BISC 577 Unit 3 HW 2

Liana Engie

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First, the necessary packages are loaded into R. I am using R version 3.3.0.

```
## Loading required package: GenomicRanges

## Loading required package: BiocGenerics

## Loading required package: parallel

##
## Attaching package: 'BiocGenerics'

## The following objects are masked from 'package:parallel':
##
##     clusterApply, clusterApplyLB, clusterCall, clusterEvalQ,
##     clusterExport, clusterMap, parApply, parCapply, parLapply,
##     parLapplyLB, parRapply, parSapply, parSapplyLB

## The following objects are masked from 'package:stats':
##
##     IQR, mad, xtabs

## The following objects are masked from 'package:base':
##
##     anyDuplicated, append, as.data.frame, cbind, colnames,
##     do.call, duplicated, eval, evalq, Filter, Find, get, grep,
##     grepl, intersect, is.unsorted, lapply, lengths, Map, mapply,
##     match, mget, order, paste, pmax, pmax.int, pmin, pmin.int,
##     Position, rank, rbind, Reduce, rownames, sapply, setdiff,
##     sort, table, tapply, union, unique, unsplit

## Loading required package: S4Vectors

## Loading required package: stats4

##
## Attaching package: 'S4Vectors'

## The following objects are masked from 'package:base':
##
##     colMeans, colSums, expand.grid, rowMeans, rowSums

## Loading required package: IRanges

## Loading required package: GenomeInfoDb

## Loading required package: lattice
```

High Throughput Binding Assays

Systematic evolution of ligands by exponential enrichment with next-gen sequencing, or SELEX-seq, is an iterative *in vitro* method that identifies DNA sequences that bind to the desired protein or peptide. A large DNA library is generated and the protein is introduced. Those that bind the protein are separated from the unbound DNA and these are sequenced and used as the new DNA library. Cycles are repeated with different selection criteria. SELEX-seq selects moderate to highly selective binding sites, identifies more sites than traditional SELEX, and requires fewer iterations.

```
Protein binding microarrays, or PBMs, is a procedure that involves a surface where tens of thousands of

Chromatin immuno precipitation sequencing, also known as ChIP-seq, identifies DNA binding sites \textit
```

Building prediction models for *in vitro* data

In vitro data from gcPBM is used in the following section. We will compare prediction models using sequence alone ("1-mer" sequence model) versus sequence and shape features together ("1-mer+shape" model).

```
#shape prediction
md <- "Mad.txt.fa"
predMd <- getShape(md)
```

```
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......

## Parsing files......

## Record length: 36

## Record length: 35

## Record length: 36

## Record length: 35

## Done
```

```
mx <- "Max.txt.fa"
predMx <- getShape(mx)
```

```
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......

## Parsing files......

## Record length: 36
```

```
## Record length: 35

## Record length: 36

## Record length: 35

## Done
```

```
myc <- "Myc.txt.fa"
predMyc <- getShape(myc)
```

```
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......
## Reading the input sequence......

## Parsing files......

## Record length: 36

## Record length: 35

## Record length: 36

## Record length: 35

## Done
```

```
#Feature vectors for each data set
featureType <- c("1-mer", "1-shape")
featVectMd <- encodeSeqShape(md,predMd,featureType)
featVectMx <- encodeSeqShape(mx,predMx,featureType)
featVectMyc <- encodeSeqShape(myc,predMyc,featureType)
#head(featVectMd)
#head(featVectMx)
#head(featVectMyc)

md_data <- read.table("Mad.txt")
mx_data <- read.table("Max.txt")
myc_data <- read.table("Myc.txt")
#Could put all into one data frame but it might be more convenient to keep them separate
dfMd <- data.frame(affinity=md_data$V2, featVectMd)
dfMx <- data.frame(affinity=mx_data$V2, featVectMx)
dfMyc <- data.frame(affinity=myc_data$V2, featVectMyc)

#Settings for caret package
trainControl <- trainControl(method = "cv", number = 10, savePredictions = TRUE)

#Prediction without (then with) L2-regularized
modelMd <- train (affinity~ ., data = dfMd, trControl=trainControl,
method = "lm", preProcess=NULL)
```

```
## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

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## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading
```

```r
modelMd2 <- train(affinity~., data = dfMd, trControl=trainControl,
method = "glmnet", tuneGrid = data.frame(alpha = 0, lambda = c(2^c(-15:15))))
```

```
## Loading required package: glmnet

## Loading required package: Matrix

##
## Attaching package: 'Matrix'

## The following object is masked from 'package:S4Vectors':
##
##     expand

## Loading required package: foreach

## Loaded glmnet 2.0-5

## Warning in nominalTrainWorkflow(x = x, y = y, wts = weights, info =
## trainInfo, : There were missing values in resampled performance measures.
```

```r
modelMx <- train (affinity~ ., data = dfMx, trControl=trainControl,
method = "lm", preProcess=NULL)
```

```
## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
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## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading
```

```r
modelMx2 <- train(affinity~., data = dfMx, trControl=trainControl,
method = "glmnet", tuneGrid = data.frame(alpha = 0, lambda = c(2^c(-15:15))))
```

```
## Warning in nominalTrainWorkflow(x = x, y = y, wts = weights, info =
## trainInfo, : There were missing values in resampled performance measures.
```

```r
modelMyc <- train (affinity~ ., data = dfMyc, trControl=trainControl,
method = "lm", preProcess=NULL)
```

```
## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
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```

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## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading

## Warning in predict.lm(modelFit, newdata): prediction from a rank-deficient
## fit may be misleading
```

```
modelMyc2 <- train(affinity~., data = dfMyc, trControl=trainControl,
method = "glmnet", tuneGrid = data.frame(alpha = 0, lambda = c(2^c(-15:15))))
```

```
## Warning in nominalTrainWorkflow(x = x, y = y, wts = weights, info =
## trainInfo, : There were missing values in resampled performance measures.
```

```
#Outputting the actual data
summary(modelMd)
```

```
##
## Call:
## lm(formula = .outcome ~ ., data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.56567 -0.10657 -0.00790  0.09793  1.01592
##
## Coefficients: (48 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  9.590e+01  1.312e+01   7.311 2.92e-13 ***
## X1           7.563e-03  7.861e-03   0.962 0.336043
## X2           1.808e-02  5.785e-03   3.124 0.001788 **
## X3           1.746e-02  5.763e-03   3.029 0.002462 **
## X4                  NA         NA      NA       NA
## X5          -4.597e-02  1.087e-02  -4.231 2.36e-05 ***
## X6          -7.907e-03  8.843e-03  -0.894 0.371245
## X7          -1.651e-02  7.441e-03  -2.219 0.026499 *
## X8                  NA         NA      NA       NA
## X9          -2.809e-02  1.391e-02  -2.020 0.043393 *
## X10          7.108e-03  1.452e-02   0.490 0.624394
## X11         -2.104e-02  1.541e-02  -1.365 0.172141
## X12                 NA         NA      NA       NA
```

