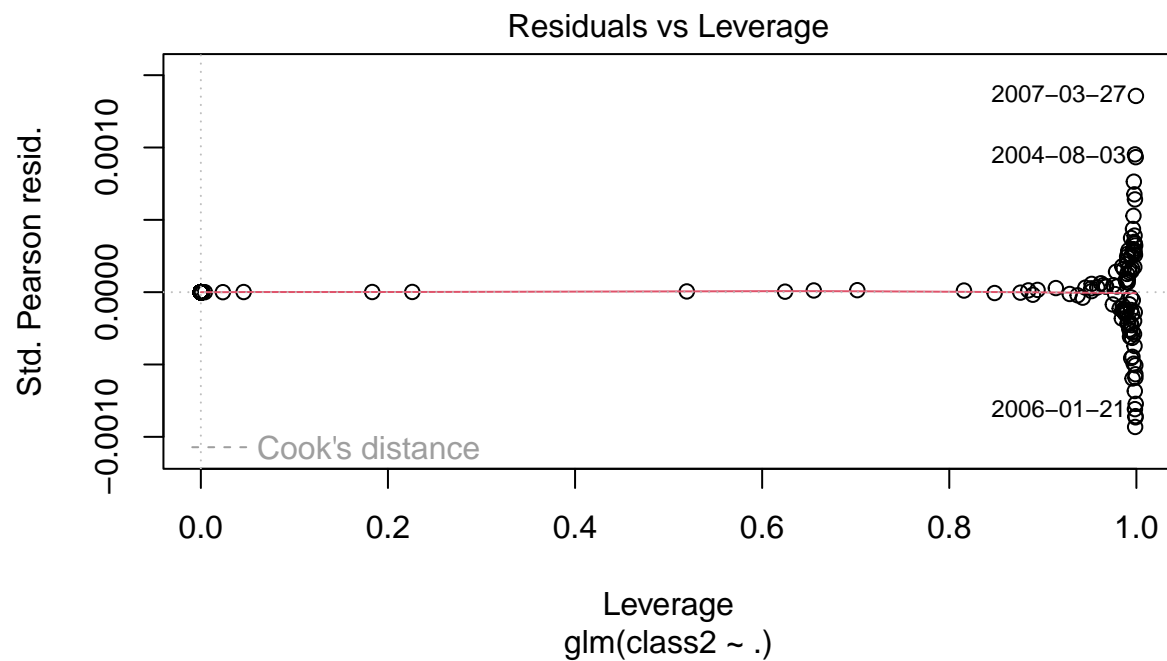
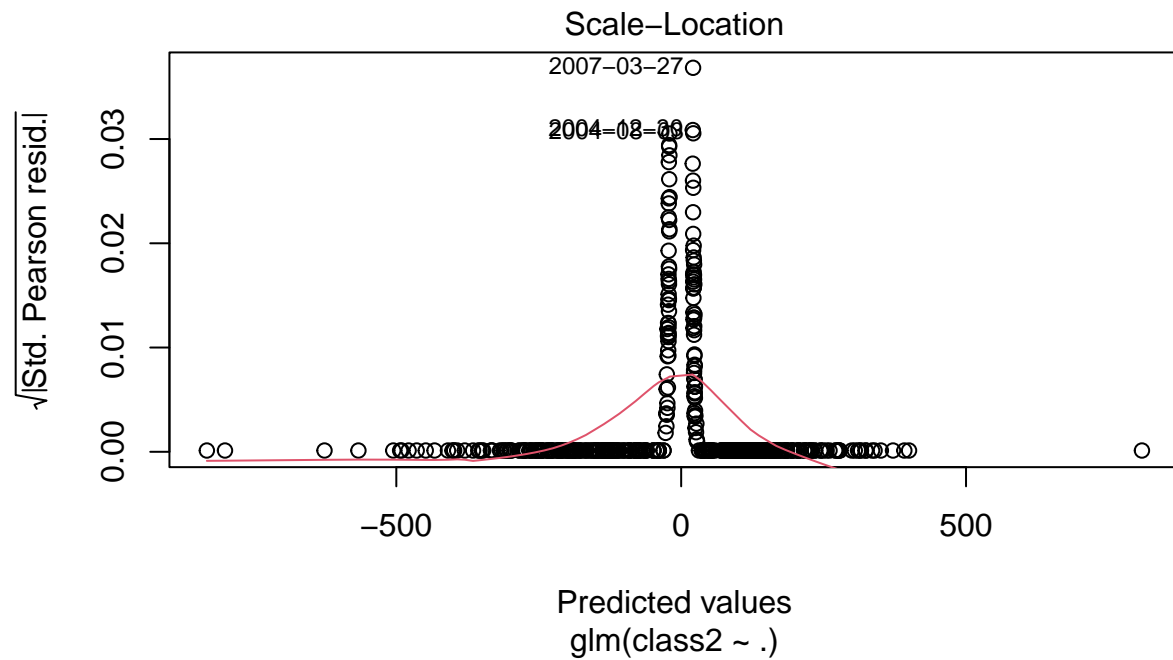
Accuracy			Perplexity		
train	test	CV	train	test	CV
0.987069	0.4267241	0.875	1.03937	1082.212	1.683712

