Assignment 2

Assignment 2 - S1665110 Ishaan

Biomedical Data Science

Due on Thursday 18th March 2020, 5:00pm

The assignment is marked out of 100 points, and will contribute to 30% of your final mark. Please knit this document in PDF format and submit using the gradescope link on Learn. If you can't knit to PDF directly, knit it to word and you should be able to either convert to PDF or print it and scan to PDF using a scanning app on your phone. If you have any code that doesn't run you won't be able to knit the document so comment it as you might still get some grades for partial code. Clear and reusable code will be rewarded so pay attention to indentation, choice of variable identifiers, comments, error checking, etc. An initial code chunk is provided after each subquestion but create as many chunks as you feel is necessary to make a clear report. Add plain text explanations in between the chunks as and when required and any comments necessary within code chunks to make it easier to follow your code/reasoning.

Problem 1 (27 points)

File wdbc2.csv (available from the accompanying zip folder on Learn) refers to a study of breast cancer where the outcome of interest is the type of the tumour (benign or malignant, recorded in column "diagnosis"). The study collected 30 imaging biomarkers on 569 patients.

Problem 1.a (7 points)

Using package caret, create a data partition so that the training set contains 70% of the observations (set the random seed to 984065 beforehand). Fit both a ridge regression model and a lasso model which uses cross-validation on the training set to diagnose the type of tumour from the 30 biomarkers. Then use a plot to help identify the penalty parameter λ that maximizes the AUC. Note: There is no need to use the prepare.glmnet() function from lab 4, using as.matrix() with the required columns is sufficient.

```
#Load the required libraries
library(caret)
```

```
## Loading required package: lattice
```

```
## Loading required package: ggplot2
```

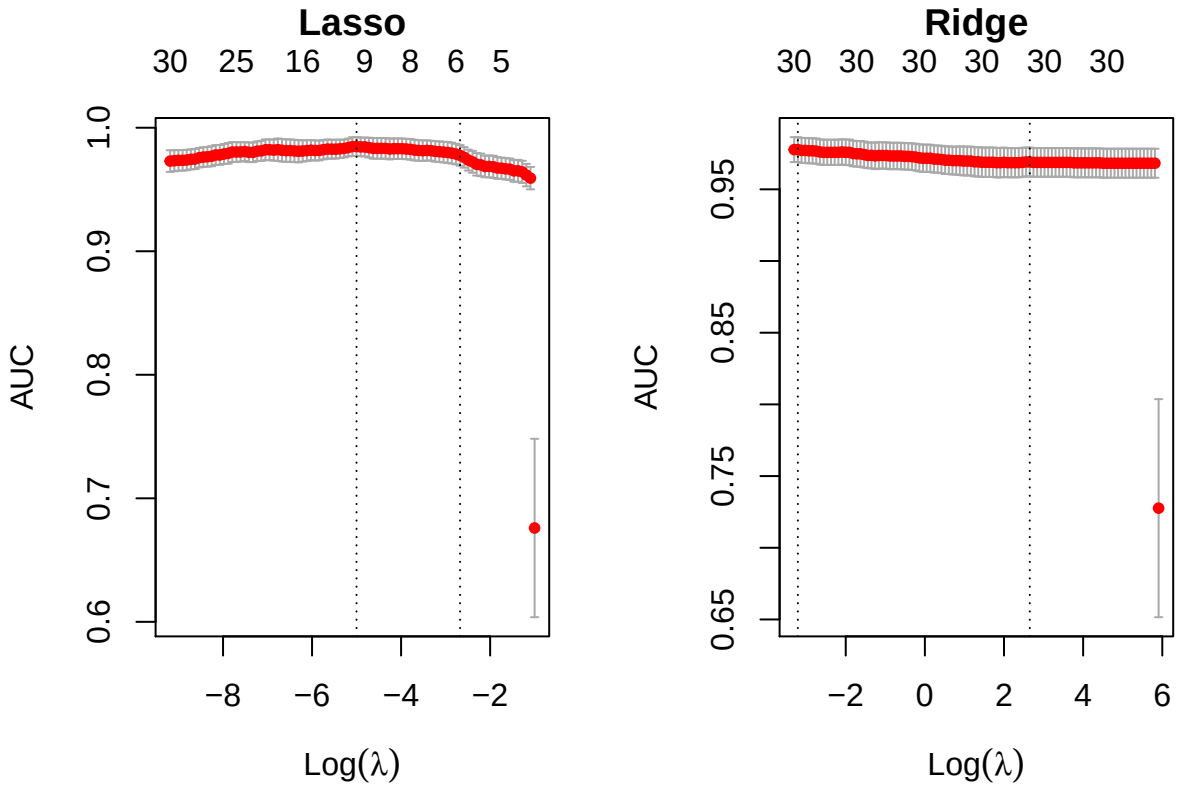
```
library(data.table)
library(glmnet)
```

```
## Loading required package: Matrix
```

```
## Loaded glmnet 4.1-1
```

```
library(magrittr)


set.seed(984065)

#Read the file as required
```

```r
breast_cancer<- fread("assignment2/wdbc2.csv", sep =',',
                  stringsAsFactors = T)

# Change the diagnosis factor to a numerical value
breast_cancer$diagnosis = as.numeric(breast_cancer$diagnosis, levels=c('benign', 'malignant'), labels=c
breast_cancer$diagnosis[breast_cancer$diagnosis == 1 ] =0
breast_cancer$diagnosis[breast_cancer$diagnosis == 2 ] =1


# we split into 70% training and 30% testing data
split_index <- createDataPartition(breast_cancer$diagnosis,
                                   p = .7, list = FALSE, times = 1)


#train and test data sets
train_breast_cancer <- breast_cancer[split_index, ]
test_breast_cancer <- breast_cancer[-split_index, ]

#-- We first prepare the training data

# Input matrix
biomarkers_matrix.x <- as.matrix(subset(train_breast_cancer, select = -c(id, diagnosis)))

biomakers_matrix_predictors.y <- as.matrix(subset(train_breast_cancer, select = c(diagnosis)))



#  We fit the ridge regression on training data
fit.ridge = cv.glmnet(biomarkers_matrix.x, biomakers_matrix_predictors.y , alpha = 0, family = "binomial


# We fit the Lasso regression on training data

fit.lasso = cv.glmnet(biomarkers_matrix.x, biomakers_matrix_predictors.y , alpha = 1, family = "binomial

par(mfrow=c(1,2), mar=c(4,4,5,2))
plot(fit.lasso, main="Lasso")
plot(fit.ridge, main="Ridge")
```




```
cat("The values of lambda for lasso that maximises the AUC is:", fit.lasso$lambda.min,"\n")
```

```
## The values of lambda for lasso that maximises the AUC is: 0.006732317
```

```
cat("The values of lambda for ridge that maximises the AUC is:", fit.ridge$lambda.min,"\n")
```

```
## The values of lambda for ridge that maximises the AUC is: 0.04035918
```

From the plots we can see that the best AUC for Lasso is obtained approximately in log(lambda) = -5 (i.e. exp(-5)), and for the Ridge regression in log(lambda) - -3 (i.e. exp(-3)). These are approximate values only. ### Problem 1.b (2 points)

Create a data table that for each value of 'lambda.min' and 'lambda.1se' for each model fitted in problem 1.a reports: * the corresponding AUC, * the corresponding model size. Use 3 significant digits for floating point values and comment on these results. Hint: The AUC values are stored in the field called 'cvm'.

```
#Our Lambdas

lambdamin.lasso = fit.lasso$lambda.min
lambdamin.ridge = fit.ridge$lambda.min

# We will need to find the position at which lambda min is located at lambda

index_lambdamin.lasso= which(lambdamin.lasso ==fit.lasso$lambda)
index_lambdamin.ridge= which(lambdamin.ridge ==fit.ridge$lambda)

#Now we find the position at which lambda lse is located
```

```
#lambda lse is the largest value of lambda that is located within 1 standard error

lambda1se.lasso = fit.lasso$lambda.1se
lambda1se.ridge = fit.ridge$lambda.1se

# We will need to find the position at which lambda lse is located at lambda
index_lambda1se.lasso= which(lambda1se.lasso ==fit.lasso$lambda)
index_lambda1se.ridge= which(lambda1se.ridge ==fit.ridge$lambda)

#We can find the corresponding AUC's

AUC.lambdamin.lasso = signif(fit.lasso$cvm[index_lambdamin.lasso],3)
AUC.lambda1se.lasso = signif(fit.lasso$cvm[index_lambda1se.lasso],3)

AUC.lambdamin.ridge = signif(fit.ridge$cvm[index_lambdamin.ridge],3)
AUC.lambda1se.ridge = signif(fit.ridge$cvm[index_lambda1se.ridge],3)

AUC.lambdamin.lasso
```

```
## [1] 0.985
```

```
AUC.lambda1se.lasso
```

```
## [1] 0.978
```

```
AUC.lambdamin.ridge
```

```
## [1] 0.978
```

```
AUC.lambda1se.ridge
```

```
## [1] 0.969
```

```
#We make  a table:

table1 <-data.table(model = c("Lasso (min)", "Lasso (1se)", "Ridge  (min)", "Ridge (1se)"),Lambda = c(la

table1
```

```
##           model       Lambda   AUC
## 1:  Lasso (min)  0.006732317 0.985
## 2:  Lasso (1se)  0.068907355 0.978
## 3: Ridge  (min)  0.040359182 0.978
## 4:  Ridge (1se) 14.170882485 0.969
```

Problem 1.c (7 points)

Perform both backward (we'll later refer to this as model B) and forward (model S) stepwise selection on the same training set derived in problem 1.a. Report the variables selected and their standardized regression coefficients in decreasing order of the absolute value of their standardized regression coefficient. Discuss the results and how the different variables entering or leaving the model influenced the final result.

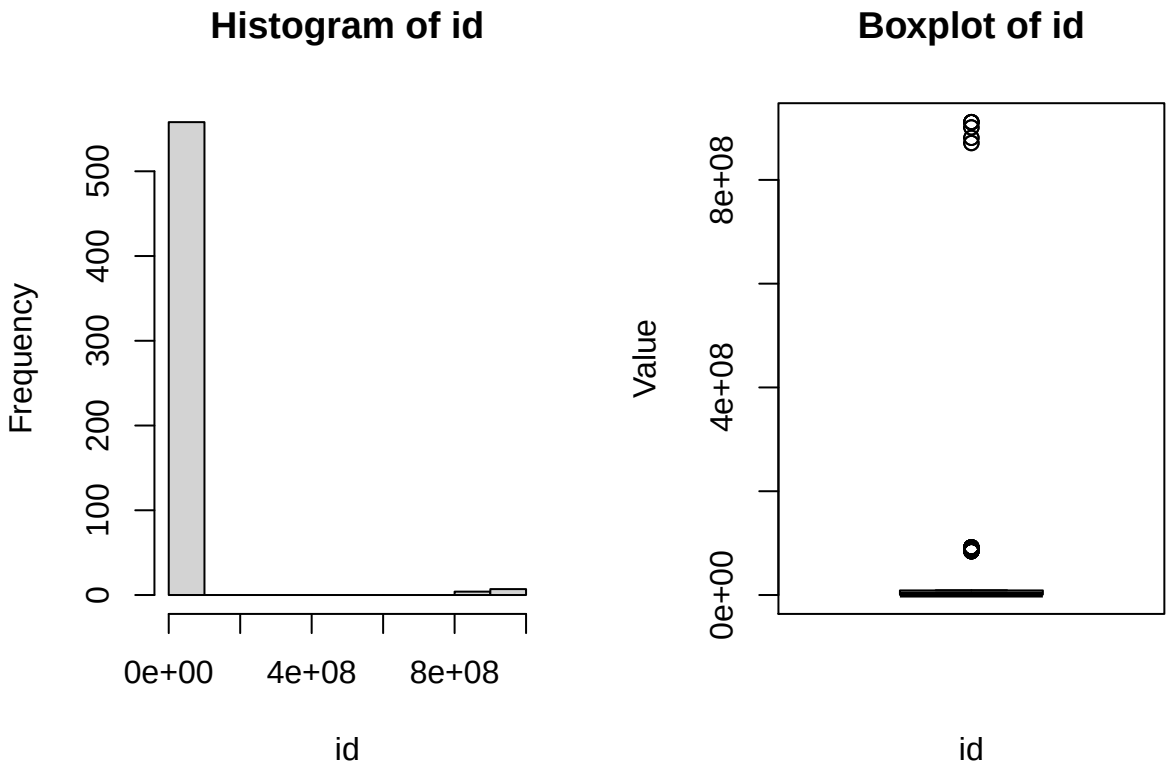
```
library(dplyr)
```

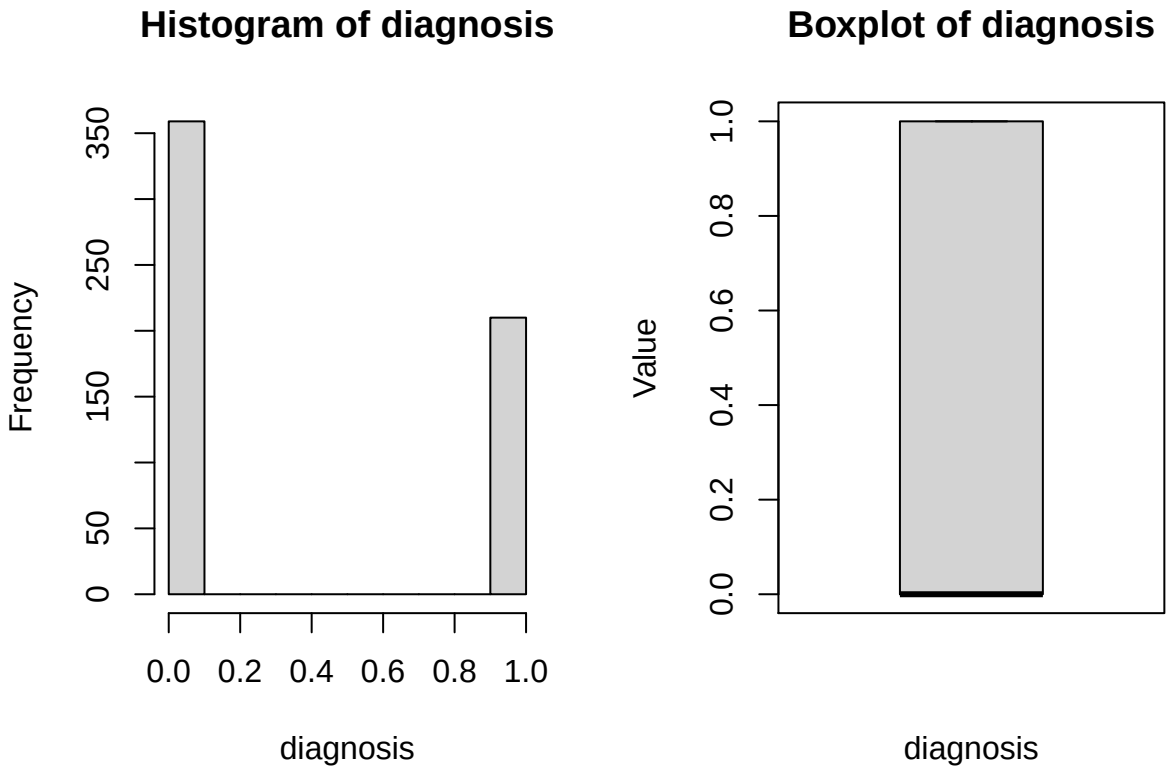
```
##
## Attaching package: 'dplyr'
```

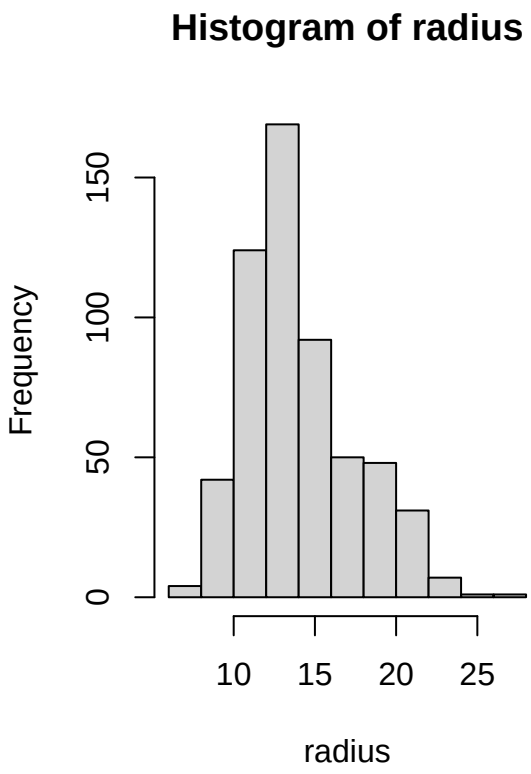
```
## The following objects are masked from 'package:data.table':
##
```