```
## X13         -8.159e-03  1.392e-02  -0.586 0.557701
## X14          2.828e-02  1.467e-02   1.927 0.054020 .
## X15          9.273e-03  1.474e-02   0.629 0.529283
## X16                 NA         NA      NA       NA
## X17         -4.247e-02  1.443e-02  -2.944 0.003253 **
## X18          3.640e-02  1.494e-02   2.436 0.014859 *
## X19          1.386e-02  1.525e-02   0.909 0.363257
## X20                 NA         NA      NA       NA
## X21         -5.684e-02  1.478e-02  -3.845 0.000121 ***
## X22         -1.408e-02  1.512e-02  -0.931 0.351731
## X23         -2.596e-03  1.516e-02  -0.171 0.864060
## X24                 NA         NA      NA       NA
## X25         -3.509e-02  1.470e-02  -2.388 0.016989 *
## X26          9.740e-03  1.526e-02   0.638 0.523393
## X27         -3.342e-02  1.512e-02  -2.211 0.027075 *
## X28                 NA         NA      NA       NA
## X29         -2.962e-02  1.468e-02  -2.017 0.043701 *
## X30         -3.397e-02  1.530e-02  -2.221 0.026397 *
## X31         -3.760e-02  1.511e-02  -2.488 0.012859 *
## X32                 NA         NA      NA       NA
## X33          8.272e-03  1.495e-02   0.553 0.580062
## X34         -1.419e-02  1.520e-02  -0.934 0.350284
## X35         -1.158e-02  1.514e-02  -0.765 0.444393
## X36                 NA         NA      NA       NA
## X37          1.730e-03  1.466e-02   0.118 0.906035
## X38         -3.427e-03  1.532e-02  -0.224 0.823045
## X39          9.854e-03  1.541e-02   0.640 0.522415
## X40                 NA         NA      NA       NA
## X41         -2.615e-02  1.468e-02  -1.781 0.074947 .
## X42         -5.741e-03  1.566e-02  -0.367 0.713993
## X43         -3.434e-02  1.542e-02  -2.227 0.026001 *
## X44                 NA         NA      NA       NA
## X45         -7.093e-03  1.506e-02  -0.471 0.637610
## X46         -1.813e-02  1.564e-02  -1.160 0.246240
## X47          1.872e-03  1.606e-02   0.117 0.907223
## X48                 NA         NA      NA       NA
## X49         -1.605e-02  1.628e-02  -0.986 0.324360
## X50         -1.502e-02  1.664e-02  -0.903 0.366768
## X51          6.037e-02  1.657e-02   3.642 0.000272 ***
## X52                 NA         NA      NA       NA
## X53          3.557e-01  2.932e-02  12.129  < 2e-16 ***
## X54          2.042e-01  2.394e-02   8.532  < 2e-16 ***
## X55          8.952e-02  2.076e-02   4.313 1.63e-05 ***
## X56                 NA         NA      NA       NA
## X57          2.571e+00  1.929e-01  13.323  < 2e-16 ***
## X58          2.415e+00  1.342e-01  18.001  < 2e-16 ***
## X59          1.663e+00  1.253e-01  13.274  < 2e-16 ***
## X60                 NA         NA      NA       NA
## X61         -1.307e+00  4.410e-01  -2.963 0.003055 **
## X62                 NA         NA      NA       NA
## X63                 NA         NA      NA       NA
## X64                 NA         NA      NA       NA
## X65          7.397e-01  5.166e-01   1.432 0.152238
## X66                 NA         NA      NA       NA
```

```
## X67         -1.507e+00  1.783e-01  -8.454  < 2e-16 ***
## X68                 NA         NA      NA       NA
## X69                 NA         NA      NA       NA
## X70         -1.089e+00  4.559e-01  -2.390 0.016885 *
## X71                 NA         NA      NA       NA
## X72                 NA         NA      NA       NA
## X73          9.310e-01  4.506e-01   2.066 0.038840 *
## X74                 NA         NA      NA       NA
## X75                 NA         NA      NA       NA
## X76                 NA         NA      NA       NA
## X77          1.225e-01  5.035e-01   0.243 0.807764
## X78         -1.886e+00  4.247e-01  -4.441 9.08e-06 ***
## X79                 NA         NA      NA       NA
## X80                 NA         NA      NA       NA
## X81                 NA         NA      NA       NA
## X82                 NA         NA      NA       NA
## X83          7.722e-01  4.483e-01   1.722 0.085027 .
## X84                 NA         NA      NA       NA
## X85                 NA         NA      NA       NA
## X86         -6.467e-01  1.207e-01  -5.359 8.61e-08 ***
## X87          5.859e-02  9.627e-02   0.609 0.542836
## X88                 NA         NA      NA       NA
## X89         -3.097e-01  2.944e-02 -10.519  < 2e-16 ***
## X90         -2.399e-01  3.134e-02  -7.656 2.17e-14 ***
## X91         -1.747e-01  2.819e-02  -6.196 6.12e-10 ***
## X92                 NA         NA      NA       NA
## X93         -3.065e-03  1.590e-02  -0.193 0.847142
## X94          4.212e-02  1.671e-02   2.522 0.011706 *
## X95         -4.663e-02  1.736e-02  -2.687 0.007228 **
## X96                 NA         NA      NA       NA
## X97          4.807e-03  1.490e-02   0.323 0.746972
## X98         -9.205e-03  1.565e-02  -0.588 0.556490
## X99         -3.918e-02  1.513e-02  -2.590 0.009604 **
## X100                NA         NA      NA       NA
## X101        -3.223e-03  1.510e-02  -0.213 0.830953
## X102        -1.180e-02  1.515e-02  -0.779 0.435880
## X103        -7.319e-03  1.515e-02  -0.483 0.628988
## X104                NA         NA      NA       NA
## X105         1.846e-02  1.505e-02   1.227 0.219969
## X106         6.724e-03  1.527e-02   0.440 0.659717
## X107        -5.106e-03  1.506e-02  -0.339 0.734605
## X108                NA         NA      NA       NA
## X109         3.092e-02  1.488e-02   2.077 0.037811 *
## X110         1.578e-02  1.566e-02   1.008 0.313560
## X111        -1.477e-02  1.514e-02  -0.975 0.329563
## X112                NA         NA      NA       NA
## X113         3.744e-02  1.454e-02   2.574 0.010066 *
## X114         3.009e-02  1.545e-02   1.948 0.051484 .
## X115         1.666e-02  1.514e-02   1.100 0.271195
## X116                NA         NA      NA       NA
## X117         1.529e-02  1.460e-02   1.047 0.295189
## X118         7.041e-03  1.515e-02   0.465 0.642208
## X119         4.007e-02  1.515e-02   2.645 0.008195 **
## X120                NA         NA      NA       NA
```