#### QDA

Accuracy			Perplexity		
train	test	CV	train	test	CV
1	0.4396552	0.8448276	1.004092	1.724053e+22	2979.474

GLM





GLM accuracy and perplexity.

## [1] 1

## [1] 0.3678794



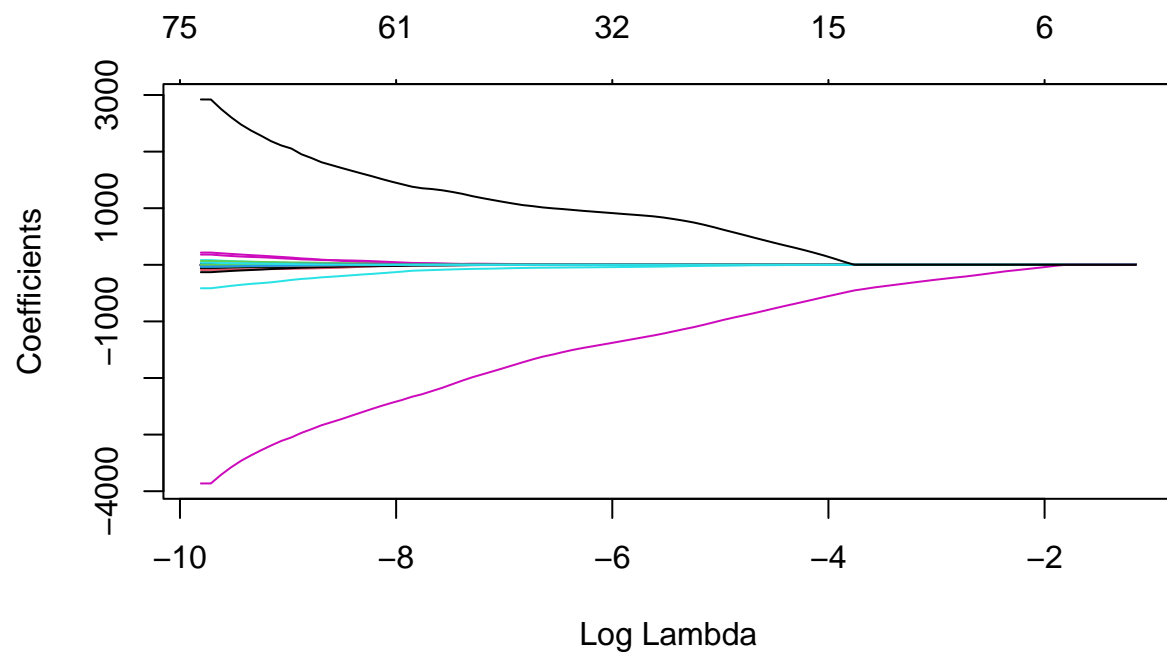
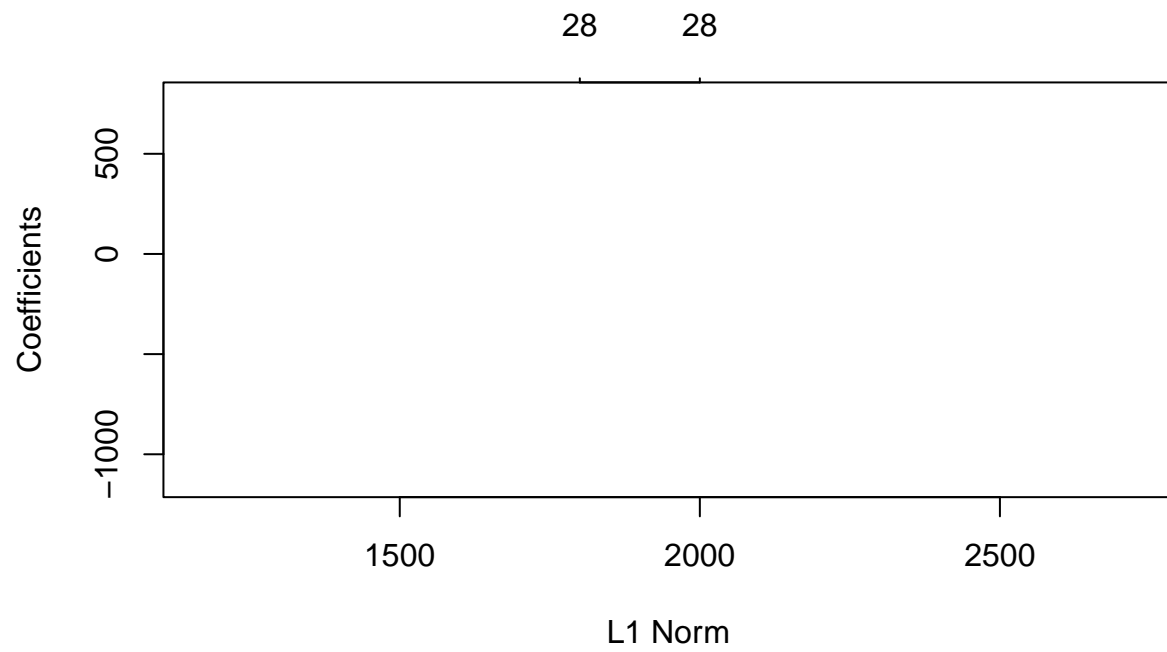
## Lasso / Ridge

```
## 101 x 1 sparse Matrix of class "dgCMatrix"
##                               s1
## (Intercept)      8.517443e+00
## C02168.mean      .
## C02168.std       .
## C02336.mean      .
## C02336.std       .
## C0242.mean      -1.203417e-02
## C0242.std       .
## C02504.mean      .
## C02504.std       .
## Glob.mean       .
## Glob.std        .
## H20168.mean     .
## H20168.std      .
## H20336.mean     .
## H20336.std      .
## H2042.mean      .
## H2042.std       .
## H20504.mean     -9.880630e-03
## H20504.std      .
## H20672.mean     -1.188948e-01
## H20672.std      .
## H2084.mean      .
## H2084.std       .
## NET.mean        .
## NET.std         .
## N0168.mean      .