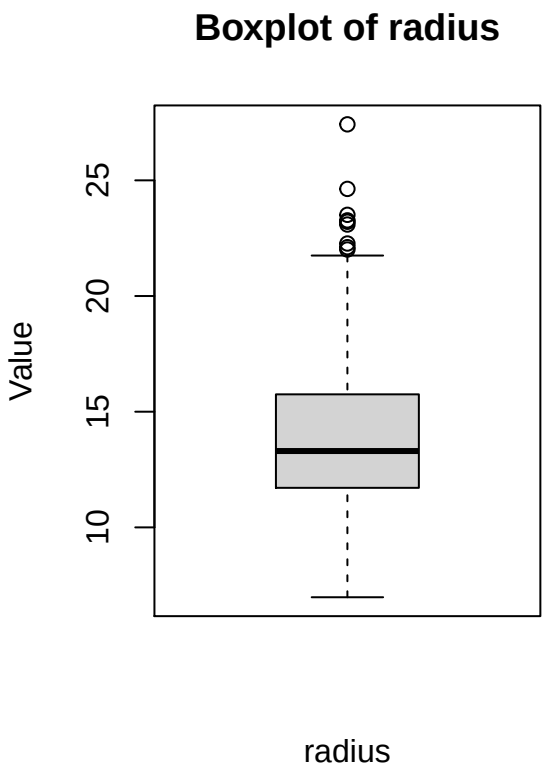
```
##     between, first, last
## The following objects are masked from 'package:stats':
##
##     filter, lag
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

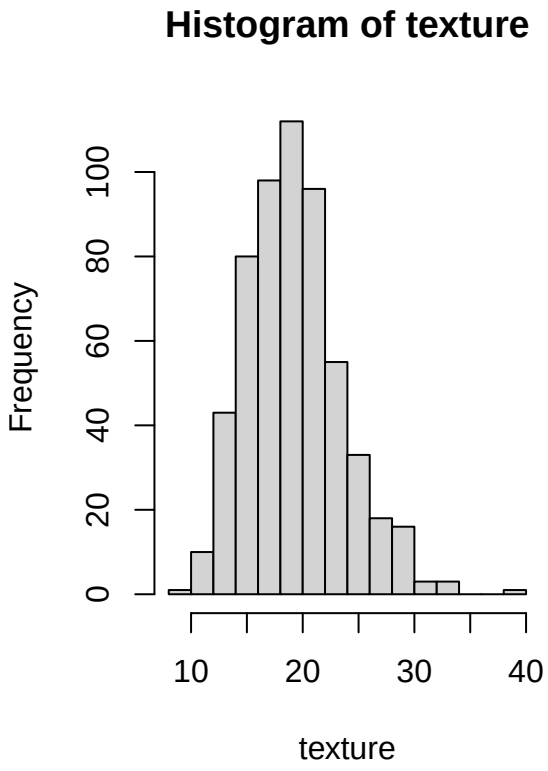
```r
library(knitr)

sbsplot <- function(varname, vars){
  par(mfrow = c(1,2))

  hist(vars[,varname],
       main = paste0("Histogram of ", varname),xlab = varname)
  boxplot(vars[,varname],
       main = paste0("Boxplot of ", varname),xlab = varname,
       ylab = "Value")