```
## X121         4.326e-02  1.451e-02   2.981 0.002882 **
## X122         1.223e-02  1.556e-02   0.786 0.431855
## X123         7.481e-03  1.511e-02   0.495 0.620549
## X124                NA         NA      NA       NA
## X125         3.458e-02  1.463e-02   2.365 0.018076 *
## X126        -1.156e-02  1.534e-02  -0.753 0.451226
## X127         2.857e-02  1.484e-02   1.925 0.054261 .
## X128                NA         NA      NA       NA
## X129         2.718e-02  1.432e-02   1.898 0.057716 .
## X130        -2.511e-03  1.513e-02  -0.166 0.868223
## X131         4.544e-02  1.480e-02   3.070 0.002150 **
## X132                NA         NA      NA       NA
## X133         5.349e-02  1.372e-02   3.899 9.76e-05 ***
## X134         4.918e-02  1.512e-02   3.254 0.001145 **
## X135         5.580e-02  1.355e-02   4.117 3.87e-05 ***
## X136                NA         NA      NA       NA
## X137         2.361e-02  1.088e-02   2.169 0.030120 *
## X138         2.476e-02  9.248e-03   2.677 0.007442 **
## X139         2.949e-02  8.527e-03   3.459 0.000546 ***
## X140                NA         NA      NA       NA
## X141        -1.703e-02  7.866e-03  -2.165 0.030435 *
## X142        -9.944e-03  7.036e-03  -1.413 0.157612
## X143        -5.850e-03  7.637e-03  -0.766 0.443677
## X144                NA         NA      NA       NA
## X145        -3.010e-02  4.795e-02  -0.628 0.530192
## X146         9.423e-04  5.347e-02   0.018 0.985941
## X147         8.603e-02  5.380e-02   1.599 0.109848
## X148        -2.712e-02  5.343e-02  -0.508 0.611732
## X149        -1.217e-01  5.384e-02  -2.260 0.023873 *
## X150        -1.677e-01  5.416e-02  -3.097 0.001962 **
## X151        -1.837e-01  5.439e-02  -3.377 0.000736 ***
## X152         6.096e-02  5.458e-02   1.117 0.264075
## X153        -7.028e-02  5.508e-02  -1.276 0.201990
## X154        -9.206e-02  5.642e-02  -1.632 0.102766
## X155        -3.143e-03  6.101e-02  -0.052 0.958909
## X156        -1.982e-01  7.450e-02  -2.660 0.007826 **
## X157         5.567e-01  1.019e-01   5.464 4.80e-08 ***
## X158        -1.992e-01  1.161e-01  -1.715 0.086306 .
## X159         8.866e+00  8.352e-01  10.616  < 2e-16 ***
## X160         1.185e+01  1.538e+00   7.705 1.49e-14 ***
## X161         1.367e+01  1.551e+00   8.814  < 2e-16 ***
## X162         9.273e+00  8.186e-01  11.328  < 2e-16 ***
## X163         7.682e-02  1.142e-01   0.673 0.501142
## X164         4.055e-01  1.026e-01   3.954 7.77e-05 ***
## X165        -2.468e-01  7.373e-02  -3.347 0.000820 ***
## X166        -6.154e-02  6.004e-02  -1.025 0.305376
## X167        -1.339e-01  5.659e-02  -2.366 0.018007 *
## X168        -9.759e-02  5.536e-02  -1.763 0.077994 .
## X169        -9.549e-02  5.395e-02  -1.770 0.076779 .
## X170        -2.672e-03  5.407e-02  -0.049 0.960582
## X171         9.462e-03  5.450e-02   0.174 0.862175
## X172         4.285e-02  5.433e-02   0.789 0.430297
## X173         4.063e-02  5.367e-02   0.757 0.449123
## X174        -8.897e-02  5.418e-02  -1.642 0.100611
```

```
## X175         3.033e-03  5.377e-02   0.056 0.955017
## X176         4.188e-02  4.984e-02   0.840 0.400730
## X177        -3.273e-02  3.052e-02  -1.072 0.283689
## X178        -7.865e-02  3.052e-02  -2.577 0.009987 **
## X179        -1.244e-01  3.224e-02  -3.858 0.000115 ***
## X180        -5.853e-02  3.183e-02  -1.839 0.065994 .
## X181        -1.009e-01  3.179e-02  -3.175 0.001505 **
## X182        -1.865e-02  3.195e-02  -0.584 0.559449
## X183        -1.878e-02  3.189e-02  -0.589 0.556004
## X184        -6.703e-02  3.203e-02  -2.093 0.036395 *
## X185        -8.719e-03  3.203e-02  -0.272 0.785506
## X186        -1.633e-02  3.177e-02  -0.514 0.607324
## X187        -8.181e-02  3.491e-02  -2.343 0.019143 *
## X188        -2.049e-01  4.295e-02  -4.771 1.87e-06 ***
## X189        -6.382e-01  8.290e-02  -7.698 1.56e-14 ***
## X190         1.856e+00  2.405e-01   7.717 1.35e-14 ***
## X191         6.307e+00  4.908e-01  12.852  < 2e-16 ***
## X192        -4.000e+01  2.976e+00 -13.443  < 2e-16 ***
## X193        -3.960e+01  2.986e+00 -13.262  < 2e-16 ***
## X194         5.832e+00  4.991e-01  11.685  < 2e-16 ***
## X195         1.313e+00  2.426e-01   5.411 6.47e-08 ***
## X196        -6.097e-01  8.324e-02  -7.324 2.66e-13 ***
## X197        -2.782e-01  4.389e-02  -6.337 2.48e-10 ***
## X198        -2.601e-02  3.529e-02  -0.737 0.461204
## X199         5.075e-02  3.211e-02   1.581 0.114009
## X200        -3.588e-02  3.179e-02  -1.129 0.259086
## X201        -5.124e-02  3.203e-02  -1.600 0.109659
## X202        -6.122e-02  3.155e-02  -1.941 0.052347 .
## X203        -9.172e-02  3.163e-02  -2.900 0.003744 **
## X204        -9.529e-02  3.173e-02  -3.004 0.002677 **
## X205         2.527e-03  3.185e-02   0.079 0.936748
## X206        -1.378e-02  3.126e-02  -0.441 0.659482
## X207        -4.321e-02  3.172e-02  -1.362 0.173183
## X208        -8.337e-02  3.029e-02  -2.752 0.005933 **
## X209        -5.240e-03  3.888e-02  -0.135 0.892800
## X210        -2.497e-02  4.630e-02  -0.539 0.589618
## X211        -4.187e-02  4.790e-02  -0.874 0.382096
## X212        -5.982e-02  4.950e-02  -1.208 0.226898
## X213         8.450e-02  4.933e-02   1.713 0.086784 .
## X214         1.471e-01  4.976e-02   2.957 0.003118 **
## X215         1.341e-01  4.949e-02   2.710 0.006740 **
## X216         7.844e-02  5.026e-02   1.561 0.118620
## X217         8.166e-02  5.137e-02   1.590 0.111953
## X218         5.020e-02  5.174e-02   0.970 0.331953
## X219         1.058e-01  5.270e-02   2.007 0.044806 *
## X220         8.078e-02  6.431e-02   1.256 0.209061
## X221         3.172e-01  7.810e-02   4.061 4.93e-05 ***
## X222        -1.810e+00  1.953e-01  -9.271  < 2e-16 ***
## X223         2.929e+00  4.425e-01   6.619 3.87e-11 ***
## X224        -1.571e+01  1.775e+00  -8.851  < 2e-16 ***
## X225        -1.118e+02  1.209e+01  -9.253  < 2e-16 ***
## X226        -1.725e+01  1.735e+00  -9.941  < 2e-16 ***
## X227         3.619e+00  4.446e-01   8.139 4.64e-16 ***
## X228        -2.060e+00  1.990e-01 -10.350  < 2e-16 ***
```

```
## X229         2.190e-01  7.750e-02   2.826 0.004726 **
## X230         2.260e-01  6.470e-02   3.494 0.000479 ***
## X231         1.563e-01  5.181e-02   3.017 0.002564 **
## X232         1.755e-01  5.108e-02   3.435 0.000595 ***
## X233         1.095e-01  5.015e-02   2.184 0.028976 *
## X234         3.209e-02  4.996e-02   0.642 0.520643
## X235        -4.405e-02  4.963e-02  -0.888 0.374767
## X236        -1.023e-01  5.074e-02  -2.017 0.043768 *
## X237        -4.706e-02  4.982e-02  -0.945 0.344915
## X238         3.179e-03  4.893e-02   0.065 0.948202
## X239         3.692e-02  4.823e-02   0.766 0.443958
## X240        -7.781e-03  4.617e-02  -0.169 0.866174
## X241        -4.473e-02  3.966e-02  -1.128 0.259380
## X242        -3.968e-02  2.433e-02  -1.631 0.102888
## X243        -8.297e-02  2.829e-02  -2.933 0.003371 **
## X244        -8.551e-02  2.813e-02  -3.040 0.002376 **
## X245        -4.442e-02  2.927e-02  -1.517 0.129234
## X246        -1.019e-01  2.873e-02  -3.547 0.000392 ***
## X247        -2.259e-02  2.868e-02  -0.788 0.430907
## X248        -1.631e-02  2.895e-02  -0.563 0.573194
## X249        -7.651e-03  2.894e-02  -0.264 0.791525
## X250        -1.735e-02  2.881e-02  -0.602 0.547087
## X251         3.425e-02  2.891e-02   1.185 0.236169
## X252         1.093e-02  2.991e-02   0.365 0.714806
## X253        -1.175e-01  3.397e-02  -3.460 0.000543 ***
## X254         3.087e-01  6.788e-02   4.547 5.53e-06 ***
## X255         1.571e-01  1.528e-01   1.028 0.303922
## X256         6.288e-01  1.695e-01   3.710 0.000208 ***
## X257         1.447e+01  7.647e-01  18.917  < 2e-16 ***
## X258                NA         NA      NA       NA
## X259         1.415e+01  7.439e-01  19.027  < 2e-16 ***
## X260         9.547e-01  1.655e-01   5.770 8.24e-09 ***
## X261        -3.441e-01  1.572e-01  -2.189 0.028622 *
## X262         7.723e-02  6.782e-02   1.139 0.254881
## X263        -1.195e-01  3.413e-02  -3.502 0.000465 ***
## X264         1.344e-02  2.990e-02   0.449 0.653159
## X265         2.849e-02  2.893e-02   0.985 0.324832
## X266        -4.067e-02  2.900e-02  -1.403 0.160797
## X267        -4.291e-02  2.867e-02  -1.496 0.134581
## X268        -1.720e-02  2.831e-02  -0.607 0.543592
## X269         1.843e-03  2.879e-02   0.064 0.948949
## X270        -5.447e-02  2.896e-02  -1.881 0.060042 .
## X271         1.162e-02  2.902e-02   0.400 0.688869
## X272        -1.105e-02  2.855e-02  -0.387 0.698843
## X273        -8.900e-02  2.857e-02  -3.115 0.001849 **
## X274        -2.979e-02  2.402e-02  -1.240 0.214878
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1637 on 7307 degrees of freedom
## Multiple R-squared:  0.9595, Adjusted R-squared:  0.9582
## F-statistic: 765.8 on 226 and 7307 DF,  p-value: < 2.2e-16
```

```
modelMd2
```