## N0168.std       .
## N0336.mean      .
## N0336.std       .
## N042.mean       .
## N042.std        .
## N0504.mean      .
## N0504.std       .
## N0672.mean      .
## N0672.std       .
## N084.mean       .
## N084.std        .
## N0x168.mean     .
## N0x168.std      .
## N0x336.mean     .
## N0x336.std      .
## N0x42.mean      .
## N0x42.std       .
## N0x504.mean     .
## N0x504.std      .
## N0x672.mean     .
## N0x672.std      .
## N0x84.mean      .
## N0x84.std       .
## O3168.mean      .
```

```

## 03168.std      .
## 0342.mean      2.035764e-02
## 0342.std      .
## 03504.mean     .
## 03504.std     .
## 03672.mean     .
## 03672.std     .
## 0384.mean     .
## 0384.std     .
## Pamb0.mean    .
## Pamb0.std     .
## PAR.mean      .
## PAR.std       .
## PTG.mean      .
## PTG.std       .
## RGlob.mean    8.172411e-03
## RGlob.std     .
## RHIRGA168.mean .
## RHIRGA168.std  6.125317e-02
## RHIRGA336.mean -1.509095e-04
## RHIRGA336.std  .
## RHIRGA42.mean  -5.307858e-02
## RHIRGA42.std   .
## RHIRGA504.mean .
## RHIRGA504.std  .
## RHIRGA672.mean .
## RHIRGA672.std  .
## RHIRGA84.mean  .
## RHIRGA84.std   .
## RPAR.mean     .
## RPAR.std      .
## S02168.mean   .
## S02168.std    .
## SWS.mean      .
## SWS.std       .
## T168.mean     .
## T168.std      5.537707e-02
## 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       -2.653194e+02
## CS.std        .

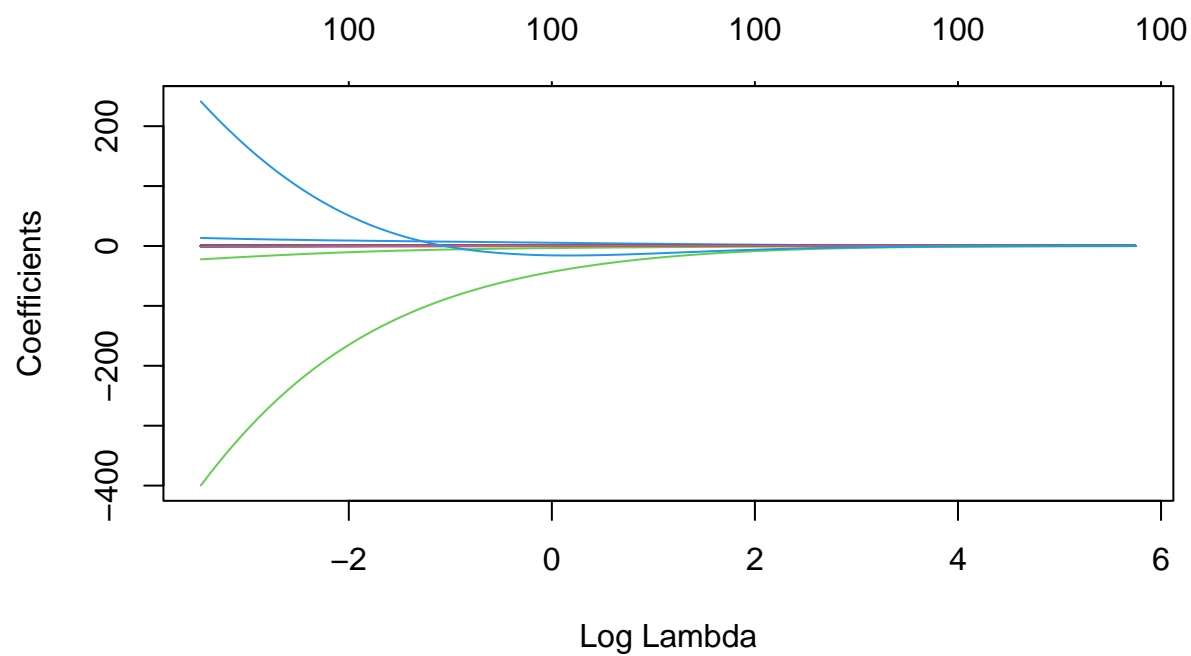
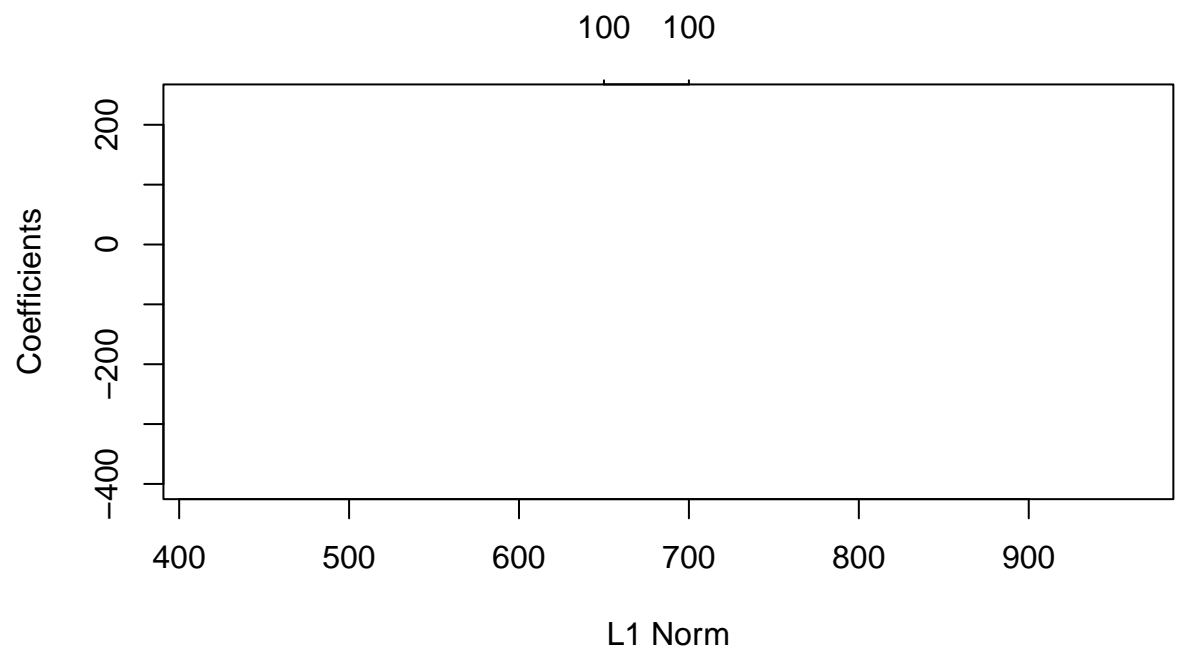
```



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] 1.309752
```

## 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	0.2954150	2.4822651
test	0.5000557	0.6595730	2.9906306
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] 0.5021552
```

```
## [1] 1.294688
```

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

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

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

## SVM (first version of actual model)