}

# We make a histogram and bar plot just to see which predictors are the best
numcols = breast_cancer %>% select_if(is.numeric) %>% colnames
sapply(numcols, sbsplot, vars = data.frame(breast_cancer))
```

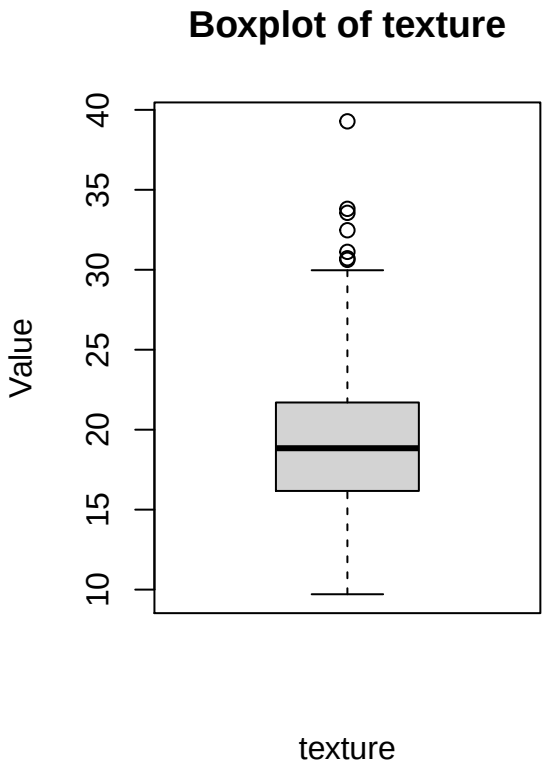


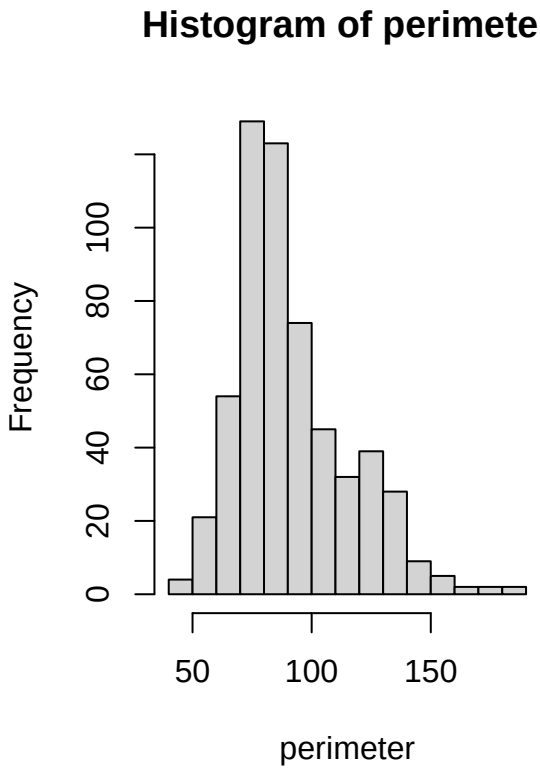

Histogram of diagnosis
Frequency
0
50
150
250
350
0.0
0.2
0.4
0.6
0.8
1.0
diagnosis
Boxplot of diagnosis
Value
0.0
0.2
0.4
0.6
0.8
1.0
diagnosis

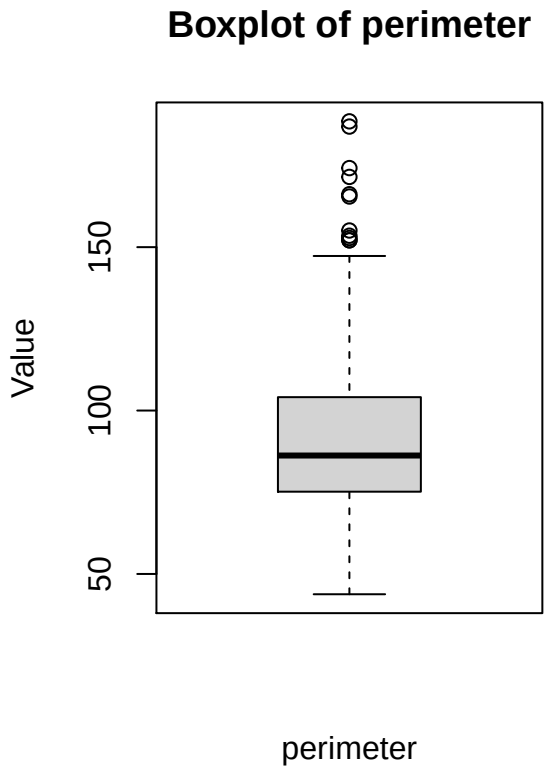

Histogram of radius
Frequency
0
50
100
150
10
15
20
25
radius

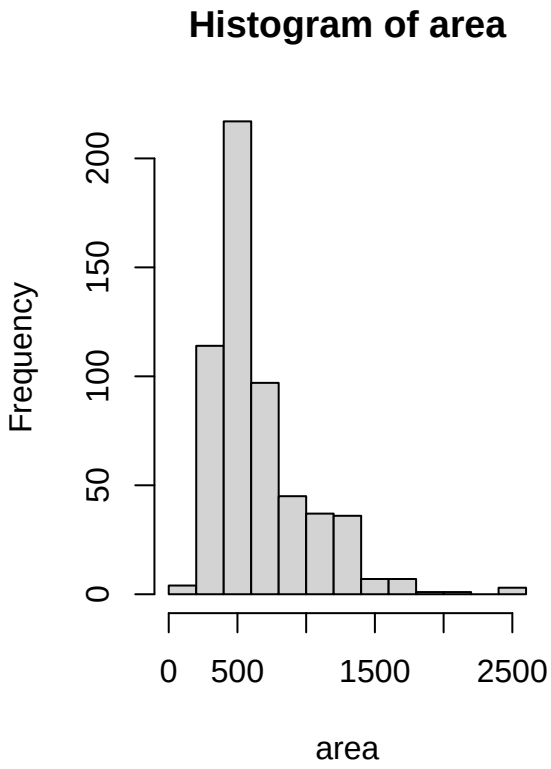

Boxplot of radius
Value
10
15
20
25
radius

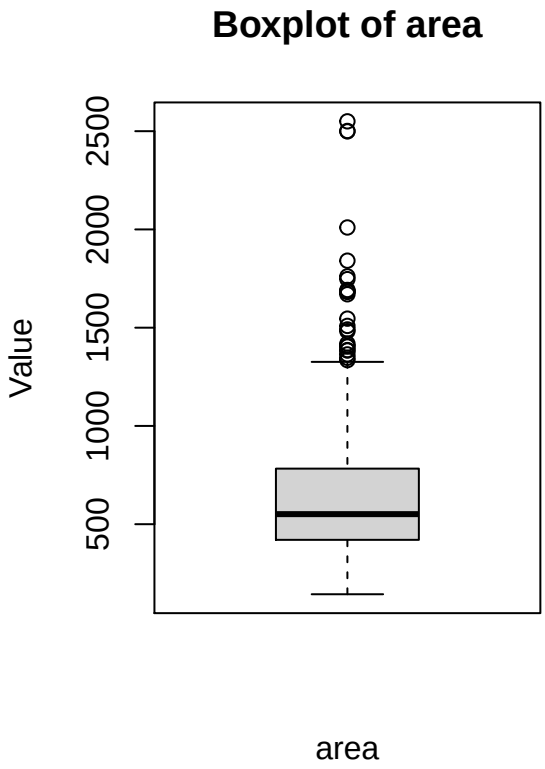

Histogram of texture
Frequency
0
20
40
60
80
100
10
20
30
40
texture

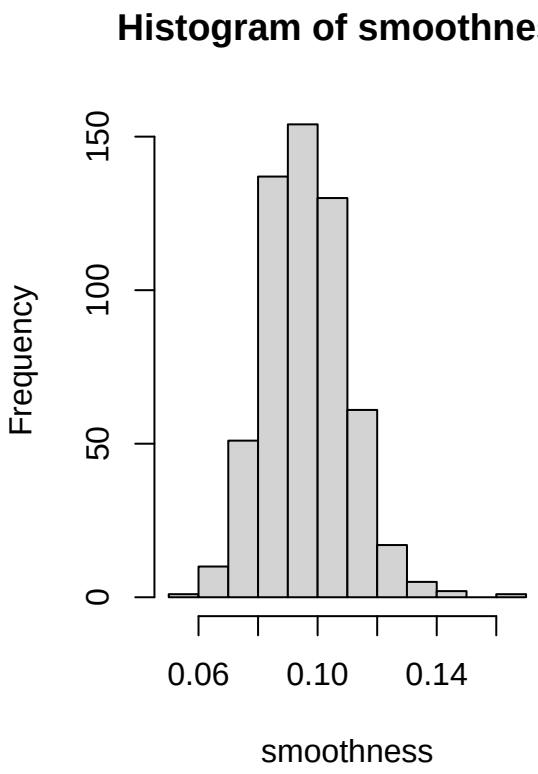

Boxplot of texture
Value
10
15
20
25
30
35
40
texture

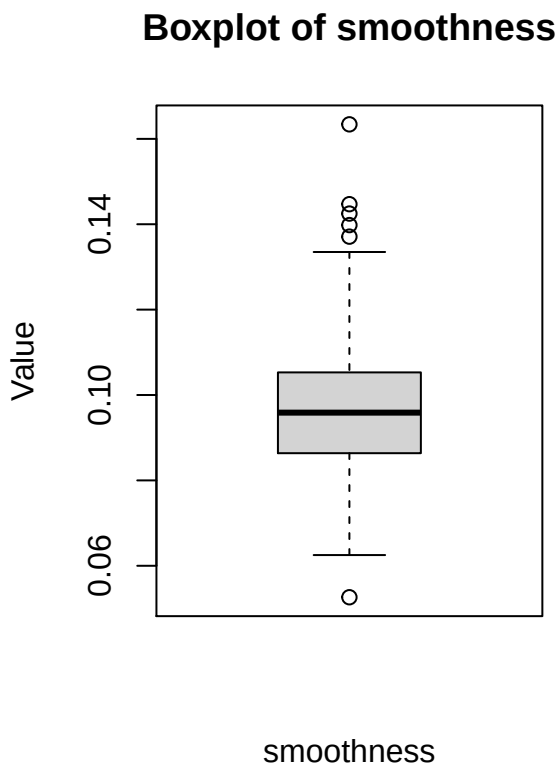

Histogram of perimeter
Frequency
0
20
40
60
80
100
50
100
150
perimeter

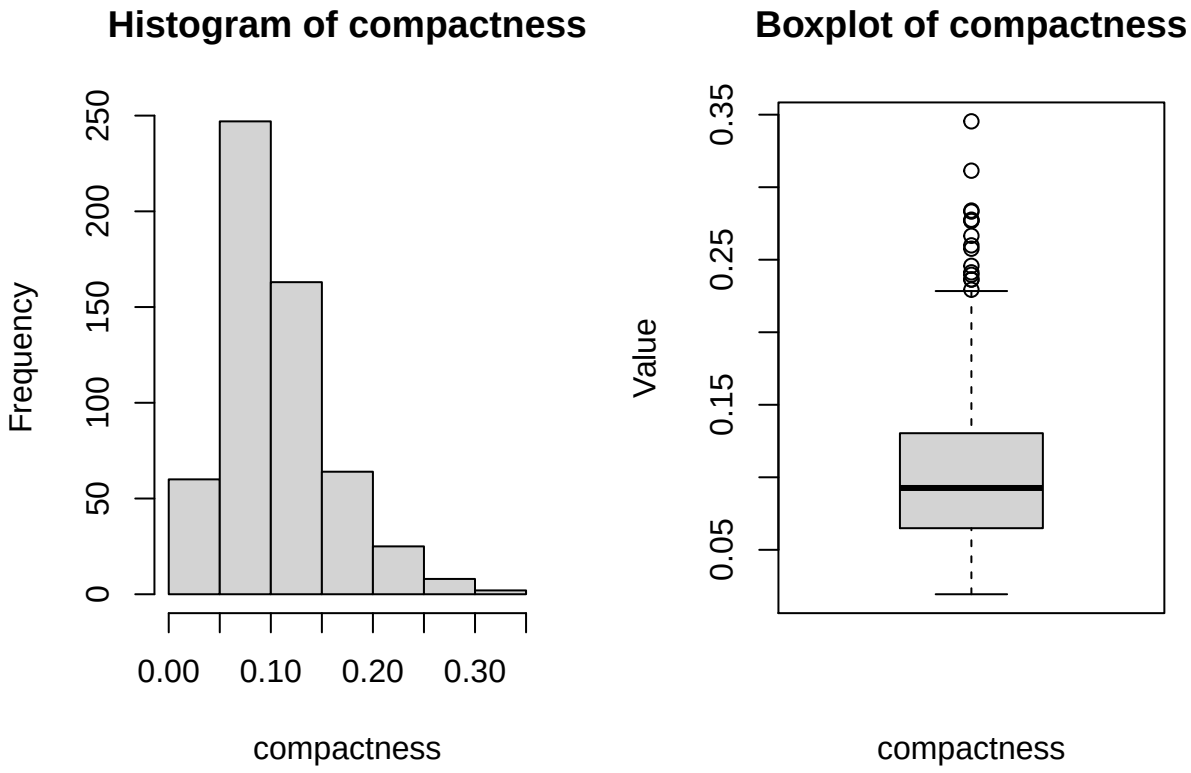

Boxplot of perimeter
Value
50
100
150
perimeter

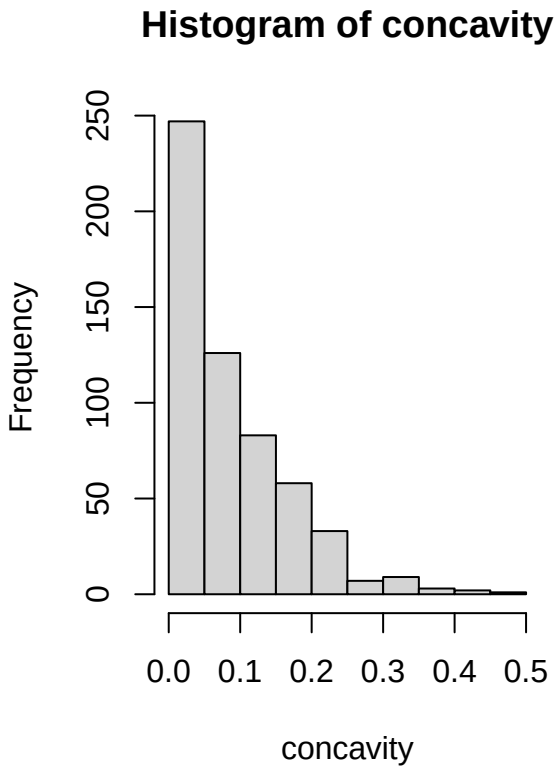

Histogram of area
Frequency
0
50
100
150
200
0
500
1500
2500
area

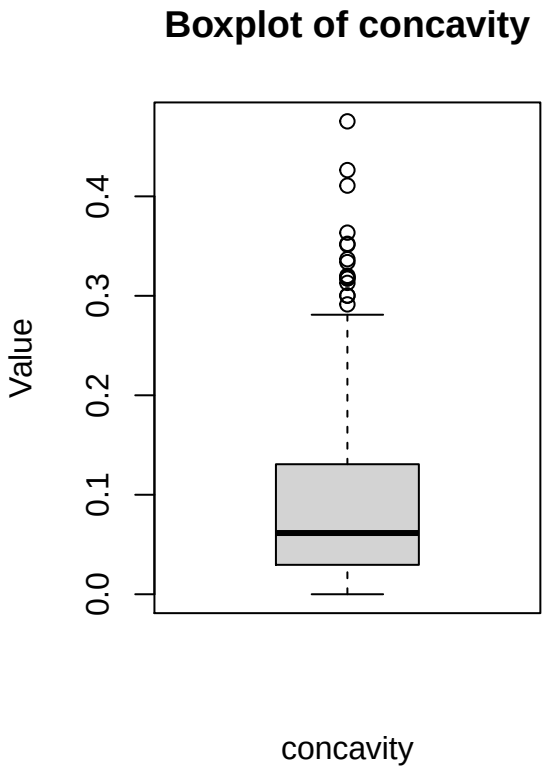

Boxplot of area
Value
500
1000
1500
2000
2500
area

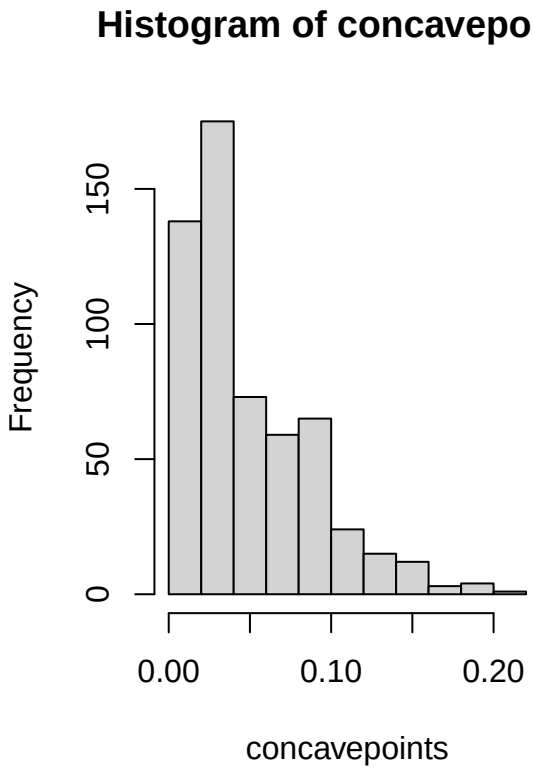

Histogram of smoothness
Frequency
0
50
100
150
0.06
0.10
0.14
smoothness

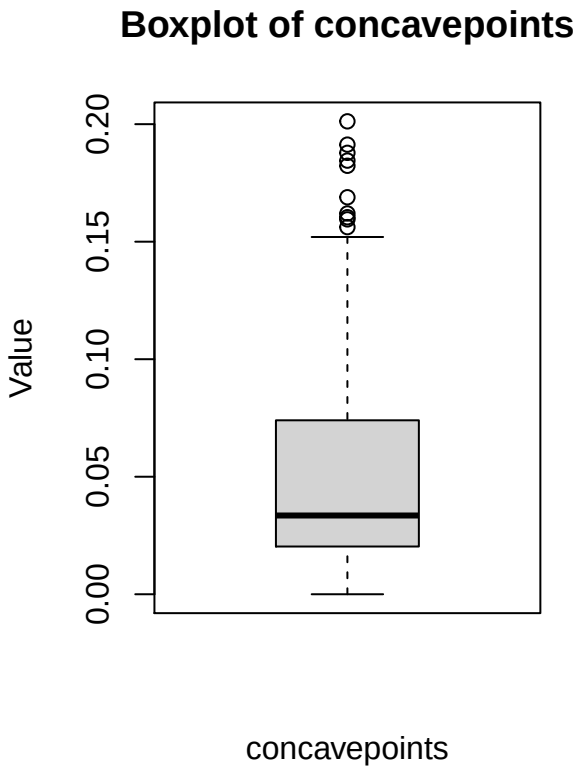

Boxplot of smoothness
Value
0.06
0.10
0.14
smoothness

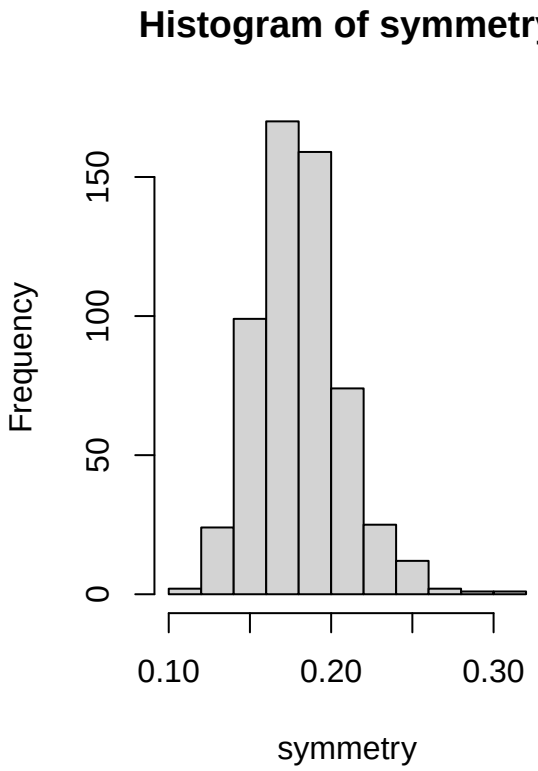

Histogram of compactness
Frequency
0
50
100
150
200
250
0.00
0.10
0.20
0.30
compactness
Boxplot of compactness
Value
0.05
0.15
0.25
0.35
compactness

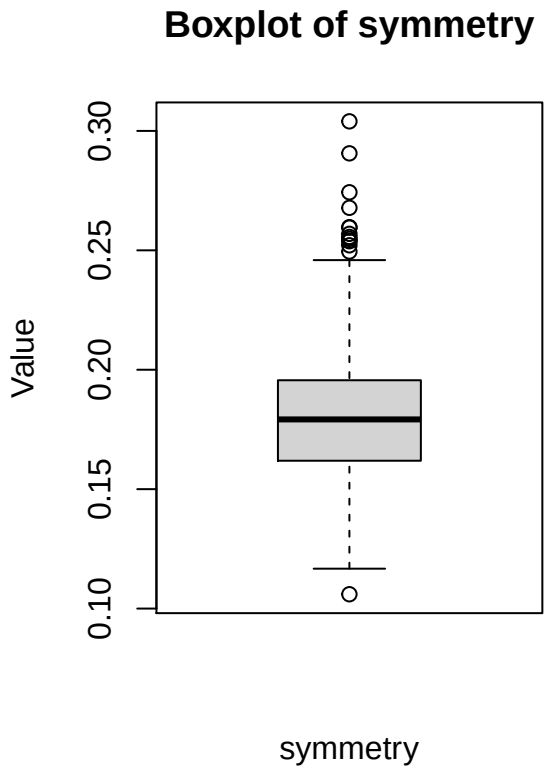

Histogram of concavity
Frequency
0
50
100
150
200
250
0.0
0.1
0.2
0.3
0.4
0.5
concavity

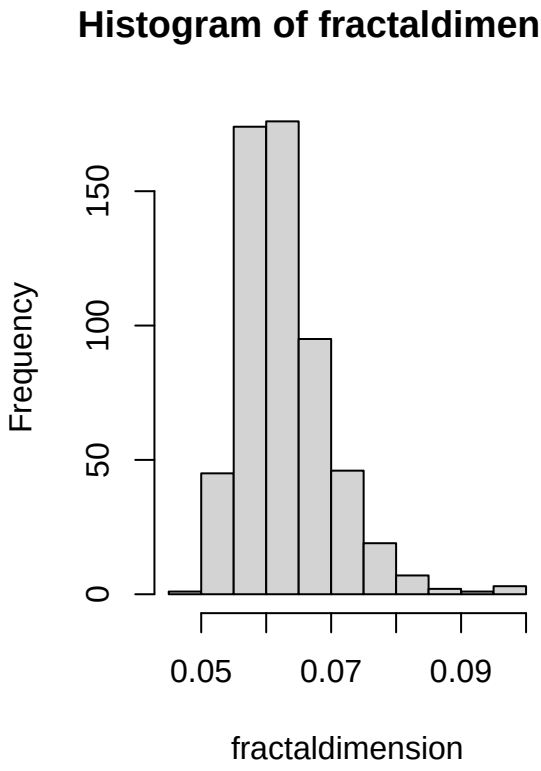

Boxplot of concavity
Value
0.0
0.1
0.2
0.3
0.4
concavity

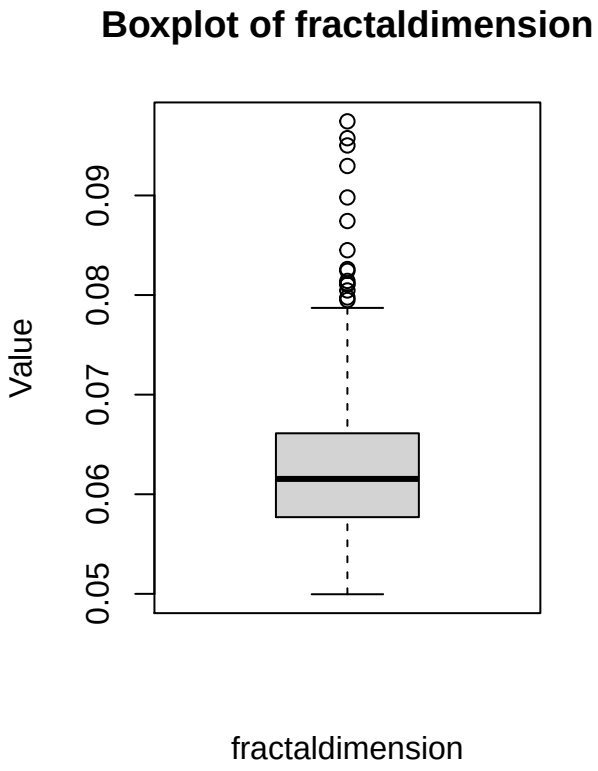

Histogram of concavepoints
Frequency
0
50
100
150
0.00
0.10
0.20
concavepoints

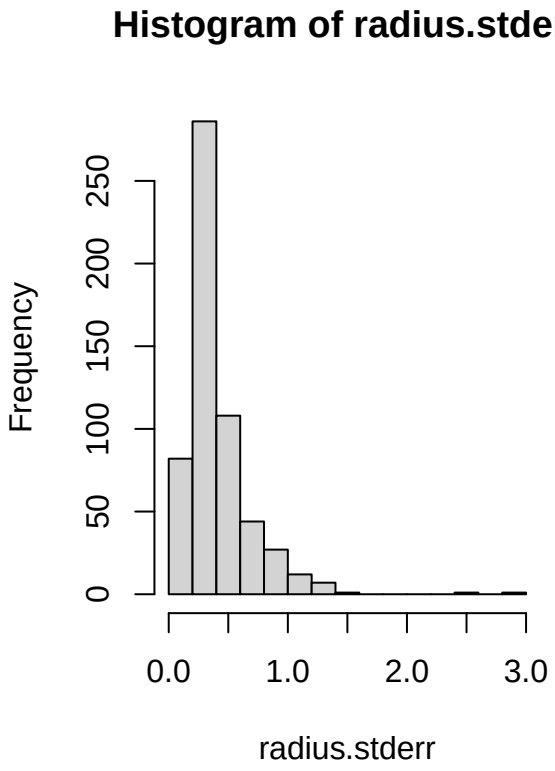

Boxplot of concavepoints
Value
0.00
0.05
0.10
0.15
0.20
concavepoints

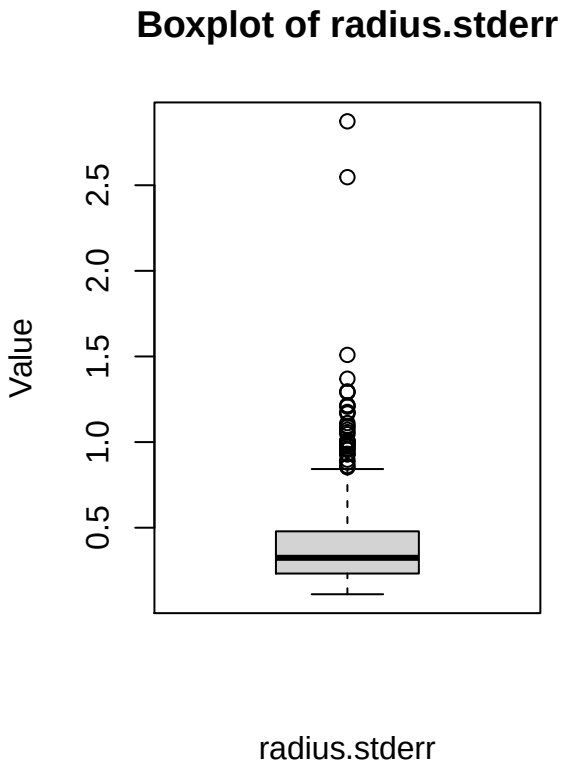

Histogram of symmetry
Frequency
0
50
100
150
0.10
0.20
0.30
symmetry

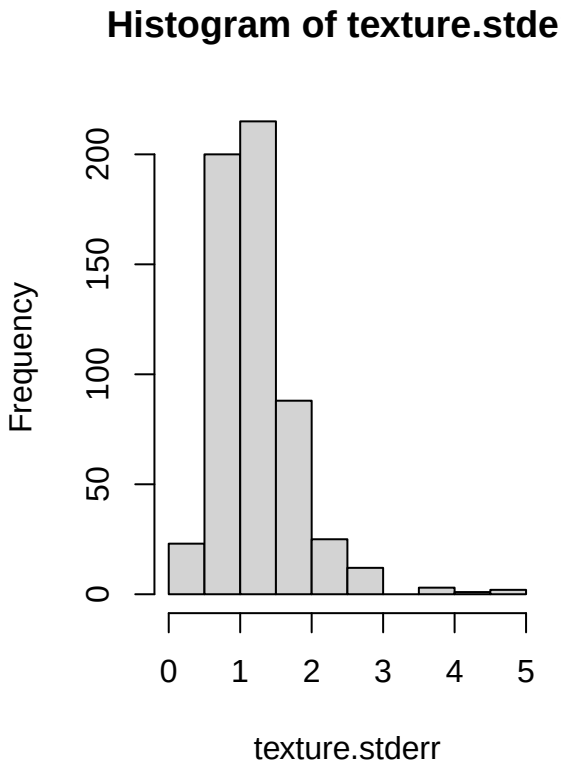

Boxplot of symmetry
Value
0.10
0.15
0.20
0.25
0.30
symmetry

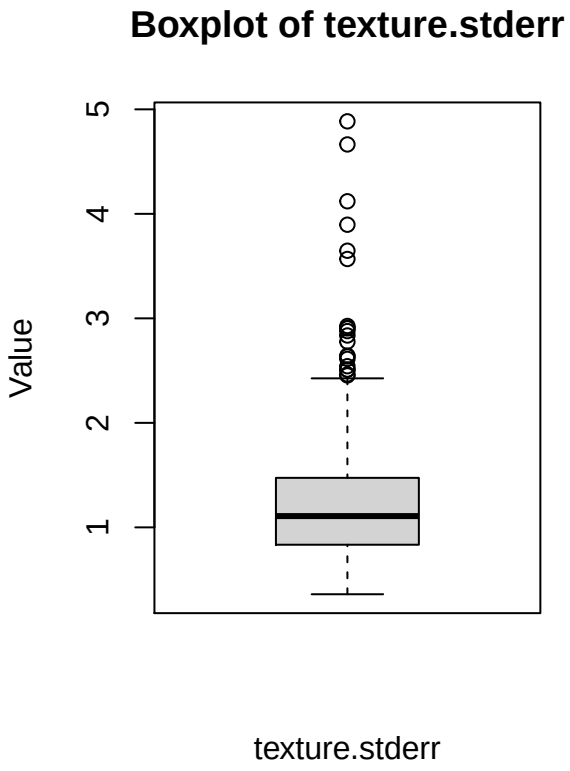

Histogram of fractaldimension
Frequency
0
50
100
150
0.05
0.07
0.09
fractaldimension

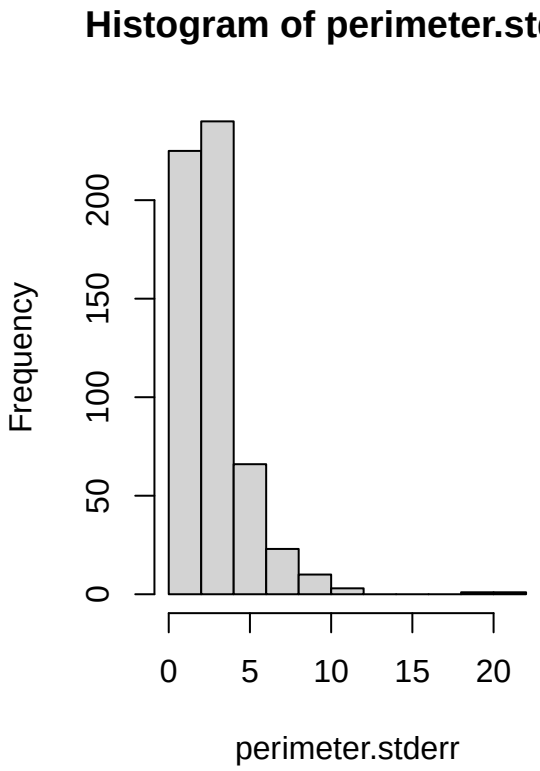

Boxplot of fractaldimension
Value
0.05
0.06
0.07
0.08
0.09
fractaldimension

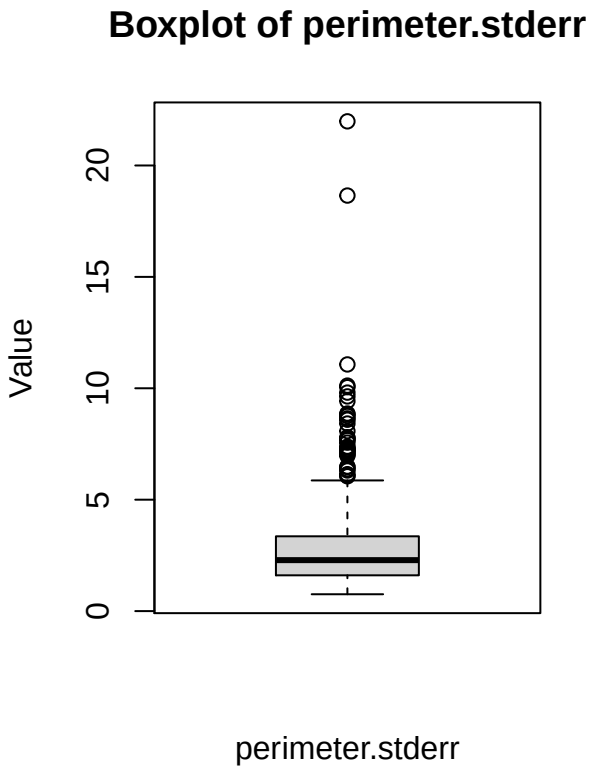

Histogram of radius.stderr
Frequency
0
50
100
150
200
250
0.0
1.0
2.0
3.0
radius.stderr

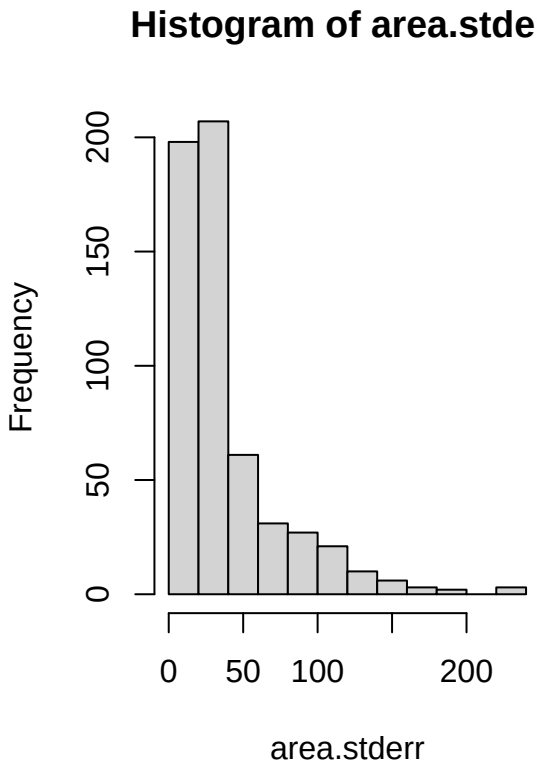

Boxplot of radius.stderr
Value
0.5
1.0
1.5
2.0
2.5
radius.stderr

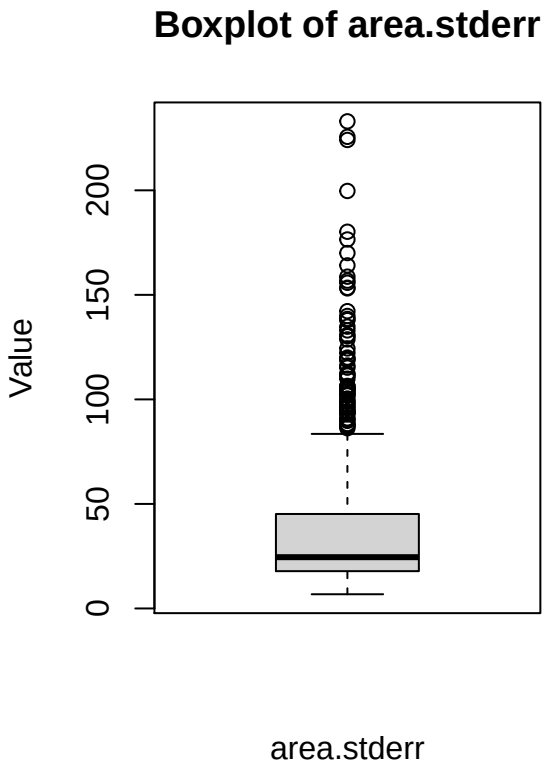

Histogram of texture.stderr
Frequency
0
50
100
150
200
0
1
2
3
4
5
texture.stderr

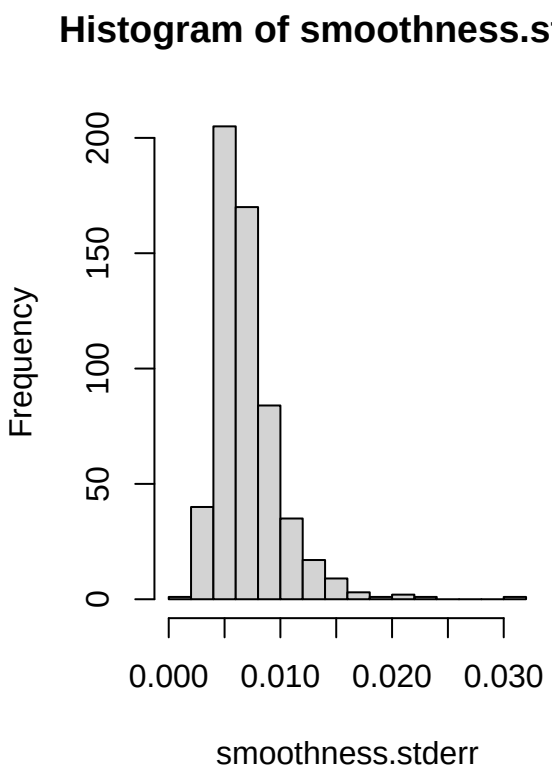

Boxplot of texture.stderr
Value
1
2
3
4
5
texture.stderr

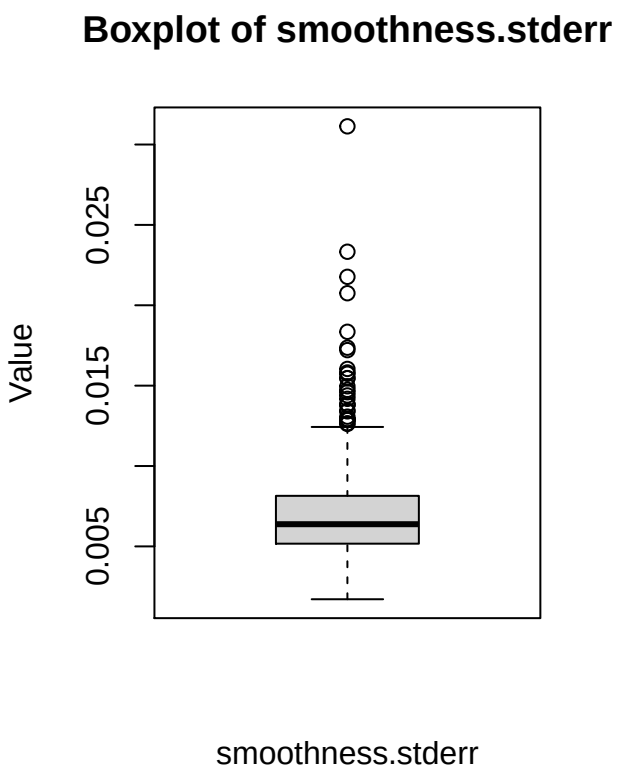

Histogram of perimeter.stderr
Frequency
0
50
100
150
200
0
5
10
15
20
perimeter.stderr

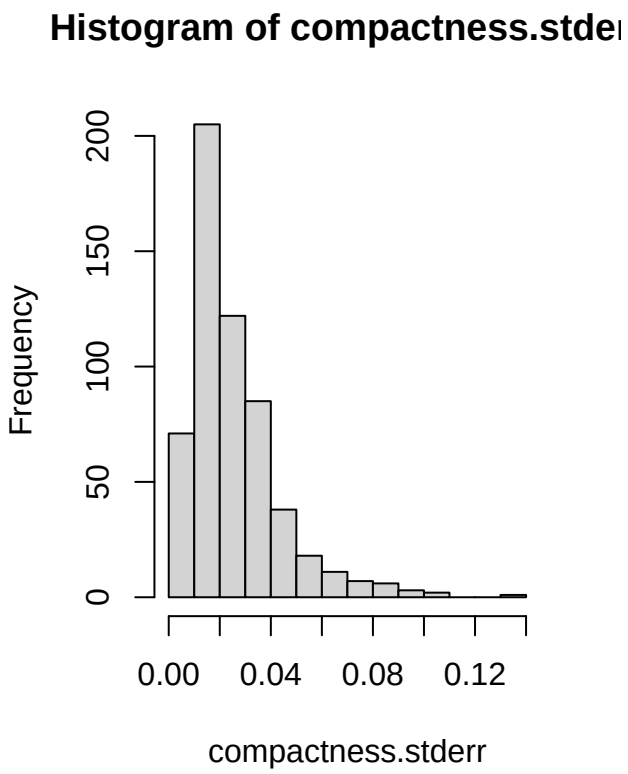

Boxplot of perimeter.stderr
Value
0
5
10
15
20
perimeter.stderr

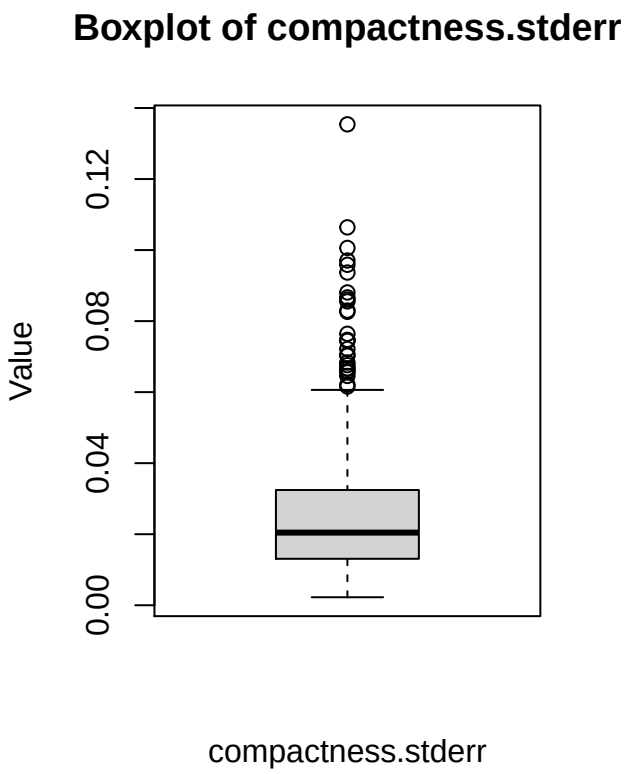

Histogram of area.stderr
Frequency
0
50
100
150
200
0
50
100
200
area.stderr

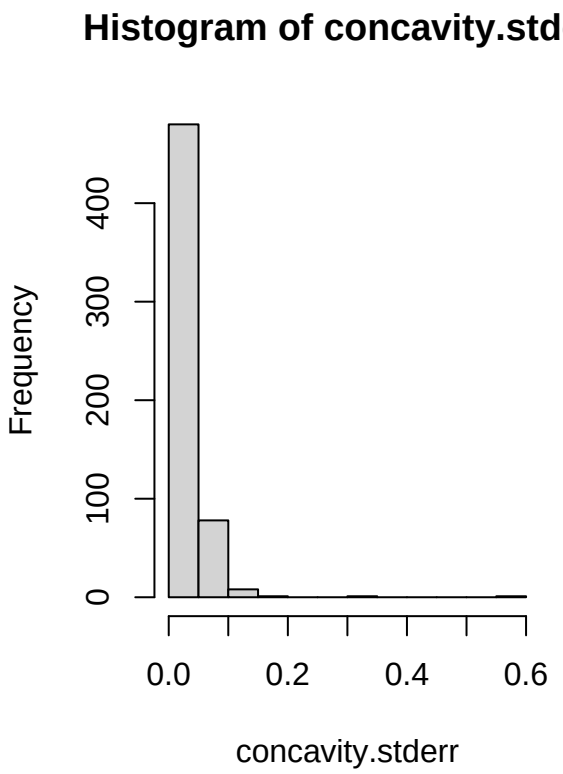

Boxplot of area.stderr
Value
0
50
100
150
200
area.stderr

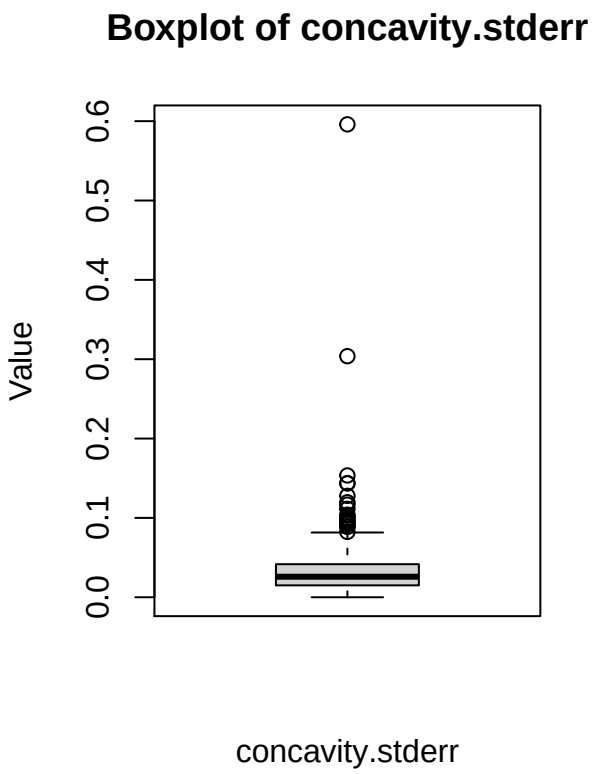