```
## glmnet
##
## 7534 samples
##  274 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 6778, 6780, 6782, 6780, 6781, 6780, ...
## Resampling results across tuning parameters:
##
##   lambda        RMSE       Rsquared
##   3.051758e-05  0.3012891  0.8633959
##   6.103516e-05  0.3012891  0.8633959
##   1.220703e-04  0.3012891  0.8633959
##   2.441406e-04  0.3012891  0.8633959
##   4.882812e-04  0.3012891  0.8633959
##   9.765625e-04  0.3012891  0.8633959
##   1.953125e-03  0.3012891  0.8633959
##   3.906250e-03  0.3012891  0.8633959
##   7.812500e-03  0.3012891  0.8633959
##   1.562500e-02  0.3012891  0.8633959
##   3.125000e-02  0.3012891  0.8633959
##   6.250000e-02  0.3159889  0.8499393
##   1.250000e-01  0.3506898  0.8169614
##   2.500000e-01  0.3837816  0.7868560
##   5.000000e-01  0.4210273  0.7593370
##   1.000000e+00  0.4715964  0.7291844
##   2.000000e+00  0.5383322  0.6881996
##   4.000000e+00  0.6111729  0.6317794
##   8.000000e+00  0.6760436  0.5669995
##   1.600000e+01  0.7249750  0.5098632
##   3.200000e+01  0.7578148  0.4691670
##   6.400000e+01  0.7776444  0.4447001
##   1.280000e+02  0.7888308  0.4310698
##   2.560000e+02  0.7947785  0.4239362
##   5.120000e+02  0.8010271        NaN
##   1.024000e+03  0.8010271        NaN
##   2.048000e+03  0.8010271        NaN
##   4.096000e+03  0.8010271        NaN
##   8.192000e+03  0.8010271        NaN
##   1.638400e+04  0.8010271        NaN
##   3.276800e+04  0.8010271        NaN
##
## Tuning parameter 'alpha' was held constant at a value of 0
## RMSE was used to select the optimal model using  the smallest value.
## The final values used for the model were alpha = 0 and lambda = 0.03125.
```

```
summary(modelMx)
```

```
##
## Call:
```

```
## lm(formula = .outcome ~ ., data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.17956 -0.03539 -0.00343  0.03195  0.32781
##
## Coefficients: (46 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.266e+01  2.498e+00 -13.071  < 2e-16 ***
## X1           7.941e-04  2.451e-03   0.324 0.745918
## X2          -1.951e-03  1.792e-03  -1.089 0.276243
## X3           1.845e-03  1.786e-03   1.033 0.301426
## X4                  NA         NA      NA       NA
## X5          -1.257e-02  3.365e-03  -3.736 0.000188 ***
## X6          -6.089e-03  2.762e-03  -2.205 0.027501 *
## X7          -1.255e-02  2.328e-03  -5.393 7.11e-08 ***
## X8                  NA         NA      NA       NA
## X9          -1.204e-02  4.288e-03  -2.807 0.005008 **
## X10         -5.444e-03  4.431e-03  -1.228 0.219352
## X11         -1.211e-02  4.777e-03  -2.536 0.011238 *
## X12                 NA         NA      NA       NA
## X13         -2.908e-03  4.305e-03  -0.675 0.499401
## X14          4.920e-03  4.539e-03   1.084 0.278370
## X15         -8.108e-03  4.577e-03  -1.772 0.076500 .
## X16                 NA         NA      NA       NA
## X17          3.626e-03  4.472e-03   0.811 0.417487
## X18          1.205e-02  4.689e-03   2.570 0.010186 *
## X19          1.623e-03  4.721e-03   0.344 0.731053
## X20                 NA         NA      NA       NA
## X21         -8.493e-03  4.578e-03  -1.855 0.063597 .
## X22         -5.245e-03  4.674e-03  -1.122 0.261831
## X23         -2.260e-03  4.726e-03  -0.478 0.632472
## X24                 NA         NA      NA       NA
## X25         -7.768e-03  4.554e-03  -1.706 0.088078 .
## X26          4.902e-03  4.728e-03   1.037 0.299821
## X27         -1.006e-02  4.710e-03  -2.137 0.032664 *
## X28                 NA         NA      NA       NA
## X29         -5.587e-03  4.553e-03  -1.227 0.219792
## X30         -4.915e-03  4.731e-03  -1.039 0.298895
## X31         -1.124e-02  4.696e-03  -2.394 0.016668 *
## X32                 NA         NA      NA       NA
## X33         -2.269e-03  4.621e-03  -0.491 0.623401
## X34         -2.487e-03  4.670e-03  -0.533 0.594369
## X35         -7.525e-03  4.724e-03  -1.593 0.111230
## X36                 NA         NA      NA       NA
## X37         -6.285e-03  4.556e-03  -1.380 0.167743
## X38         -5.350e-03  4.773e-03  -1.121 0.262357
## X39         -6.273e-03  4.779e-03  -1.313 0.189345
## X40                 NA         NA      NA       NA
## X41         -9.623e-03  4.539e-03  -2.120 0.034040 *
## X42         -3.871e-03  4.780e-03  -0.810 0.418040
## X43         -2.130e-02  4.814e-03  -4.424 9.82e-06 ***
## X44                 NA         NA      NA       NA
## X45          5.045e-03  4.602e-03   1.096 0.272929
```

```
## X46         -3.686e-03  4.797e-03  -0.769 0.442199
## X47          1.101e-03  4.936e-03   0.223 0.823462
## X48                 NA         NA      NA       NA
## X49          5.109e-03  4.907e-03   1.041 0.297886
## X50         -1.505e-02  5.129e-03  -2.935 0.003348 **
## X51          3.153e-02  5.161e-03   6.110 1.04e-09 ***
## X52                 NA         NA      NA       NA
## X53          9.516e-02  8.240e-03  11.548  < 2e-16 ***
## X54          5.170e-02  7.217e-03   7.164 8.51e-13 ***
## X55          3.176e-02  6.465e-03   4.912 9.17e-07 ***
## X56                 NA         NA      NA       NA
## X57          6.925e-02  2.438e-02   2.840 0.004520 **
## X58          2.570e-01  1.321e-02  19.458  < 2e-16 ***
## X59         -4.284e-02  1.543e-02  -2.777 0.005495 **
## X60                 NA         NA      NA       NA
## X61          3.785e-01  1.025e-01   3.693 0.000223 ***
## X62                 NA         NA      NA       NA
## X63                 NA         NA      NA       NA
## X64                 NA         NA      NA       NA
## X65          6.512e-01  1.527e-01   4.265 2.02e-05 ***
## X66                 NA         NA      NA       NA
## X67          2.768e-01  5.355e-02   5.170 2.40e-07 ***
## X68                 NA         NA      NA       NA
## X69                 NA         NA      NA       NA
## X70          8.306e-01  1.185e-01   7.008 2.61e-12 ***
## X71                 NA         NA      NA       NA
## X72                 NA         NA      NA       NA
## X73         -6.944e-01  1.172e-01  -5.926 3.23e-09 ***
## X74                 NA         NA      NA       NA
## X75                 NA         NA      NA       NA
## X76                 NA         NA      NA       NA
## X77         -5.489e-01  1.516e-01  -3.621 0.000295 ***
## X78         -4.660e-01  1.557e-01  -2.992 0.002777 **
## X79                 NA         NA      NA       NA
## X80                 NA         NA      NA       NA
## X81                 NA         NA      NA       NA
## X82                 NA         NA      NA       NA
## X83         -6.190e-01  1.072e-01  -5.773 8.07e-09 ***
## X84                 NA         NA      NA       NA
## X85         -2.587e-02  2.611e-02  -0.991 0.321950
## X86         -3.371e-02  3.160e-02  -1.067 0.286164
## X87          2.513e-01  2.515e-02   9.993  < 2e-16 ***
## X88                 NA         NA      NA       NA
## X89         -9.701e-02  8.209e-03 -11.817  < 2e-16 ***
## X90         -7.078e-02  8.730e-03  -8.107 5.94e-16 ***
## X91         -5.004e-02  8.161e-03  -6.132 9.10e-10 ***
## X92                 NA         NA      NA       NA
## X93         -7.107e-03  4.795e-03  -1.482 0.138321
## X94          2.734e-02  5.132e-03   5.327 1.03e-07 ***
## X95         -2.529e-02  5.205e-03  -4.859 1.20e-06 ***
## X96                 NA         NA      NA       NA
## X97         -5.936e-04  4.553e-03  -0.130 0.896262
## X98         -8.047e-03  4.769e-03  -1.688 0.091527 .
## X99         -9.322e-03  4.708e-03  -1.980 0.047704 *
```

```
## X100              NA         NA      NA       NA
## X101       -2.371e-03  4.650e-03  -0.510 0.610172
## X102       -1.143e-02  4.709e-03  -2.427 0.015249 *
## X103        1.054e-03  4.700e-03   0.224 0.822618
## X104              NA         NA      NA       NA
## X105        1.121e-02  4.598e-03   2.437 0.014828 *
## X106        5.927e-03  4.701e-03   1.261 0.207477
## X107        2.524e-03  4.684e-03   0.539 0.590067
## X108              NA         NA      NA       NA
## X109        2.385e-03  4.585e-03   0.520 0.602968
## X110       -2.970e-03  4.878e-03  -0.609 0.542685
## X111        1.061e-03  4.706e-03   0.226 0.821586
## X112              NA         NA      NA       NA
## X113        1.146e-02  4.517e-03   2.536 0.011223 *
## X114        6.464e-03  4.753e-03   1.360 0.173845
## X115        5.290e-03  4.660e-03   1.135 0.256334
## X116              NA         NA      NA       NA
## X117        9.136e-03  4.478e-03   2.040 0.041357 *
## X118        5.135e-03  4.660e-03   1.102 0.270456
## X119        1.180e-02  4.674e-03   2.525 0.011596 *
## X120              NA         NA      NA       NA
## X121        1.434e-03  4.489e-03   0.319 0.749384
## X122       -3.398e-03  4.824e-03  -0.705 0.481124
## X123       -1.030e-03  4.713e-03  -0.219 0.826961
## X124              NA         NA      NA       NA
## X125        1.013e-02  4.469e-03   2.266 0.023490 *
## X126       -8.515e-03  4.647e-03  -1.832 0.066951 .
## X127        7.496e-03  4.581e-03   1.636 0.101816
## X128              NA         NA      NA       NA
## X129        3.676e-03  4.398e-03   0.836 0.403275
## X130       -2.344e-03  4.653e-03  -0.504 0.614436
## X131        5.158e-03  4.522e-03   1.141 0.254081
## X132              NA         NA      NA       NA
## X133        1.034e-02  4.287e-03   2.412 0.015890 *
## X134        8.441e-03  4.637e-03   1.820 0.068740 .
## X135        1.212e-02  4.253e-03   2.849 0.004396 **
## X136              NA         NA      NA       NA
## X137        5.559e-03  3.383e-03   1.643 0.100444
## X138       -4.898e-03  2.864e-03  -1.710 0.087278 .
## X139       -1.868e-03  2.624e-03  -0.712 0.476445
## X140              NA         NA      NA       NA
## X141       -9.347e-03  2.435e-03  -3.838 0.000125 ***
## X142       -9.999e-03  2.165e-03  -4.618 3.93e-06 ***
## X143       -1.548e-02  2.357e-03  -6.568 5.40e-11 ***
## X144              NA         NA      NA       NA
## X145       -1.416e-02  1.507e-02  -0.940 0.347396
## X146       -2.934e-02  1.650e-02  -1.778 0.075408 .
## X147        2.234e-02  1.649e-02   1.354 0.175636
## X148       -3.620e-03  1.661e-02  -0.218 0.827441
## X149       -1.161e-02  1.673e-02  -0.694 0.487655
## X150       -3.025e-02  1.678e-02  -1.802 0.071511 .
## X151       -2.033e-02  1.663e-02  -1.223 0.221435
## X152       -3.179e-03  1.683e-02  -0.189 0.850208
## X153       -1.488e-02  1.705e-02  -0.873 0.382840
```

```
## X154       -4.735e-02  1.748e-02  -2.709 0.006752 **
## X155       -1.152e-02  1.914e-02  -0.602 0.547148
## X156       -5.964e-02  2.332e-02  -2.557 0.010573 *
## X157        9.035e-02  3.066e-02   2.947 0.003219 **
## X158       -1.661e-01  3.440e-02  -4.828 1.41e-06 ***
## X159        1.595e+00  1.926e-01   8.283  < 2e-16 ***
## X160        1.859e+00  4.680e-01   3.971 7.21e-05 ***
## X161        2.423e+00  4.844e-01   5.001 5.81e-07 ***
## X162        1.389e+00  2.021e-01   6.870 6.88e-12 ***
## X163       -1.158e-01  3.407e-02  -3.400 0.000678 ***
## X164        8.053e-02  3.088e-02   2.608 0.009124 **
## X165       -1.869e-02  2.281e-02  -0.820 0.412442
## X166       -1.362e-02  1.874e-02  -0.727 0.467197
## X167       -6.014e-02  1.770e-02  -3.398 0.000682 ***
## X168       -9.140e-03  1.710e-02  -0.534 0.593020
## X169       -3.744e-02  1.675e-02  -2.235 0.025424 *
## X170        1.859e-02  1.683e-02   1.104 0.269623
## X171       -1.094e-02  1.667e-02  -0.656 0.511705
## X172        1.320e-04  1.674e-02   0.008 0.993709
## X173        1.996e-02  1.684e-02   1.185 0.235938
## X174       -3.503e-02  1.664e-02  -2.106 0.035237 *
## X175        2.615e-02  1.666e-02   1.569 0.116580
## X176        2.258e-02  1.541e-02   1.466 0.142783
## X177       -2.004e-02  9.437e-03  -2.123 0.033759 *
## X178       -1.319e-02  9.702e-03  -1.359 0.174129
## X179       -2.794e-02  1.012e-02  -2.760 0.005787 **
## X180       -2.213e-02  9.884e-03  -2.239 0.025177 *
## X181       -2.584e-02  9.960e-03  -2.594 0.009504 **
## X182       -1.726e-03  1.000e-02  -0.173 0.862972
## X183       -4.495e-03  1.002e-02  -0.449 0.653750
## X184       -1.066e-02  1.007e-02  -1.058 0.290137
## X185        2.311e-02  1.015e-02   2.277 0.022839 *
## X186        6.904e-03  1.003e-02   0.688 0.491440
## X187       -1.478e-02  1.079e-02  -1.370 0.170758
## X188       -7.182e-02  1.347e-02  -5.333 9.93e-08 ***
## X189        3.621e-03  2.451e-02   0.148 0.882557
## X190        1.537e-01  6.236e-02   2.464 0.013765 *
## X191        6.284e-03  1.189e-01   0.053 0.957846
## X192        5.029e+00  4.578e-01  10.984  < 2e-16 ***
## X193        4.900e+00  4.510e-01  10.865  < 2e-16 ***
## X194       -8.135e-03  1.229e-01  -0.066 0.947241
## X195        2.237e-01  6.198e-02   3.609 0.000309 ***
## X196       -1.608e-02  2.456e-02  -0.655 0.512662
## X197       -8.602e-02  1.361e-02  -6.322 2.71e-10 ***
## X198       -1.572e-02  1.103e-02  -1.425 0.154322
## X199        1.544e-02  1.009e-02   1.530 0.126012
## X200        2.745e-03  9.964e-03   0.276 0.782905
## X201       -7.231e-03  9.968e-03  -0.725 0.468226
## X202       -1.567e-02  1.003e-02  -1.562 0.118349
## X203       -1.575e-02  9.966e-03  -1.580 0.114181
## X204       -3.072e-02  9.913e-03  -3.099 0.001949 **
## X205       -7.171e-03  1.006e-02  -0.713 0.475924
## X206       -1.359e-02  9.800e-03  -1.387 0.165416
## X207       -2.233e-02  9.790e-03  -2.281 0.022570 *
```