Histogram of smoothness.stder
Frequency
0
50
100
150
200
0.000
0.010
0.020
0.030
smoothness.stderr

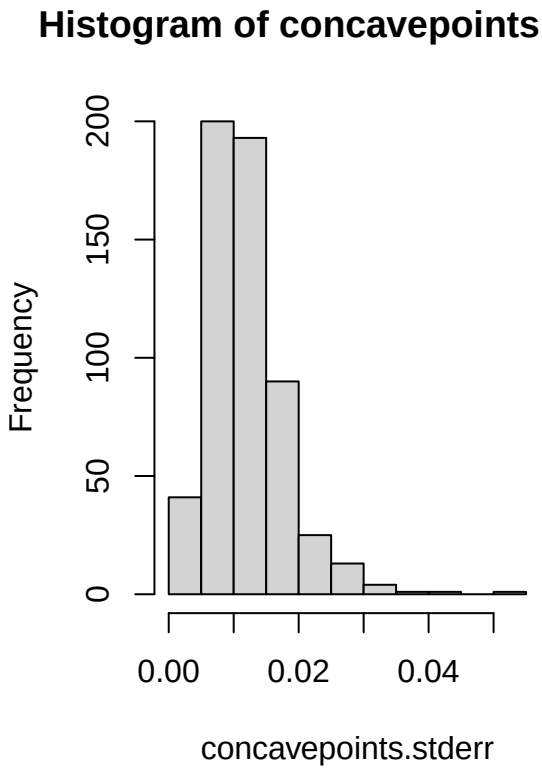

Boxplot of smoothness.stderr
Value
0.005
0.015
0.025
smoothness.stderr

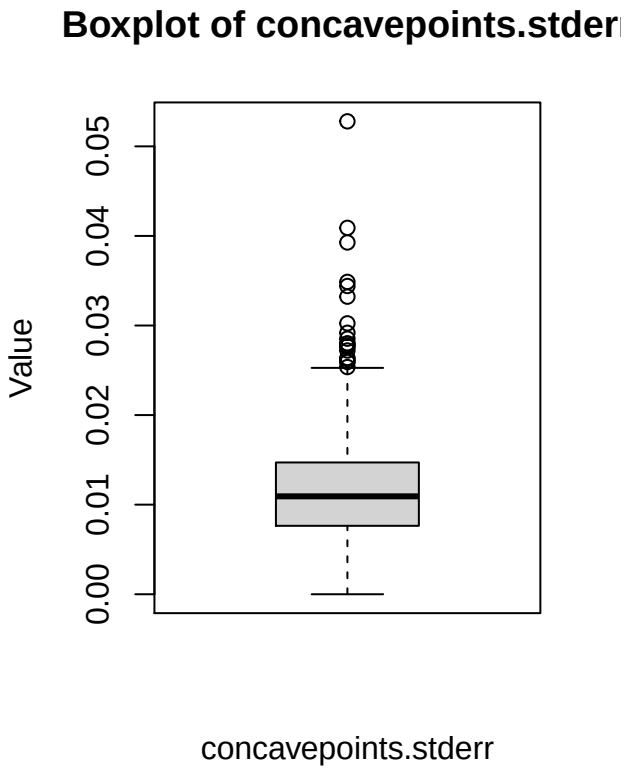

Histogram of compactness.stde
Frequency
0
50
100
150
200
0.00
0.04
0.08
0.12
compactness.stderr

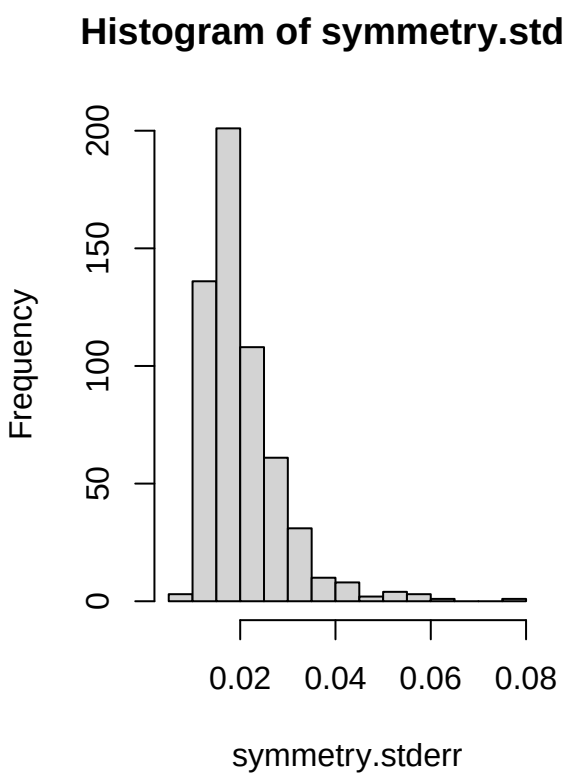

Boxplot of compactness.stderr
Value
0.00
0.04
0.08
0.12
compactness.stderr

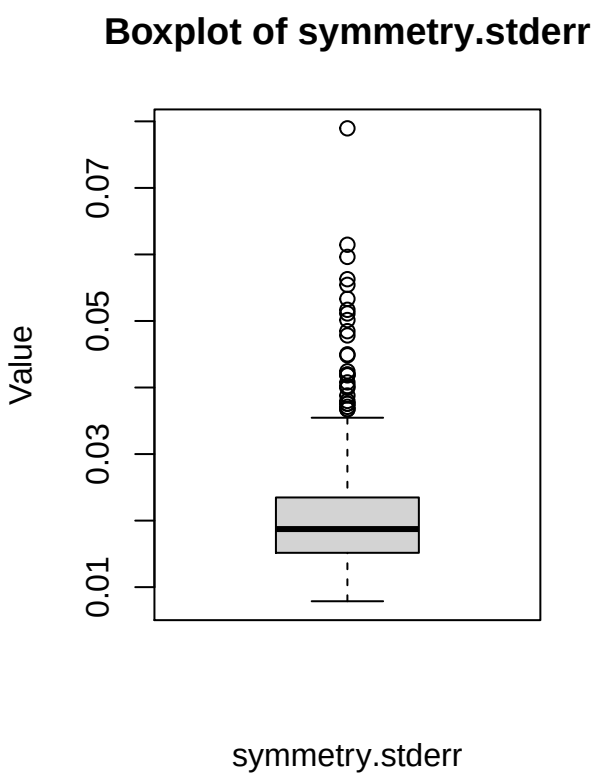

Histogram of concavity.stderr
Frequency
0
100
200
300
400
0.0
0.2
0.4
0.6
concavity.stderr

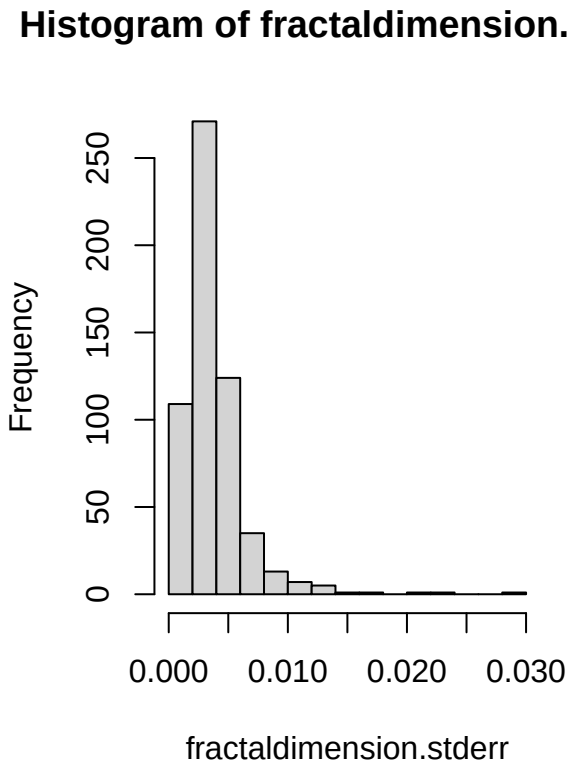

Boxplot of concavity.stderr
Value
0.0
0.1
0.2
0.3
0.4
0.5
0.6
concavity.stderr

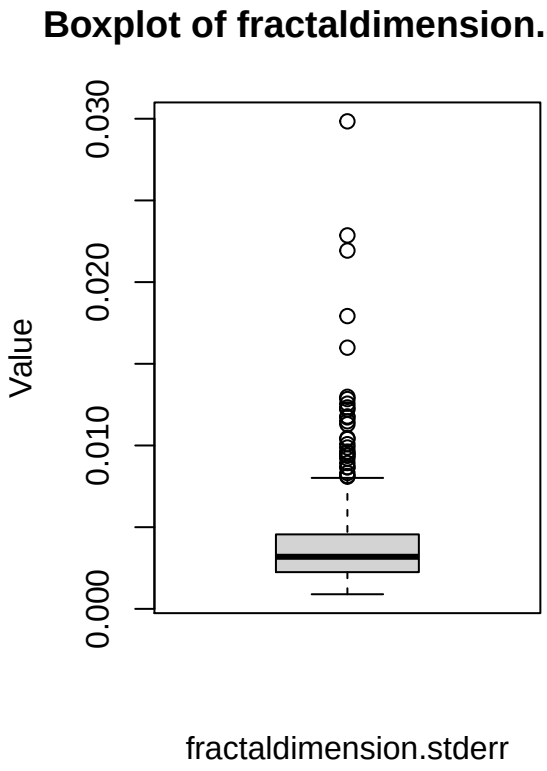

Histogram of concavepoints.stde
Frequency
0
50
100
150
200
0.00
0.02
0.04
concavepoints.stderr

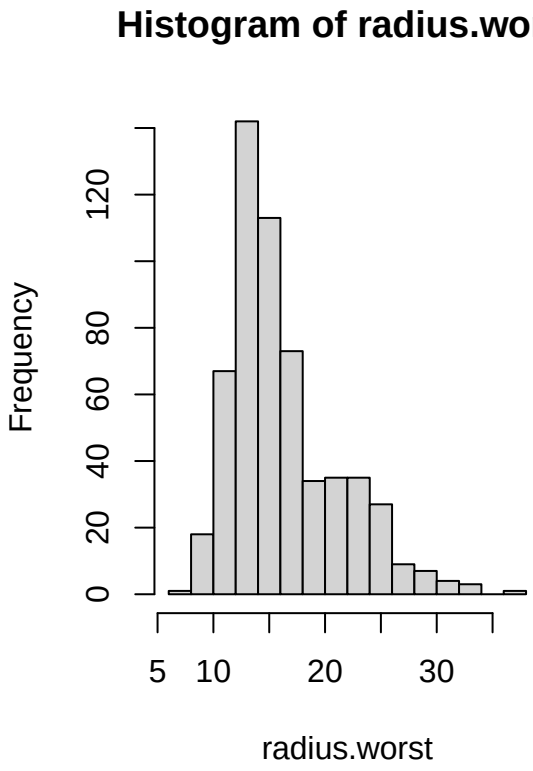

Boxplot of concavepoints.stderr
Value
0.00
0.01
0.02
0.03
0.04
0.05
concavepoints.stderr

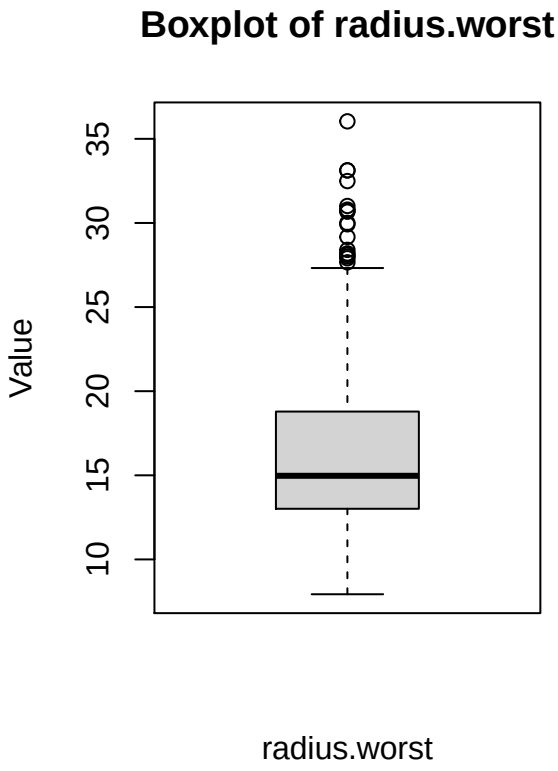

Histogram of symmetry.stderr
Frequency
0
50
100
150
200
0.02
0.04
0.06
0.08
symmetry.stderr

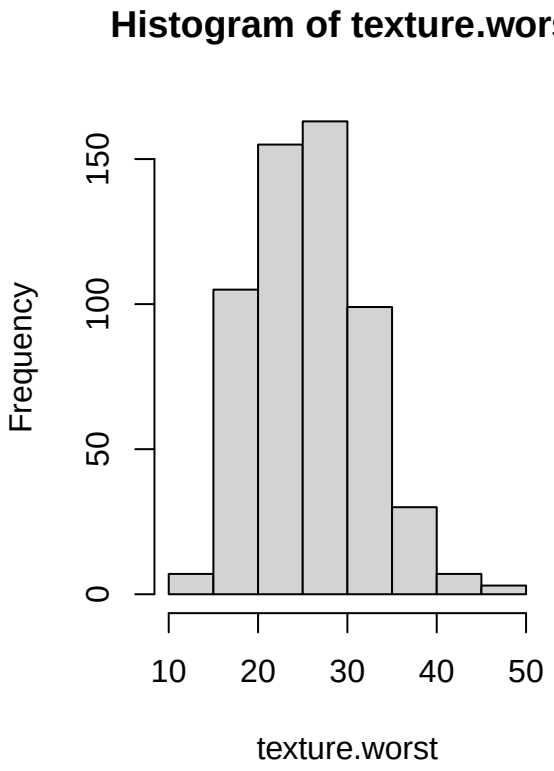

Boxplot of symmetry.stderr
Value
0.01
0.03
0.05
0.07
symmetry.stderr

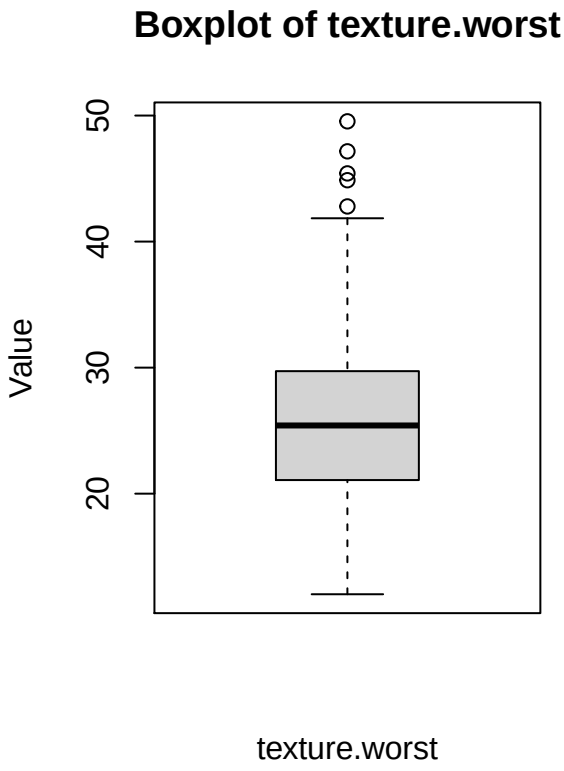

Histogram of fractaldimension.std
Frequency
0
50
100
150
200
250
0.000
0.010
0.020
0.030
fractaldimension.stderr

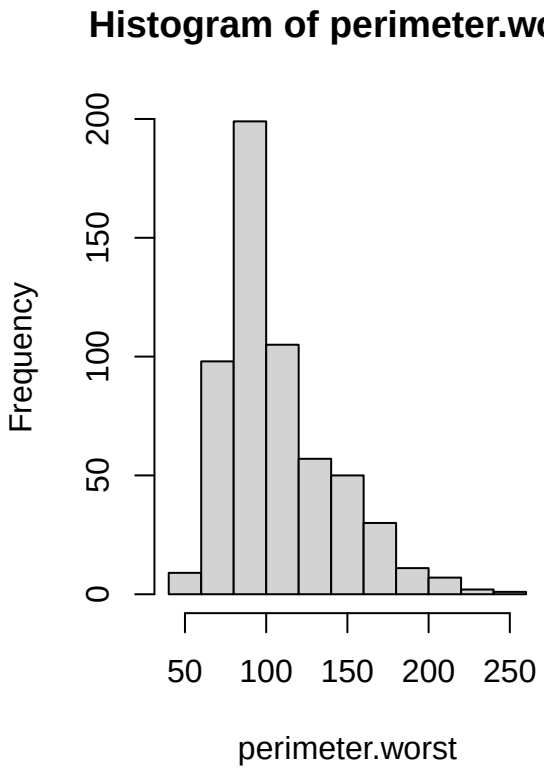

Boxplot of fractaldimension.stde
Value
0.000
0.010
0.020
0.030
fractaldimension.stderr

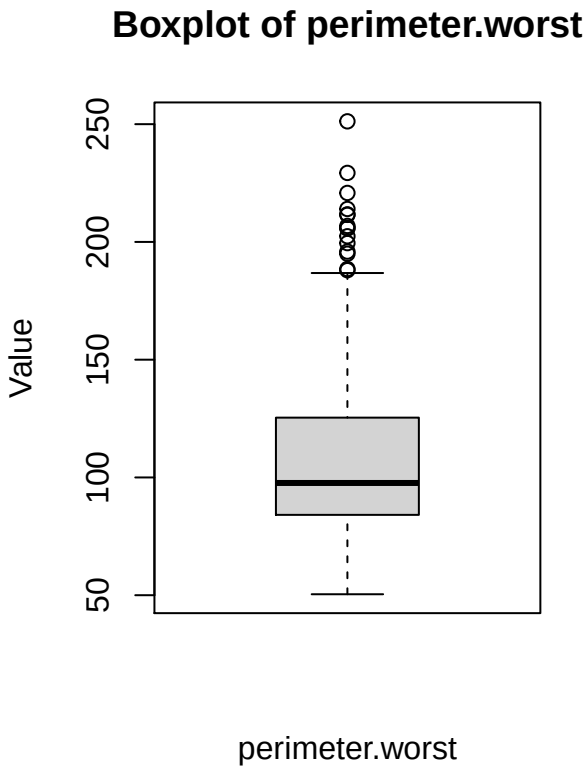

Histogram of radius.worst
Frequency
0
20
40
60
80
120
5
10
20
30
radius.worst

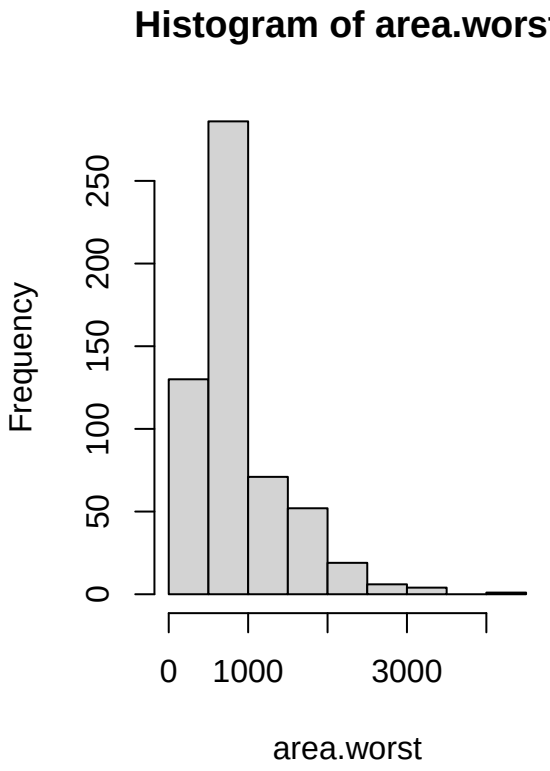

Boxplot of radius.worst
Value
10
15
20
25
30
35
radius.worst

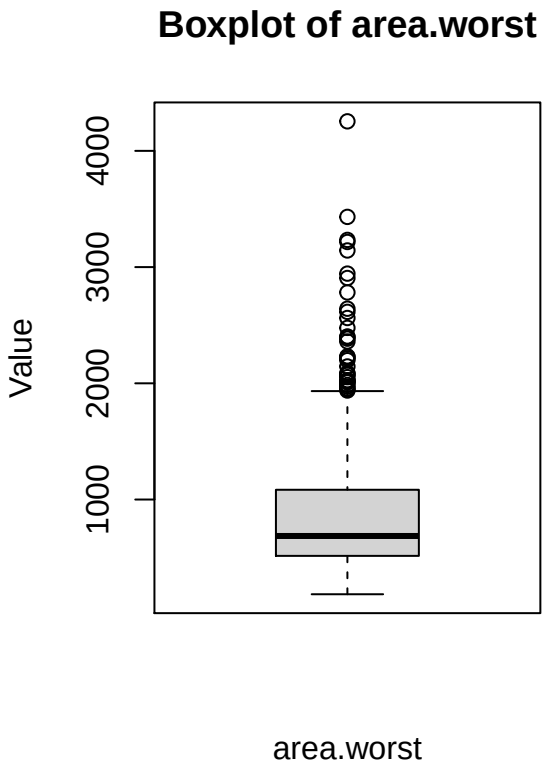

Histogram of texture.worst
Frequency
0
50
100
150
10
20
30
40
50
texture.worst

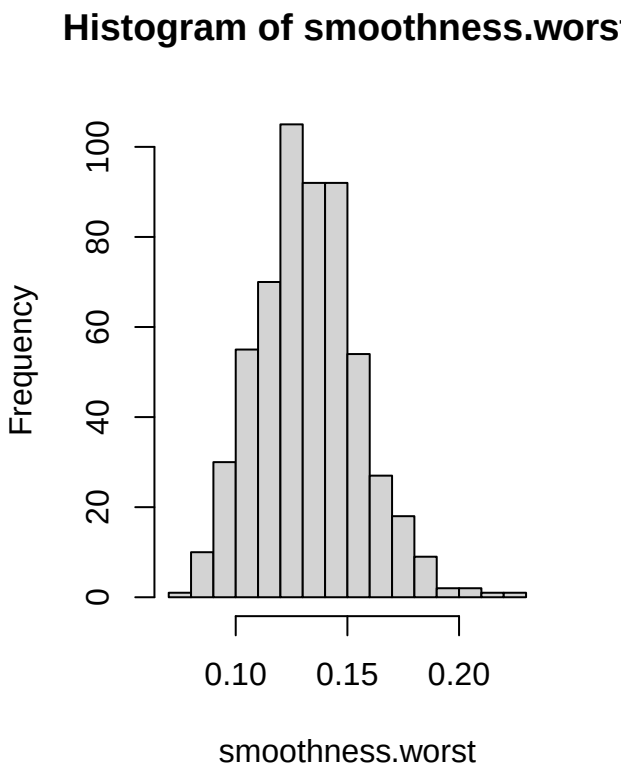

Boxplot of texture.worst
Value
20
30
40
50
texture.worst

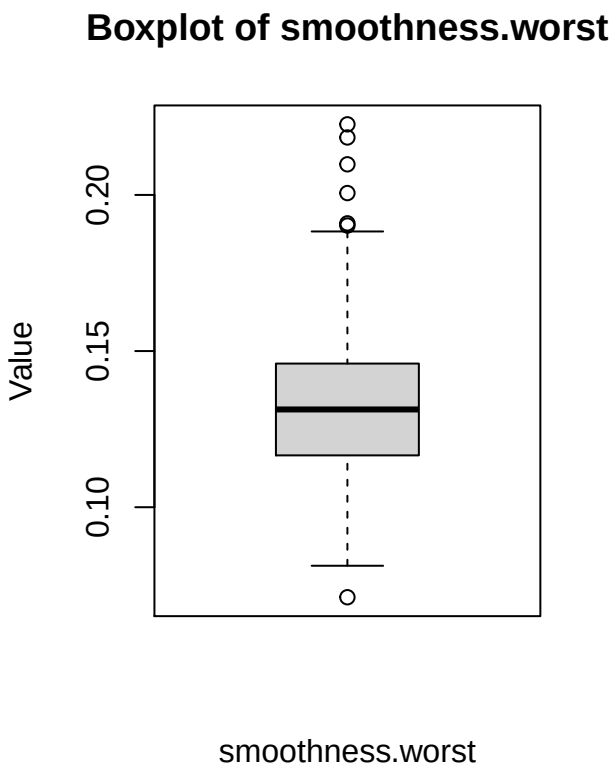

Histogram of perimeter.worst
Frequency
0
50
100
150
200
50
100
150
200
250
perimeter.worst

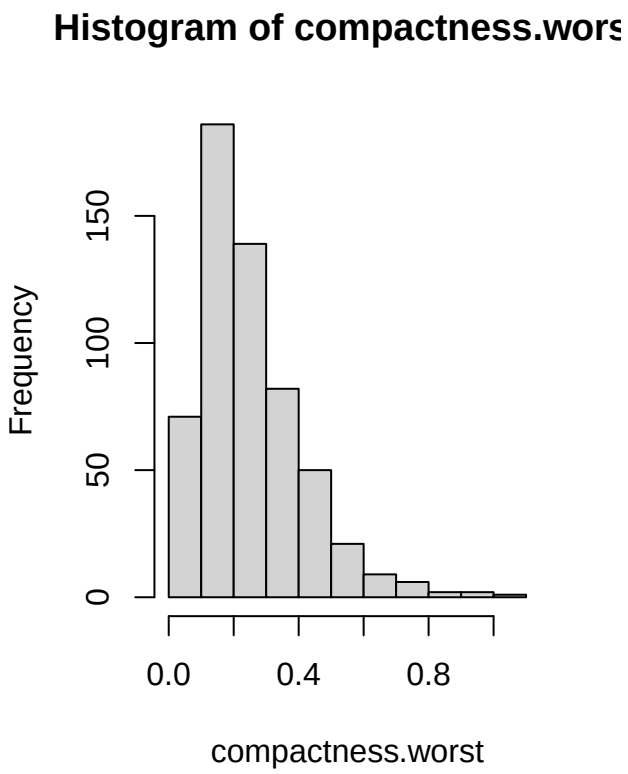

Boxplot of perimeter.worst
Value
50
100
150
200
250
perimeter.worst

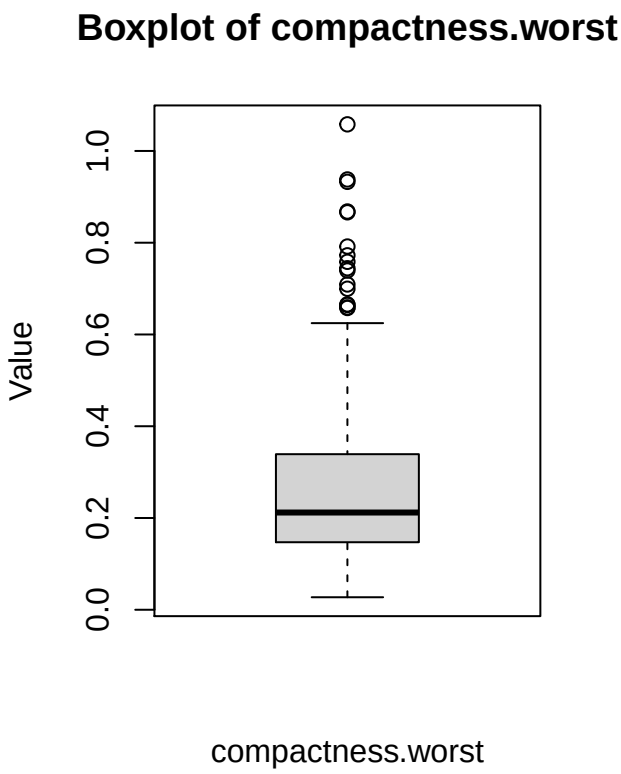

Histogram of area.worst
Frequency
0
50
100
150
200
250
0
1000
3000
area.worst

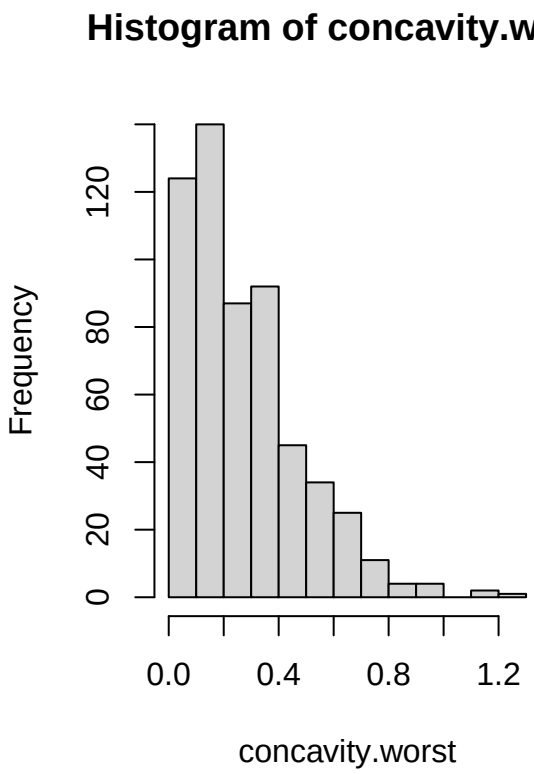

Boxplot of area.worst
Value
1000
2000
3000
4000
area.worst

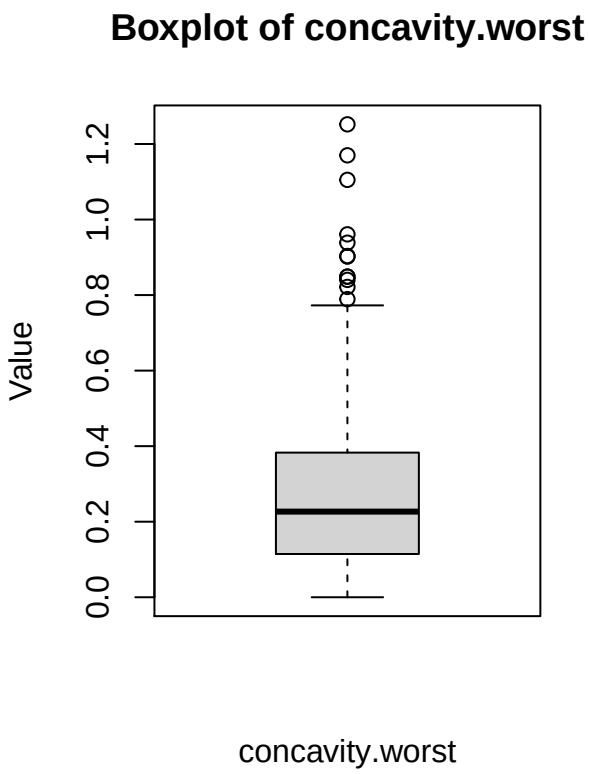

Histogram of smoothness.wors
Frequency
0
20
40
60
80
100
0.10
0.15
0.20
smoothness.worst

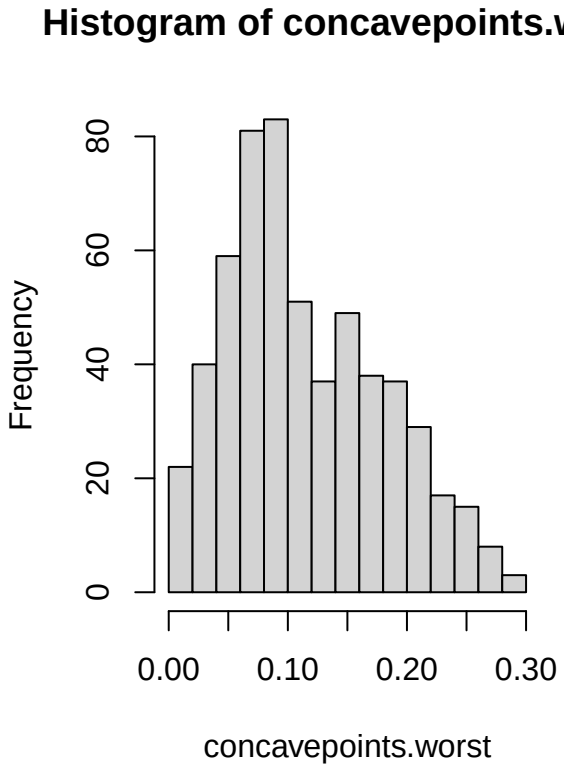

Boxplot of smoothness.worst
Value
0.10
0.15
0.20
smoothness.worst

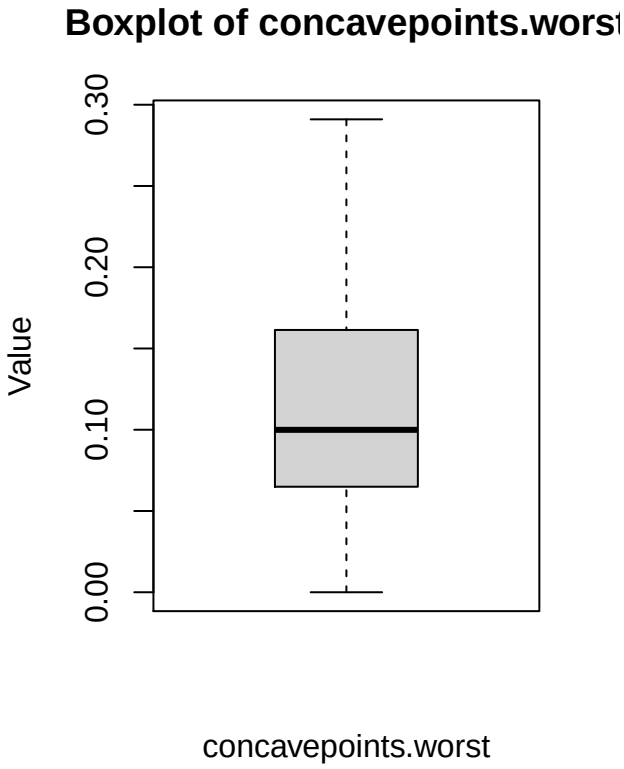

Histogram of compactness.wors
Frequency
0
50
100
150
0.0
0.4
0.8
compactness.worst

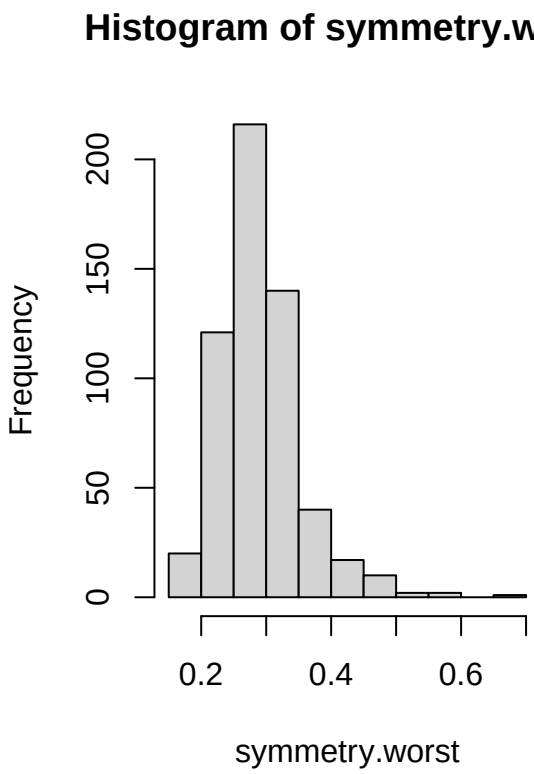

Boxplot of compactness.worst
Value
0.0
0.2
0.4
0.6
0.8
1.0
compactness.worst

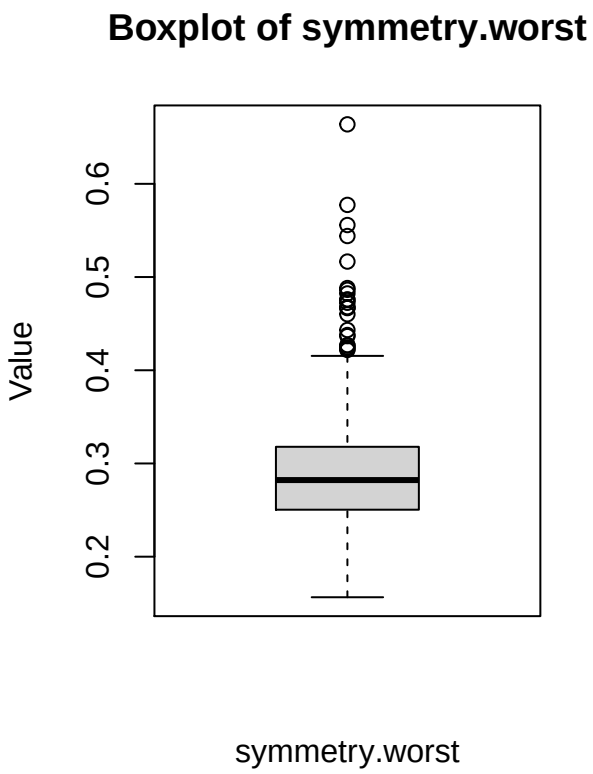

Histogram of concavity.worst
Frequency
0
20
40
60
80
120
0.0
0.4
0.8
1.2
concavity.worst

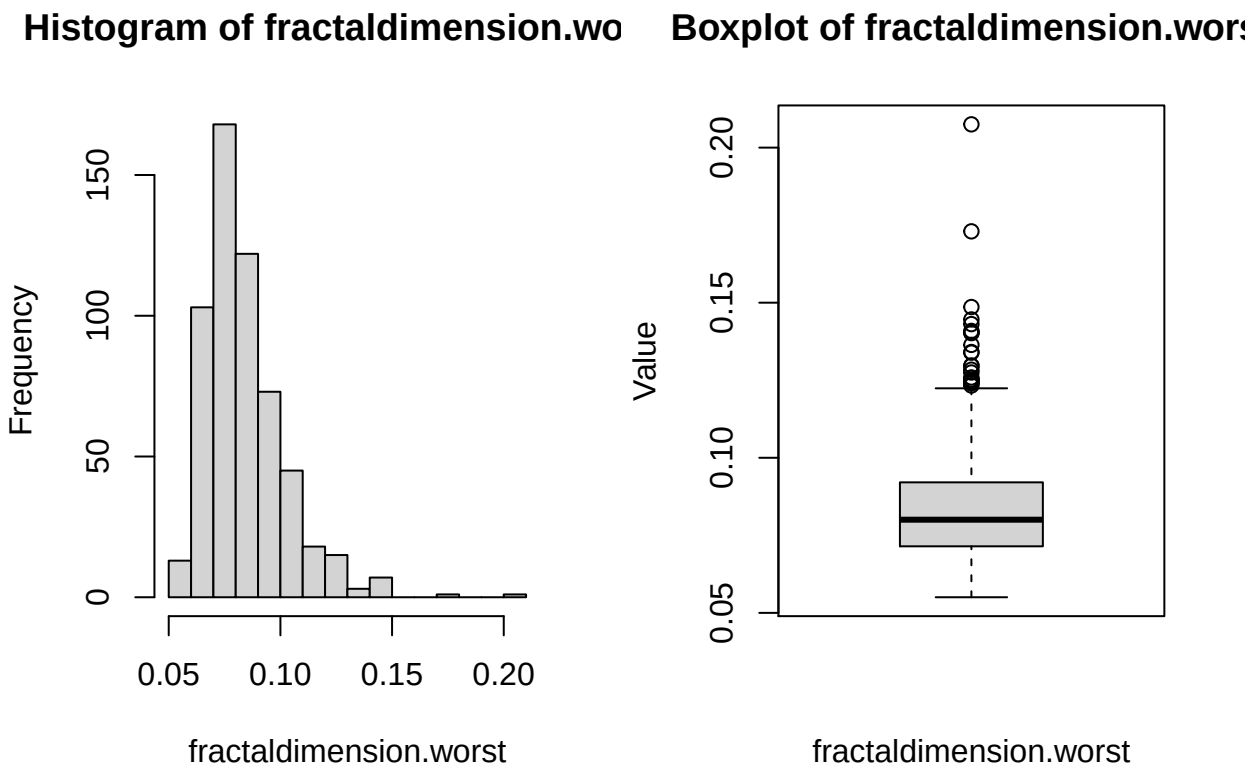

Boxplot of concavity.worst
Value
0.0
0.2
0.4
0.6
0.8
1.0
1.2
concavity.worst


Histogram of concavepoints.wor
Frequency
0
20
40
60
80
0.00
0.10
0.20
0.30
concavepoints.worst


Boxplot of concavepoints.worst
Value
0.00
0.10
0.20
0.30
concavepoints.worst


Histogram of symmetry.worst
Frequency
0
50
100
150
200
0.2
0.4
0.6
symmetry.worst


Boxplot of symmetry.worst
Value
0.2
0.3
0.4
0.5
0.6
symmetry.worst




```
##       id          diagnosis radius    texture   perimeter  area       smoothness
## stats Numeric,5   Numeric,5 Numeric,5 Numeric,5 Numeric,5  Numeric,5  Numeric,5
## n     569         569       569       569       569        569        569
## conf  Numeric,2   Numeric,2 Numeric,2 Numeric,2 Numeric,2  Numeric,2  Numeric,2
## out   Numeric,81  Numeric,0 Numeric,9 Numeric,7 Numeric,11 Numeric,24 Numeric,6
## group Numeric,81  Numeric,0 Numeric,9 Numeric,7 Numeric,11 Numeric,24 Numeric,6
## names ""          ""        ""        ""        ""         ""         ""
##       compactness concavity  concavepoints symmetry   fractaldimension
## stats Numeric,5   Numeric,5  Numeric,5     Numeric,5  Numeric,5
## n     569         569        569           569        569
## conf  Numeric,2   Numeric,2  Numeric,2     Numeric,2  Numeric,2
## out   Numeric,16  Numeric,16 Numeric,10    Numeric,14 Numeric,15
## group Numeric,16  Numeric,16 Numeric,10    Numeric,14 Numeric,15
## names ""          ""         ""            ""         ""
##       radius.stderr texture.stderr perimeter.stderr area.stderr
## stats Numeric,5     Numeric,5      Numeric,5        Numeric,5
## n     569           569            569              569
## conf  Numeric,2     Numeric,2      Numeric,2        Numeric,2
## out   Numeric,38    Numeric,20     Numeric,38       Numeric,65
## group Numeric,38    Numeric,20     Numeric,38       Numeric,65
## names ""            ""             ""               ""
##       smoothness.stderr compactness.stderr concavity.stderr
## stats Numeric,5         Numeric,5          Numeric,5
## n     569               569                569
## conf  Numeric,2         Numeric,2          Numeric,2
## out   Numeric,30        Numeric,28         Numeric,22
```