```
## X208        -3.462e-02  9.498e-03  -3.645 0.000269 ***
## X209         2.433e-03  1.211e-02   0.201 0.840705
## X210         7.991e-03  1.421e-02   0.562 0.574012
## X211        -1.164e-02  1.496e-02  -0.778 0.436474
## X212        -1.983e-02  1.555e-02  -1.275 0.202275
## X213         1.693e-02  1.554e-02   1.089 0.276041
## X214         1.964e-02  1.551e-02   1.266 0.205393
## X215         2.556e-02  1.548e-02   1.652 0.098673 .
## X216         1.849e-02  1.552e-02   1.191 0.233559
## X217         3.266e-02  1.585e-02   2.061 0.039360 *
## X218         2.142e-02  1.603e-02   1.337 0.181396
## X219         3.754e-02  1.688e-02   2.223 0.026218 *
## X220         5.203e-02  2.022e-02   2.573 0.010097 *
## X221         1.898e-01  2.377e-02   7.985 1.59e-15 ***
## X222        -3.227e-01  5.456e-02  -5.914 3.46e-09 ***
## X223         6.546e-01  1.129e-01   5.797 6.99e-09 ***
## X224        -3.512e+00  4.596e-01  -7.641 2.39e-14 ***
## X225         2.790e+01  2.222e+00  12.553  < 2e-16 ***
## X226        -2.730e+00  4.681e-01  -5.834 5.62e-09 ***
## X227         1.147e+00  1.126e-01  10.187  < 2e-16 ***
## X228        -4.355e-01  5.511e-02  -7.902 3.09e-15 ***
## X229         1.259e-01  2.306e-02   5.461 4.88e-08 ***
## X230         5.183e-02  1.993e-02   2.600 0.009335 **
## X231         3.000e-02  1.640e-02   1.829 0.067373 .
## X232         6.085e-02  1.597e-02   3.811 0.000139 ***
## X233         3.261e-02  1.587e-02   2.055 0.039954 *
## X234         1.049e-02  1.564e-02   0.671 0.502236
## X235        -4.300e-03  1.544e-02  -0.278 0.780688
## X236        -7.275e-03  1.570e-02  -0.464 0.643016
## X237        -1.272e-03  1.570e-02  -0.081 0.935443
## X238        -7.473e-03  1.541e-02  -0.485 0.627715
## X239        -2.455e-03  1.507e-02  -0.163 0.870559
## X240        -2.856e-02  1.445e-02  -1.977 0.048082 *
## X241        -1.849e-02  1.226e-02  -1.508 0.131636
## X242        -7.061e-03  7.515e-03  -0.940 0.347454
## X243        -3.270e-02  8.739e-03  -3.742 0.000184 ***
## X244        -2.791e-02  8.759e-03  -3.187 0.001444 **
## X245        -6.999e-03  8.931e-03  -0.784 0.433240
## X246        -3.213e-02  8.852e-03  -3.629 0.000286 ***
## X247        -1.453e-02  8.866e-03  -1.638 0.101374
## X248        -4.452e-03  8.806e-03  -0.506 0.613143
## X249        -3.513e-03  8.884e-03  -0.395 0.692499
## X250        -1.278e-02  8.786e-03  -1.454 0.145942
## X251         1.438e-02  8.894e-03   1.616 0.106039
## X252         4.840e-03  9.067e-03   0.534 0.593487
## X253        -5.895e-02  1.040e-02  -5.665 1.51e-08 ***
## X254         5.660e-02  1.955e-02   2.896 0.003791 **
## X255         2.085e-01  4.763e-02   4.377 1.22e-05 ***
## X256         2.841e-01  4.151e-02   6.845 8.22e-12 ***
## X257         2.923e+00  1.917e-01  15.248  < 2e-16 ***
## X258         3.151e+00  3.181e-01   9.908  < 2e-16 ***
## X259         3.285e+00  1.889e-01  17.391  < 2e-16 ***
## X260         3.757e-01  4.101e-02   9.162  < 2e-16 ***
## X261         1.233e-01  4.769e-02   2.586 0.009718 **
```

```
## X262         4.496e-02  1.933e-02   2.326 0.020043 *
## X263        -5.716e-02  1.040e-02  -5.497 3.97e-08 ***
## X264         7.213e-03  9.234e-03   0.781 0.434785
## X265         1.276e-02  8.933e-03   1.428 0.153275
## X266        -1.768e-02  8.885e-03  -1.990 0.046655 *
## X267        -5.160e-03  8.845e-03  -0.583 0.559652
## X268        -1.342e-02  8.732e-03  -1.537 0.124389
## X269        -1.333e-02  8.919e-03  -1.494 0.135176
## X270        -1.174e-02  8.931e-03  -1.314 0.188879
## X271        -1.100e-02  8.889e-03  -1.237 0.215946
## X272        -2.389e-02  8.855e-03  -2.697 0.007003 **
## X273        -3.212e-02  8.753e-03  -3.669 0.000245 ***
## X274        -1.413e-02  7.501e-03  -1.883 0.059688 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.05401 on 8339 degrees of freedom
## Multiple R-squared:  0.9382, Adjusted R-squared:  0.9365
## F-statistic:   555 on 228 and 8339 DF,  p-value: < 2.2e-16
```

```
modelMx2
```

```
## glmnet
##
## 8568 samples
##  274 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 7712, 7712, 7712, 7710, 7711, 7710, ...
## Resampling results across tuning parameters:
##
##   lambda        RMSE        Rsquared
##   3.051758e-05  0.07971504  0.8644663
##   6.103516e-05  0.07971504  0.8644663
##   1.220703e-04  0.07971504  0.8644663
##   2.441406e-04  0.07971504  0.8644663
##   4.882812e-04  0.07971504  0.8644663
##   9.765625e-04  0.07971504  0.8644663
##   1.953125e-03  0.07971504  0.8644663
##   3.906250e-03  0.07971504  0.8644663
##   7.812500e-03  0.07971504  0.8644663
##   1.562500e-02  0.08282499  0.8543000
##   3.125000e-02  0.08979045  0.8315567
##   6.250000e-02  0.09762601  0.8077803
##   1.250000e-01  0.10771172  0.7816958
##   2.500000e-01  0.12189800  0.7485536
##   5.000000e-01  0.14039598  0.7000294
##   1.000000e+00  0.16033054  0.6322984
##   2.000000e+00  0.17801147  0.5564377
##   4.000000e+00  0.19168102  0.4905501
##   8.000000e+00  0.20110024  0.4451311
##   1.600000e+01  0.20703848  0.4177690
##   3.200000e+01  0.21045272  0.4028826
```

```
##   6.400000e+01  0.21231212  0.3950102
##   1.280000e+02  0.21428407        NaN
##   2.560000e+02  0.21428407        NaN
##   5.120000e+02  0.21428407        NaN
##   1.024000e+03  0.21428407        NaN
##   2.048000e+03  0.21428407        NaN
##   4.096000e+03  0.21428407        NaN
##   8.192000e+03  0.21428407        NaN
##   1.638400e+04  0.21428407        NaN
##   3.276800e+04  0.21428407        NaN
##
## Tuning parameter 'alpha' was held constant at a value of 0
## RMSE was used to select the optimal model using  the smallest value.
## The final values used for the model were alpha = 0 and lambda = 0.0078125.
```

```
summary(modelMyc)
```

```
##
## Call:
## lm(formula = .outcome ~ ., data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.64188 -0.13941 -0.01564  0.11437  1.58588