```
## group Numeric,30        Numeric,28         Numeric,22
## names ""                ""                 ""
##       concavepoints.stderr symmetry.stderr fractaldimension.stderr radius.worst
## stats Numeric,5            Numeric,5       Numeric,5                Numeric,5
## n     569                  569             569                      569
## conf  Numeric,2            Numeric,2       Numeric,2                Numeric,2
## out   Numeric,19           Numeric,27      Numeric,29               Numeric,17
## group Numeric,19           Numeric,27      Numeric,29               Numeric,17
## names ""                   ""              ""                       ""
##       texture.worst perimeter.worst area.worst smoothness.worst
## stats Numeric,5     Numeric,5       Numeric,5  Numeric,5
## n     569           569             569        569
## conf  Numeric,2     Numeric,2       Numeric,2  Numeric,2
## out   Numeric,5     Numeric,15      Numeric,35 Numeric,7
## group Numeric,5     Numeric,15      Numeric,35 Numeric,7
## names ""            ""              ""         ""
##       compactness.worst concavity.worst concavepoints.worst symmetry.worst
## stats Numeric,5         Numeric,5       Numeric,5           Numeric,5
## n     569               569             569                 569
## conf  Numeric,2         Numeric,2       Numeric,2           Numeric,2
## out   Numeric,16        Numeric,12      Numeric,0           Numeric,23
## group Numeric,16        Numeric,12      Numeric,0           Numeric,23
## names ""                ""              ""                  ""
##       fractaldimension.worst
## stats Numeric,5
## n     569
## conf  Numeric,2
## out   Numeric,24
## group Numeric,24
## names ""
```