##
## Coefficients: (47 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.204e+01  1.552e+01   3.998 6.46e-05 ***
## X1           6.865e-03  1.095e-02   0.627 0.530573
## X2          -2.777e-03  8.109e-03  -0.343 0.731975
## X3          -5.123e-03  8.044e-03  -0.637 0.524262
## X4                  NA         NA      NA       NA
## X5          -3.385e-02  1.510e-02  -2.242 0.025014 *
## X6          -4.078e-03  1.219e-02  -0.334 0.738035
## X7          -3.164e-02  1.047e-02  -3.022 0.002519 **
## X8                  NA         NA      NA       NA
## X9          -4.240e-02  1.947e-02  -2.177 0.029505 *
## X10         -2.653e-02  1.999e-02  -1.327 0.184604
## X11         -4.699e-02  2.169e-02  -2.167 0.030293 *
## X12                 NA         NA      NA       NA
## X13         -1.379e-02  1.941e-02  -0.711 0.477384
## X14          1.477e-02  2.041e-02   0.724 0.469314
## X15         -1.605e-02  2.061e-02  -0.779 0.436168
## X16                 NA         NA      NA       NA
## X17         -2.466e-02  2.010e-02  -1.227 0.220001
## X18          2.013e-02  2.083e-02   0.966 0.333953
## X19         -1.340e-02  2.138e-02  -0.627 0.530907
## X20                 NA         NA      NA       NA
## X21         -4.821e-02  2.049e-02  -2.352 0.018680 *
## X22         -3.799e-02  2.094e-02  -1.814 0.069690 .
## X23          1.010e-02  2.116e-02   0.477 0.633248
## X24                 NA         NA      NA       NA
## X25         -5.482e-03  2.048e-02  -0.268 0.788963
## X26          2.386e-02  2.122e-02   1.124 0.260968
```

```
## X27         -3.426e-02  2.110e-02  -1.624 0.104470
## X28                 NA         NA      NA       NA
## X29         -3.182e-02  2.049e-02  -1.553 0.120425
## X30         -1.874e-02  2.142e-02  -0.875 0.381671
## X31         -4.175e-02  2.104e-02  -1.984 0.047292 *
## X32                 NA         NA      NA       NA
## X33          2.962e-02  2.071e-02   1.430 0.152640
## X34          1.266e-02  2.088e-02   0.606 0.544464
## X35         -8.782e-04  2.099e-02  -0.042 0.966637
## X36                 NA         NA      NA       NA
## X37         -6.430e-02  2.035e-02  -3.159 0.001588 **
## X38         -3.462e-02  2.124e-02  -1.630 0.103205
## X39         -2.467e-02  2.143e-02  -1.151 0.249663
## X40                 NA         NA      NA       NA
## X41         -1.908e-02  2.051e-02  -0.931 0.352044
## X42          1.816e-02  2.147e-02   0.846 0.397720
## X43         -4.327e-02  2.155e-02  -2.008 0.044678 *
## X44                 NA         NA      NA       NA
## X45         -6.712e-03  2.083e-02  -0.322 0.747277
## X46         -2.501e-02  2.163e-02  -1.157 0.247473
## X47         -5.572e-03  2.225e-02  -0.250 0.802242
## X48                 NA         NA      NA       NA
## X49         -2.594e-02  2.238e-02  -1.159 0.246385
## X50         -3.398e-02  2.272e-02  -1.495 0.134897
## X51          9.948e-02  2.367e-02   4.204 2.66e-05 ***
## X52                 NA         NA      NA       NA
## X53          5.264e-01  4.005e-02  13.144  < 2e-16 ***
## X54          2.045e-01  3.306e-02   6.185 6.58e-10 ***
## X55          1.953e-01  2.803e-02   6.967 3.55e-12 ***
## X56                 NA         NA      NA       NA
## X57          4.696e+00  2.787e-01  16.850  < 2e-16 ***
## X58          3.821e+00  1.907e-01  20.032  < 2e-16 ***
## X59          2.620e+00  1.778e-01  14.732  < 2e-16 ***
## X60                 NA         NA      NA       NA
## X61         -5.276e+00  6.929e-01  -7.614 3.01e-14 ***
## X62                 NA         NA      NA       NA
## X63                 NA         NA      NA       NA
## X64                 NA         NA      NA       NA
## X65         -1.031e+01  9.819e-01 -10.496  < 2e-16 ***
## X66                 NA         NA      NA       NA
## X67          1.075e+00  2.467e-01   4.356 1.34e-05 ***
## X68                 NA         NA      NA       NA
## X69                 NA         NA      NA       NA
## X70          2.086e+00  7.240e-01   2.882 0.003970 **
## X71                 NA         NA      NA       NA
## X72                 NA         NA      NA       NA
## X73         -2.121e+00  7.350e-01  -2.885 0.003926 **
## X74                 NA         NA      NA       NA
## X75                 NA         NA      NA       NA
## X76                 NA         NA      NA       NA
## X77          1.095e+01  9.951e-01  11.000  < 2e-16 ***
## X78          1.160e+01  1.006e+00  11.530  < 2e-16 ***
## X79                 NA         NA      NA       NA
## X80                 NA         NA      NA       NA
```

```
## X81                NA         NA      NA       NA
## X82                NA         NA      NA       NA
## X83         4.607e+00  7.117e-01   6.472 1.03e-10 ***
## X84                NA         NA      NA       NA
## X85                NA         NA      NA       NA
## X86        -1.635e+00  1.732e-01  -9.444  < 2e-16 ***
## X87        -4.582e-01  1.395e-01  -3.285 0.001023 **
## X88                NA         NA      NA       NA
## X89        -4.798e-01  4.071e-02 -11.785  < 2e-16 ***
## X90        -2.824e-01  4.390e-02  -6.434 1.33e-10 ***
## X91        -2.658e-01  3.964e-02  -6.705 2.18e-11 ***
## X92                NA         NA      NA       NA
## X93         5.371e-02  2.180e-02   2.464 0.013755 *
## X94         1.734e-01  2.288e-02   7.576 4.04e-14 ***
## X95         4.412e-02  2.424e-02   1.820 0.068799 .
## X96                NA         NA      NA       NA
## X97        -3.047e-02  2.071e-02  -1.471 0.141321
## X98        -5.908e-02  2.172e-02  -2.720 0.006540 **
## X99        -5.906e-02  2.136e-02  -2.765 0.005708 **
## X100               NA         NA      NA       NA
## X101        1.246e-02  2.090e-02   0.596 0.551313
## X102       -2.343e-02  2.090e-02  -1.121 0.262318
## X103       -7.444e-04  2.098e-02  -0.035 0.971701
## X104               NA         NA      NA       NA
## X105        4.370e-02  2.090e-02   2.091 0.036528 *
## X106        3.760e-02  2.113e-02   1.779 0.075217 .
## X107        1.291e-02  2.114e-02   0.611 0.541471
## X108               NA         NA      NA       NA
## X109        3.229e-02  2.059e-02   1.568 0.116875
## X110        2.162e-02  2.157e-02   1.002 0.316416
## X111        5.888e-03  2.107e-02   0.279 0.779924
## X112               NA         NA      NA       NA
## X113        4.705e-02  2.030e-02   2.317 0.020533 *
## X114        2.772e-02  2.100e-02   1.320 0.186917
## X115        1.316e-02  2.086e-02   0.631 0.527930
## X116               NA         NA      NA       NA
## X117        3.311e-02  2.025e-02   1.636 0.101977
## X118        2.183e-02  2.088e-02   1.045 0.295832
## X119        7.049e-02  2.108e-02   3.343 0.000833 ***
## X120               NA         NA      NA       NA
## X121        7.509e-03  2.006e-02   0.374 0.708236
## X122       -2.742e-02  2.145e-02  -1.278 0.201195
## X123       -8.417e-03  2.107e-02  -0.400 0.689487
## X124               NA         NA      NA       NA
## X125        3.535e-02  2.017e-02   1.753 0.079701 .
## X126       -2.991e-02  2.142e-02  -1.396 0.162614
## X127        9.079e-03  2.057e-02   0.441 0.658936
## X128               NA         NA      NA       NA
## X129        1.408e-02  1.983e-02   0.710 0.477934
## X130       -9.406e-03  2.112e-02  -0.445 0.656024
## X131        2.315e-02  2.052e-02   1.128 0.259215
## X132               NA         NA      NA       NA
## X133        9.073e-02  1.920e-02   4.727 2.33e-06 ***
## X134        6.467e-02  2.114e-02   3.059 0.002231 **
```

```
## X135         9.430e-02  1.902e-02   4.957 7.32e-07 ***
## X136                NA         NA      NA       NA
## X137        -4.194e-03  1.525e-02  -0.275 0.783351
## X138        -7.491e-03  1.296e-02  -0.578 0.563247
## X139         1.227e-03  1.198e-02   0.102 0.918414
## X140                NA         NA      NA       NA
## X141        -3.325e-02  1.083e-02  -3.071 0.002143 **
## X142        -3.360e-02  9.762e-03  -3.442 0.000581 ***
## X143        -3.876e-02  1.060e-02  -3.657 0.000257 ***
## X144                NA         NA      NA       NA
## X145        -2.632e-02  6.793e-02  -0.387 0.698431
## X146        -1.169e-01  7.531e-02  -1.552 0.120691
## X147         1.036e-02  7.425e-02   0.140 0.888998
## X148        -1.631e-01  7.414e-02  -2.199 0.027880 *
## X149        -1.726e-01  7.396e-02  -2.333 0.019668 *
## X150        -1.340e-01  7.563e-02  -1.771 0.076549 .
## X151        -1.523e-01  7.380e-02  -2.064 0.039102 *
## X152         2.841e-02  7.469e-02   0.380 0.703651
## X153        -8.316e-02  7.580e-02  -1.097 0.272633
## X154        -6.782e-02  7.813e-02  -0.868 0.385389
## X155        -1.065e-01  8.441e-02  -1.262 0.207134
## X156        -9.519e-02  1.047e-01  -0.909 0.363455
## X157         3.057e-01  1.341e-01   2.279 0.022706 *
## X158         1.537e-01  1.637e-01   0.939 0.347822
## X159         2.006e+01  1.241e+00  16.164  < 2e-16 ***
## X160        -2.026e+01  2.390e+00  -8.477  < 2e-16 ***
## X161        -1.426e+01  2.412e+00  -5.911 3.56e-09 ***
## X162         1.888e+01  1.254e+00  15.050  < 2e-16 ***
## X163         5.195e-01  1.658e-01   3.133 0.001737 **
## X164         7.918e-02  1.370e-01   0.578 0.563270
## X165         6.935e-02  1.053e-01   0.658 0.510345
## X166        -3.647e-02  8.395e-02  -0.434 0.663990
## X167        -2.121e-01  7.892e-02  -2.687 0.007220 **
## X168        -1.419e-01  7.773e-02  -1.825 0.068029 .
## X169        -1.899e-01  7.498e-02  -2.533 0.011343 *
## X170        -2.007e-02  7.433e-02  -0.270 0.787199
## X171        -6.013e-02  7.474e-02  -0.804 0.421142
## X172         5.525e-02  7.526e-02   0.734 0.462837
## X173         3.618e-02  7.460e-02   0.485 0.627667
## X174        -1.949e-01  7.475e-02  -2.608 0.009141 **
## X175        -7.083e-02  7.443e-02  -0.952 0.341295
## X176         9.964e-02  6.970e-02   1.430 0.152884
## X177         2.572e-02  4.285e-02   0.600 0.548344
## X178        -8.929e-02  4.293e-02  -2.080 0.037570 *
## X179        -2.601e-02  4.548e-02  -0.572 0.567337
## X180        -1.066e-01  4.436e-02  -2.402 0.016316 *
## X181        -7.411e-02  4.451e-02  -1.665 0.095938 .
## X182        -1.072e-02  4.501e-02  -0.238 0.811762
## X183        -3.108e-02  4.484e-02  -0.693 0.488184
## X184        -2.615e-02  4.472e-02  -0.585 0.558692
## X185         3.863e-02  4.517e-02   0.855 0.392547
## X186         5.785e-02  4.442e-02   1.303 0.192790
## X187        -5.789e-02  4.988e-02  -1.161 0.245824
## X188        -1.182e-01  5.933e-02  -1.993 0.046341 *
```

```
## X189         9.227e-02  1.116e-01   0.827 0.408458
## X190         2.239e-01  3.692e-01   0.606 0.544209
## X191         6.087e+00  6.745e-01   9.024  < 2e-16 ***
## X192        -2.012e+01  2.892e+00  -6.957 3.81e-12 ***
## X193        -1.986e+01  2.866e+00  -6.929 4.63e-12 ***
## X194         5.293e+00  6.954e-01   7.612 3.08e-14 ***
## X195        -5.161e-01  3.781e-01  -1.365 0.172286
## X196         1.151e-01  1.142e-01   1.008 0.313603
## X197        -2.581e-01  6.071e-02  -4.251 2.15e-05 ***
## X198        -1.754e-01  5.113e-02  -3.429 0.000608 ***
## X199         1.218e-01  4.547e-02   2.678 0.007429 **
## X200         2.286e-02  4.488e-02   0.509 0.610491
## X201        -2.121e-02  4.498e-02  -0.472 0.637296
## X202        -4.003e-02  4.459e-02  -0.898 0.369297
## X203        -3.493e-03  4.392e-02  -0.080 0.936607
## X204        -1.203e-01  4.431e-02  -2.715 0.006643 **
## X205         7.028e-02  4.478e-02   1.569 0.116582
## X206        -3.923e-02  4.465e-02  -0.879 0.379592
## X207        -6.928e-03  4.503e-02  -0.154 0.877729
## X208        -1.187e-01  4.299e-02  -2.762 0.005766 **
## X209         2.265e-02  5.463e-02   0.415 0.678393
## X210         4.947e-02  6.482e-02   0.763 0.445416
## X211         5.047e-02  6.753e-02   0.747 0.454887
## X212         5.881e-02  6.941e-02   0.847 0.396823
## X213         2.066e-01  6.886e-02   3.000 0.002705 **
## X214         1.988e-01  6.897e-02   2.882 0.003965 **
## X215         1.373e-01  6.915e-02   1.985 0.047148 *
## X216         1.462e-01  6.901e-02   2.119 0.034157 *
## X217         6.416e-02  7.132e-02   0.900 0.368318
## X218         6.723e-02  7.159e-02   0.939 0.347732
## X219         1.863e-01  7.469e-02   2.495 0.012620 *
## X220         9.886e-02  8.874e-02   1.114 0.265291
## X221         6.974e-01  1.082e-01   6.447 1.22e-10 ***
## X222        -8.511e-01  2.665e-01  -3.194 0.001411 **
## X223         7.012e-01  7.701e-01   0.910 0.362609
## X224        -4.124e+01  2.992e+00 -13.785  < 2e-16 ***
## X225        -5.844e+01  1.317e+01  -4.436 9.30e-06 ***
## X226        -4.252e+01  3.086e+00 -13.776  < 2e-16 ***
## X227         1.107e+00  7.903e-01   1.401 0.161178
## X228        -1.257e+00  2.768e-01  -4.541 5.69e-06 ***
## X229         3.437e-01  1.084e-01   3.171 0.001527 **
## X230         2.072e-03  9.053e-02   0.023 0.981743
## X231         1.731e-01  7.448e-02   2.324 0.020168 *
## X232         2.913e-01  7.162e-02   4.067 4.82e-05 ***
## X233         2.159e-01  7.120e-02   3.032 0.002438 **
## X234         1.216e-01  6.883e-02   1.766 0.077405 .
## X235         4.363e-02  6.914e-02   0.631 0.527985
## X236        -3.849e-02  6.978e-02  -0.552 0.581192
## X237         1.687e-02  6.922e-02   0.244 0.807412
## X238         1.173e-01  6.805e-02   1.724 0.084744 .
## X239         1.531e-01  6.761e-02   2.264 0.023580 *
## X240        -1.291e-02  6.448e-02  -0.200 0.841279
## X241         2.123e-02  5.552e-02   0.382 0.702238
## X242         1.297e-02  3.361e-02   0.386 0.699476
```

```
## X243        -8.894e-02  3.941e-02  -2.257 0.024040 *
## X244        -8.052e-02  3.938e-02  -2.045 0.040890 *
## X245        -1.300e-02  4.058e-02  -0.320 0.748812
## X246        -1.758e-01  3.991e-02  -4.406 1.07e-05 ***
## X247        -5.154e-02  3.992e-02  -1.291 0.196699
## X248        -3.287e-02  3.961e-02  -0.830 0.406713
## X249         3.983e-02  3.988e-02   0.999 0.317937
## X250        -4.924e-02  3.946e-02  -1.248 0.212122
## X251         8.983e-02  4.036e-02   2.226 0.026073 *
## X252         4.830e-02  4.120e-02   1.172 0.241150
## X253        -8.152e-02  4.684e-02  -1.741 0.081809 .
## X254         3.696e-01  9.357e-02   3.950 7.88e-05 ***
## X255         3.395e-01  2.016e-01   1.684 0.092216 .
## X256         6.906e-03  2.546e-01   0.027 0.978357
## X257         1.186e+01  1.410e+00   8.413  < 2e-16 ***
## X258         3.123e+01  1.593e+00  19.598  < 2e-16 ***
## X259         1.217e+01  1.437e+00   8.467  < 2e-16 ***
## X260         2.160e-01  2.606e-01   0.829 0.407075
## X261        -5.473e-02  2.071e-01  -0.264 0.791627
## X262         1.123e-01  9.463e-02   1.186 0.235554
## X263        -2.010e-01  4.706e-02  -4.271 1.97e-05 ***
## X264        -2.474e-02  4.180e-02  -0.592 0.553919
## X265         2.278e-02  4.014e-02   0.568 0.570332
## X266        -4.494e-02  3.976e-02  -1.130 0.258392
## X267         1.643e-02  3.944e-02   0.417 0.677053
## X268         2.972e-02  3.931e-02   0.756 0.449591
## X269         5.757e-02  3.949e-02   1.458 0.144920
## X270         9.824e-03  4.039e-02   0.243 0.807824
## X271         3.863e-03  4.007e-02   0.096 0.923206
## X272        -2.920e-02  4.004e-02  -0.729 0.465852
## X273        -8.606e-02  3.978e-02  -2.163 0.030555 *
## X274        -1.925e-02  3.360e-02  -0.573 0.566744
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2188 on 6698 degrees of freedom
## Multiple R-squared:  0.9263, Adjusted R-squared:  0.9238
## F-statistic: 370.8 on 227 and 6698 DF,  p-value: < 2.2e-16
```

```
modelMyc2
```

```
## glmnet
##
## 6926 samples
##  274 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 6234, 6234, 6232, 6234, 6233, 6233, ...
## Resampling results across tuning parameters:
##
##   lambda        RMSE       Rsquared
##   3.051758e-05  0.3044978  0.8550450
##   6.103516e-05  0.3044978  0.8550450
```

```
##   1.220703e-04  0.3044978  0.8550450
##   2.441406e-04  0.3044978  0.8550450
##   4.882812e-04  0.3044978  0.8550450
##   9.765625e-04  0.3044978  0.8550450
##   1.953125e-03  0.3044978  0.8550450
##   3.906250e-03  0.3044978  0.8550450
##   7.812500e-03  0.3044978  0.8550450
##   1.562500e-02  0.3044978  0.8550450
##   3.125000e-02  0.3044978  0.8550450
##   6.250000e-02  0.3238855  0.8370852
##   1.250000e-01  0.3478227  0.8154769
##   2.500000e-01  0.3754777  0.7937382
##   5.000000e-01  0.4135148  0.7697796
##   1.000000e+00  0.4691556  0.7379471
##   2.000000e+00  0.5402967  0.6916609
##   4.000000e+00  0.6140693  0.6300944
##   8.000000e+00  0.6769559  0.5640469
##   1.600000e+01  0.7232160  0.5077882
##   3.200000e+01  0.7535233  0.4683717
##   6.400000e+01  0.7715599  0.4445622
##   1.280000e+02  0.7816079  0.4312866
##   2.560000e+02  0.7869168  0.4243144
##   5.120000e+02  0.7924673        NaN
##   1.024000e+03  0.7924673        NaN
##   2.048000e+03  0.7924673        NaN
##   4.096000e+03  0.7924673        NaN
##   8.192000e+03  0.7924673        NaN
##   1.638400e+04  0.7924673        NaN
##   3.276800e+04  0.7924673        NaN
##
## Tuning parameter 'alpha' was held constant at a value of 0
## RMSE was used to select the optimal model using  the smallest value.
## The final values used for the model were alpha = 0 and lambda = 0.03125.
```