```
#We define full model, null model

full_model <- glm(diagnosis~., data = train_breast_cancer)

Null_model <- glm(diagnosis~1, data = train_breast_cancer)
```

```
#Backward Selection
library(MASS)
```

```
##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##     select
```

```
Model_B<- stepAIC(full_model, direction = "back")
```

```
## Start:  AIC=80.26
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavity + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + area.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     concavepoints.stderr + symmetry.stderr + fractaldimension.stderr +
##     radius.worst + texture.worst + perimeter.worst + area.worst +
```

```
##     smoothness.worst + compactness.worst + concavity.worst +
##     concavepoints.worst + symmetry.worst + fractaldimension.worst
##
##                            Df Deviance    AIC
## - fractaldimension.stderr   1   24.211 78.256
## - symmetry.stderr           1   24.211 78.257
## - concavepoints.stderr      1   24.211 78.258
## - concavity                 1   24.212 78.263
## - area.stderr               1   24.212 78.276
## - compactness.worst         1   24.214 78.296
## - smoothness                1   24.215 78.318
## - area                      1   24.215 78.327
## - texture                   1   24.220 78.397
## - perimeter.worst           1   24.220 78.397
## - texture.stderr            1   24.224 78.473
## - concavepoints.worst       1   24.230 78.574
## - compactness.stderr        1   24.235 78.650
## - symmetry                  1   24.238 78.704
## - fractaldimension          1   24.241 78.744
## - perimeter.stderr          1   24.245 78.807
## - id                        1   24.251 78.913
## - concavity.worst           1   24.260 79.055
## - smoothness.worst          1   24.267 79.173
## - concavity.stderr          1   24.278 79.358
## - smoothness.stderr         1   24.280 79.397
## - texture.worst             1   24.289 79.536
## <none>                          24.211 80.256
## - symmetry.worst            1   24.382 81.063
## - radius.worst              1   24.396 81.284
## - fractaldimension.worst    1   24.396 81.286
## - compactness               1   24.403 81.401
## - radius.stderr             1   24.414 81.584
## - perimeter                 1   24.623 84.984
## - concavepoints             1   24.625 85.021
## - area.worst                1   24.892 89.315
## - radius                    1   25.252 95.050
##
## Step:  AIC=78.26
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavity + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + area.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     concavepoints.stderr + symmetry.stderr + radius.worst + texture.worst +
##     perimeter.worst + area.worst + smoothness.worst + compactness.worst +
##     concavity.worst + concavepoints.worst + symmetry.worst +
##     fractaldimension.worst
##
##                           Df Deviance    AIC
## - symmetry.stderr          1   24.211 76.257
## - concavepoints.stderr     1   24.211 76.258
## - concavity                1   24.212 76.263
## - area.stderr              1   24.212 76.276
## - compactness.worst        1   24.214 76.301
## - smoothness               1   24.215 76.318
```

```
## - area                    1   24.215 76.327
## - texture                 1   24.220 76.397
## - perimeter.worst         1   24.220 76.397
## - texture.stderr          1   24.224 76.473
## - concavepoints.worst     1   24.230 76.575
## - symmetry                1   24.238 76.705
## - fractaldimension        1   24.241 76.746
## - compactness.stderr      1   24.244 76.799
## - perimeter.stderr        1   24.245 76.807
## - id                      1   24.251 76.914
## - concavity.worst         1   24.263 77.103
## - smoothness.worst        1   24.268 77.192
## - smoothness.stderr       1   24.281 77.408
## - concavity.stderr        1   24.283 77.438
## - texture.worst           1   24.289 77.537
## <none>                        24.211 78.256
## - symmetry.worst          1   24.382 79.063
## - radius.worst            1   24.396 79.285
## - compactness             1   24.403 79.412
## - radius.stderr           1   24.415 79.598
## - fractaldimension.worst  1   24.472 80.535
## - perimeter               1   24.626 83.028
## - concavepoints           1   24.641 83.274
## - area.worst              1   24.892 87.315
## - radius                  1   25.252 93.052
##
## Step:  AIC=76.26
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavity + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + area.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     concavepoints.stderr + radius.worst + texture.worst + perimeter.worst +
##     area.worst + smoothness.worst + compactness.worst + concavity.worst +
##     concavepoints.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - concavepoints.stderr    1   24.211 74.258
## - concavity               1   24.212 74.263
## - area.stderr             1   24.212 74.276
## - compactness.worst       1   24.214 74.301
## - smoothness              1   24.215 74.318
## - area                    1   24.215 74.327
## - perimeter.worst         1   24.220 74.398
## - texture                 1   24.220 74.406
## - texture.stderr          1   24.227 74.525
## - concavepoints.worst     1   24.230 74.575
## - symmetry                1   24.241 74.741
## - fractaldimension        1   24.241 74.749
## - perimeter.stderr        1   24.245 74.810
## - compactness.stderr      1   24.246 74.833
## - id                      1   24.251 74.914
## - concavity.worst         1   24.263 75.104
## - smoothness.worst        1   24.270 75.227
## - smoothness.stderr       1   24.282 75.422
```

```
## - concavity.stderr        1   24.291 75.576
## - texture.worst           1   24.300 75.725
## <none>                        24.211 76.257
## - radius.worst            1   24.396 77.294
## - compactness             1   24.404 77.413
## - radius.stderr           1   24.415 77.599
## - fractaldimension.worst  1   24.477 78.611
## - symmetry.worst          1   24.591 80.470
## - perimeter               1   24.628 81.070
## - concavepoints           1   24.645 81.336
## - area.worst              1   24.893 85.344
## - radius                  1   25.254 91.077
##
## Step:  AIC=74.26
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavity + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + area.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     radius.worst + texture.worst + perimeter.worst + area.worst +
##     smoothness.worst + compactness.worst + concavity.worst +
##     concavepoints.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - concavity               1   24.212 72.265
## - area.stderr             1   24.213 72.280
## - compactness.worst       1   24.214 72.307
## - smoothness              1   24.216 72.329
## - area                    1   24.216 72.331
## - perimeter.worst         1   24.220 72.400
## - texture                 1   24.220 72.408
## - texture.stderr          1   24.228 72.531
## - symmetry                1   24.241 72.744
## - concavepoints.worst     1   24.241 72.751
## - fractaldimension        1   24.243 72.775
## - compactness.stderr      1   24.249 72.872
## - perimeter.stderr        1   24.249 72.873
## - id                      1   24.251 72.916
## - concavity.worst         1   24.263 73.112
## - smoothness.worst        1   24.272 73.256
## - smoothness.stderr       1   24.291 73.570
## - texture.worst           1   24.300 73.725
## - concavity.stderr        1   24.316 73.981
## <none>                        24.211 74.258
## - radius.worst            1   24.399 75.338
## - compactness             1   24.405 75.446
## - radius.stderr           1   24.418 75.642
## - fractaldimension.worst  1   24.477 76.612
## - symmetry.worst          1   24.603 78.655
## - perimeter               1   24.628 79.074
## - concavepoints           1   24.657 79.544
## - area.worst              1   24.894 83.347
## - radius                  1   25.283 89.536
##
## Step:  AIC=72.26
```

```
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + area.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     radius.worst + texture.worst + perimeter.worst + area.worst +
##     smoothness.worst + compactness.worst + concavity.worst +
##     concavepoints.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - area.stderr             1   24.213 70.289
## - compactness.worst       1   24.216 70.329
## - smoothness              1   24.216 70.329
## - area                    1   24.216 70.331
## - texture                 1   24.221 70.412
## - perimeter.worst         1   24.221 70.413
## - texture.stderr          1   24.228 70.535
## - symmetry                1   24.241 70.751
## - fractaldimension        1   24.243 70.786
## - compactness.stderr      1   24.249 70.874
## - perimeter.stderr        1   24.249 70.880
## - concavepoints.worst     1   24.250 70.898
## - id                      1   24.251 70.917
## - smoothness.worst        1   24.273 71.273
## - smoothness.stderr       1   24.292 71.584
## - texture.worst           1   24.302 71.745
## - concavity.stderr        1   24.320 72.054
## - concavity.worst         1   24.330 72.208
## <none>                        24.212 72.265
## - radius.worst            1   24.401 73.367
## - radius.stderr           1   24.419 73.671
## - compactness             1   24.441 74.021
## - fractaldimension.worst  1   24.477 74.612
## - symmetry.worst          1   24.607 76.728
## - perimeter               1   24.629 77.083
## - area.worst              1   24.909 81.589
## - concavepoints           1   24.923 81.815
## - radius                  1   25.355 88.677
##
## Step:  AIC=70.29
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + smoothness.stderr +
##     compactness.stderr + concavity.stderr + radius.worst + texture.worst +
##     perimeter.worst + area.worst + smoothness.worst + compactness.worst +
##     concavity.worst + concavepoints.worst + symmetry.worst +
##     fractaldimension.worst
##
##                          Df Deviance    AIC
## - compactness.worst       1   24.217 68.347
## - smoothness              1   24.217 68.353
## - area                    1   24.218 68.371
## - perimeter.worst         1   24.222 68.428
## - texture                 1   24.223 68.446
## - texture.stderr          1   24.229 68.555
```

```
## - symmetry                1   24.241 68.756
## - fractaldimension        1   24.244 68.794
## - perimeter.stderr        1   24.250 68.904
## - concavepoints.worst     1   24.252 68.924
## - compactness.stderr      1   24.253 68.947
## - id                      1   24.254 68.958
## - smoothness.worst        1   24.273 69.277
## - smoothness.stderr       1   24.298 69.683
## - texture.worst           1   24.302 69.756
## - concavity.stderr        1   24.323 70.103
## - concavity.worst         1   24.332 70.243
## <none>                        24.213 70.289
## - radius.worst            1   24.442 72.036
## - compactness             1   24.442 72.048
## - fractaldimension.worst  1   24.477 72.616
## - radius.stderr           1   24.498 72.961
## - symmetry.worst          1   24.607 74.728
## - perimeter               1   24.736 76.818
## - concavepoints           1   24.924 79.838
## - area.worst              1   25.394 87.285
## - radius                  1   25.433 87.901
##
## Step:  AIC=68.35
## diagnosis ~ id + radius + texture + perimeter + area + smoothness +
##     compactness + concavepoints + symmetry + fractaldimension +
##     radius.stderr + texture.stderr + perimeter.stderr + smoothness.stderr +
##     compactness.stderr + concavity.stderr + radius.worst + texture.worst +
##     perimeter.worst + area.worst + smoothness.worst + concavity.worst +
##     concavepoints.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - smoothness              1   24.221 66.411
## - perimeter.worst         1   24.223 66.443
## - area                    1   24.223 66.450
## - texture                 1   24.225 66.486
## - texture.stderr          1   24.234 66.637
## - symmetry                1   24.243 66.776
## - fractaldimension        1   24.244 66.797
## - perimeter.stderr        1   24.251 66.906
## - id                      1   24.259 67.040
## - concavepoints.worst     1   24.260 67.067
## - smoothness.worst        1   24.275 67.307
## - compactness.stderr      1   24.288 67.528
## - texture.worst           1   24.309 67.865
## - smoothness.stderr       1   24.313 67.927
## <none>                        24.217 68.347
## - concavity.worst         1   24.340 68.370
## - concavity.stderr        1   24.388 69.154
## - radius.worst            1   24.473 70.543
## - radius.stderr           1   24.499 70.977
## - fractaldimension.worst  1   24.538 71.614
## - compactness             1   24.606 72.709
## - symmetry.worst          1   24.616 72.876
## - perimeter               1   24.743 74.928
```

```
## - concavepoints           1   25.008 79.183
## - area.worst              1   25.405 85.454
## - radius                  1   25.509 87.096
##
## Step:  AIC=66.41
## diagnosis ~ id + radius + texture + perimeter + area + compactness +
##     concavepoints + symmetry + fractaldimension + radius.stderr +
##     texture.stderr + perimeter.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + perimeter.worst +
##     area.worst + smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - area                    1   24.226 64.506
## - perimeter.worst         1   24.227 64.513
## - texture                 1   24.230 64.573
## - texture.stderr          1   24.236 64.659
## - symmetry                1   24.244 64.796
## - fractaldimension        1   24.245 64.806
## - perimeter.stderr        1   24.258 65.020
## - id                      1   24.262 65.092
## - concavepoints.worst     1   24.267 65.169
## - compactness.stderr      1   24.291 65.564
## - texture.worst           1   24.309 65.865
## - smoothness.stderr       1   24.314 65.943
## - concavity.worst         1   24.341 66.383
## <none>                        24.221 66.411
## - smoothness.worst        1   24.378 67.004
## - concavity.stderr        1   24.388 67.162
## - radius.worst            1   24.477 68.620
## - radius.stderr           1   24.513 69.207
## - fractaldimension.worst  1   24.545 69.716
## - compactness             1   24.607 70.732
## - symmetry.worst          1   24.617 70.896
## - perimeter               1   24.743 72.928
## - concavepoints           1   25.110 78.793
## - area.worst              1   25.449 84.149
## - radius                  1   25.509 85.096
##
## Step:  AIC=64.51
## diagnosis ~ id + radius + texture + perimeter + compactness +
##     concavepoints + symmetry + fractaldimension + radius.stderr +
##     texture.stderr + perimeter.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + perimeter.worst +
##     area.worst + smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - perimeter.worst         1   24.232 62.605
## - texture                 1   24.238 62.689
## - texture.stderr          1   24.240 62.729
## - symmetry                1   24.248 62.864
## - fractaldimension        1   24.251 62.911
## - perimeter.stderr        1   24.262 63.089
```

```
## - id                       1   24.267 63.169
## - concavepoints.worst      1   24.282 63.423
## - compactness.stderr       1   24.296 63.646
## - texture.worst            1   24.311 63.907
## - smoothness.stderr        1   24.323 64.100
## - concavity.worst          1   24.345 64.449
## <none>                         24.226 64.506
## - smoothness.worst         1   24.379 65.014
## - concavity.stderr         1   24.401 65.370
## - radius.worst             1   24.492 66.858
## - radius.stderr            1   24.515 67.229
## - fractaldimension.worst   1   24.548 67.772
## - symmetry.worst           1   24.620 68.935
## - compactness              1   24.622 68.973
## - perimeter                1   24.786 71.626
## - concavepoints            1   25.280 79.501
## - radius                   1   25.536 83.515
## - area.worst               1   25.551 83.741
##
## Step:  AIC=62.6
## diagnosis ~ id + radius + texture + perimeter + compactness +
##     concavepoints + symmetry + fractaldimension + radius.stderr +
##     texture.stderr + perimeter.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                           Df Deviance    AIC
## - texture                  1   24.242 60.770
## - texture.stderr           1   24.249 60.881
## - symmetry                 1   24.256 60.990
## - fractaldimension         1   24.264 61.120
## - perimeter.stderr         1   24.270 61.223
## - id                       1   24.275 61.312
## - concavepoints.worst      1   24.290 61.554
## - compactness.stderr       1   24.308 61.857
## - texture.worst            1   24.322 62.083
## - smoothness.stderr        1   24.333 62.261
## <none>                         24.232 62.605
## - concavity.worst          1   24.366 62.796
## - smoothness.worst         1   24.383 63.071
## - concavity.stderr         1   24.412 63.545
## - fractaldimension.worst   1   24.571 66.149
## - symmetry.worst           1   24.632 67.135
## - compactness              1   24.636 67.196
## - radius.stderr            1   24.644 67.333
## - perimeter                1   24.797 69.797
## - radius.worst             1   24.921 71.787
## - concavepoints            1   25.288 77.612
## - radius                   1   25.555 81.816
## - area.worst               1   25.560 81.889
##
## Step:  AIC=60.77
## diagnosis ~ id + radius + perimeter + compactness + concavepoints +
```

```
##     symmetry + fractaldimension + radius.stderr + texture.stderr +
##     perimeter.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - symmetry                1   24.265 59.140
## - fractaldimension        1   24.273 59.272
## - texture.stderr          1   24.276 59.323
## - perimeter.stderr        1   24.281 59.408
## - id                      1   24.285 59.476
## - concavepoints.worst     1   24.307 59.832
## - compactness.stderr      1   24.320 60.049
## - smoothness.stderr       1   24.363 60.743
## <none>                        24.242 60.770
## - concavity.worst         1   24.375 60.951
## - smoothness.worst        1   24.383 61.075
## - concavity.stderr        1   24.424 61.741
## - fractaldimension.worst  1   24.580 64.294
## - symmetry.worst          1   24.634 65.164
## - compactness             1   24.638 65.230
## - radius.stderr           1   24.686 66.004
## - perimeter               1   24.797 67.800
## - radius.worst            1   24.921 69.792
## - texture.worst           1   25.175 73.838
## - concavepoints           1   25.324 76.189
## - area.worst              1   25.564 79.958
## - radius                  1   25.603 80.558
##
## Step:  AIC=59.14
## diagnosis ~ id + radius + perimeter + compactness + concavepoints +
##     fractaldimension + radius.stderr + texture.stderr + perimeter.stderr +
##     smoothness.stderr + compactness.stderr + concavity.stderr +
##     radius.worst + texture.worst + area.worst + smoothness.worst +
##     concavity.worst + concavepoints.worst + symmetry.worst +
##     fractaldimension.worst
##
##                          Df Deviance    AIC
## - fractaldimension        1   24.296 57.651
## - perimeter.stderr        1   24.299 57.700
## - texture.stderr          1   24.302 57.743
## - id                      1   24.310 57.887
## - concavepoints.worst     1   24.327 58.164
## - compactness.stderr      1   24.339 58.357
## - smoothness.stderr       1   24.384 59.092
## <none>                        24.265 59.140
## - concavity.worst         1   24.410 59.519
## - smoothness.worst        1   24.410 59.524
## - concavity.stderr        1   24.447 60.125
## - fractaldimension.worst  1   24.610 62.776
## - radius.stderr           1   24.686 64.013
## - compactness             1   24.733 64.761
## - symmetry.worst          1   24.775 65.442
```

```
## - perimeter               1   24.809 65.996
## - radius.worst            1   24.996 68.990
## - texture.worst           1   25.214 72.450
## - concavepoints           1   25.327 74.232
## - radius                  1   25.609 78.653
## - area.worst              1   25.620 78.830
##
## Step:  AIC=57.65
## diagnosis ~ id + radius + perimeter + compactness + concavepoints +
##     radius.stderr + texture.stderr + perimeter.stderr + smoothness.stderr +
##     compactness.stderr + concavity.stderr + radius.worst + texture.worst +
##     area.worst + smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - perimeter.stderr        1   24.336 56.311
## - id                      1   24.337 56.325
## - texture.stderr          1   24.340 56.382
## - concavepoints.worst     1   24.343 56.420
## - compactness.stderr      1   24.362 56.736
## - smoothness.stderr       1   24.409 57.510
## <none>                        24.296 57.651
## - smoothness.worst        1   24.424 57.748
## - concavity.stderr        1   24.459 58.317
## - concavity.worst         1   24.515 59.236
## - fractaldimension.worst  1   24.716 62.494
## - radius.stderr           1   24.722 62.581
## - symmetry.worst          1   24.809 63.988
## - perimeter               1   24.827 64.280
## - compactness             1   25.126 69.048
## - radius.worst            1   25.180 69.905
## - texture.worst           1   25.308 71.931
## - concavepoints           1   25.328 72.258
## - radius                  1   25.624 76.889
## - area.worst              1   25.856 80.483
##
## Step:  AIC=56.31
## diagnosis ~ id + radius + perimeter + compactness + concavepoints +
##     radius.stderr + texture.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - id                      1   24.382 55.055
## - texture.stderr          1   24.394 55.257
## - concavepoints.worst     1   24.395 55.268
## - compactness.stderr      1   24.441 56.025
## <none>                        24.336 56.311
## - smoothness.worst        1   24.470 56.496
## - smoothness.stderr       1   24.479 56.644
## - concavity.worst         1   24.544 57.708
## - concavity.stderr        1   24.594 58.509
## - fractaldimension.worst  1   24.808 61.968
```

```
## - symmetry.worst          1   24.843 62.532
## - perimeter               1   24.894 63.360
## - compactness             1   25.259 69.161
## - radius.worst            1   25.335 70.354
## - texture.worst           1   25.347 70.550
## - concavepoints           1   25.416 71.627
## - radius.stderr           1   25.502 72.974
## - radius                  1   25.630 74.976
## - area.worst              1   26.005 80.772
##
## Step:  AIC=55.06
## diagnosis ~ radius + perimeter + compactness + concavepoints +
##     radius.stderr + texture.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - texture.stderr          1   24.430 53.849
## - concavepoints.worst     1   24.445 54.090
## - compactness.stderr      1   24.486 54.767
## - smoothness.stderr       1   24.503 55.028
## <none>                        24.382 55.055
## - smoothness.worst        1   24.521 55.330
## - concavity.worst         1   24.586 56.388
## - concavity.stderr        1   24.631 57.115
## - fractaldimension.worst  1   24.859 60.799
## - symmetry.worst          1   24.893 61.343
## - perimeter               1   24.943 62.137
## - compactness             1   25.291 67.664
## - texture.worst           1   25.363 68.795
## - radius.worst            1   25.412 69.563
## - concavepoints           1   25.468 70.445
## - radius.stderr           1   25.558 71.856
## - radius                  1   25.648 73.252
## - area.worst              1   26.089 80.058
##
## Step:  AIC=53.85
## diagnosis ~ radius + perimeter + compactness + concavepoints +
##     radius.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + concavepoints.worst +
##     symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - concavepoints.worst     1   24.480 52.671
## - compactness.stderr      1   24.538 53.605
## - smoothness.stderr       1   24.544 53.705
## <none>                        24.430 53.849
## - smoothness.worst        1   24.581 54.307
## - concavity.stderr        1   24.636 55.194
## - concavity.worst         1   24.666 55.689
## - fractaldimension.worst  1   24.919 59.751
## - symmetry.worst          1   24.959 60.397
```

```
## - perimeter               1   25.029 61.508
## - compactness             1   25.322 66.156
## - concavepoints           1   25.468 68.457
## - radius.stderr           1   25.573 70.091
## - radius.worst            1   25.581 70.223
## - texture.worst           1   25.688 71.882
## - radius                  1   25.708 72.186
## - area.worst              1   26.195 79.671
##
## Step:  AIC=52.67
## diagnosis ~ radius + perimeter + compactness + concavepoints +
##     radius.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     smoothness.worst + concavity.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## - smoothness.worst        1   24.594 52.522
## <none>                        24.480 52.671
## - compactness.stderr      1   24.621 52.952
## - smoothness.stderr       1   24.627 53.043
## - concavity.worst         1   24.674 53.807
## - concavity.stderr        1   24.691 54.083
## - fractaldimension.worst  1   24.949 58.231
## - symmetry.worst          1   24.984 58.792
## - perimeter               1   25.030 59.530
## - compactness             1   25.335 64.365
## - concavepoints           1   25.582 68.230
## - radius.worst            1   25.588 68.319
## - radius                  1   25.709 70.212
## - radius.stderr           1   25.726 70.468
## - texture.worst           1   25.754 70.911
## - area.worst              1   26.197 77.716
##
## Step:  AIC=52.52
## diagnosis ~ radius + perimeter + compactness + concavepoints +
##     radius.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     concavity.worst + symmetry.worst + fractaldimension.worst
##
##                          Df Deviance    AIC
## <none>                        24.594 52.522
## - concavity.stderr        1   24.783 53.568
## - concavity.worst         1   24.863 54.860
## - compactness.stderr      1   24.972 56.602
## - symmetry.worst          1   25.153 59.489
## - smoothness.stderr       1   25.160 59.586
## - perimeter               1   25.257 61.126
## - fractaldimension.worst  1   25.276 61.432
## - compactness             1   25.348 62.562
## - radius.stderr           1   25.738 68.656
## - radius                  1   25.783 69.352
## - concavepoints           1   25.828 70.043
## - texture.worst           1   25.870 70.696
## - radius.worst            1   25.878 70.819
```

```
## - area.worst               1   26.442 79.420
```

The backwards model takes the full model with 30 features.However, this does not mean that model performs well as the increasing the number of features can lead to over fitting and negatively impact on the model. We can see that the AIC(an estimator of the model's prediction error decreases) is obtained to be with 52.52 with 14 features. AIC value can be used to compare the two models. In addition, we can also see that the final backward mode(Model_B) considers concavepoints as the most representative feature for having malignant tumour. This feature has positive regression coefficinet which means it increases the probability of a malignant tumor. Thus, it's scary to have increased number of concave points as that indicates problems.

```
#Forward Selection

Model_S<- stepAIC(Null_model,scope = list(upper = full_model), direction ="forward")
```

```
## Start:  AIC=556.76
## diagnosis ~ 1
##
##                            Df Deviance    AIC
## + concavepoints.worst       1   39.401 214.56
## + concavepoints             1   40.620 226.72
## + perimeter.worst           1   40.634 226.86
## + radius.worst              1   41.657 236.77
## + perimeter                 1   44.960 267.22
## + radius                    1   45.009 267.65
## + concavity                 1   46.527 280.89
## + area.worst                1   46.864 283.77
## + area                      1   50.136 310.69
## + concavity.worst           1   50.482 313.44
## + area.stderr               1   55.244 349.41
## + radius.stderr             1   58.015 368.93
## + perimeter.stderr          1   59.413 378.44
## + compactness               1   61.101 389.62
## + compactness.worst         1   61.771 393.97
## + concavepoints.stderr      1   74.384 468.10
## + texture.worst             1   74.652 469.54
## + symmetry.worst            1   75.640 474.79
## + texture                   1   77.192 482.89
## + smoothness.worst          1   79.726 495.78
## + compactness.stderr        1   81.361 503.88
## + symmetry                  1   81.875 506.39
## + smoothness                1   82.711 510.44
## + fractaldimension.worst    1   83.818 515.75
## + concavity.stderr          1   84.595 519.43
## + fractaldimension.stderr   1   91.041 548.73
## <none>                          93.358 556.76
## + symmetry.stderr           1   93.161 557.91
## + smoothness.stderr         1   93.180 557.99
## + texture.stderr            1   93.212 558.13
## + id                        1   93.292 558.48
## + fractaldimension          1   93.349 558.72
##
## Step:  AIC=214.56
## diagnosis ~ concavepoints.worst
##
##                            Df Deviance    AIC
```

```
## + radius                   1   34.493 163.48
## + radius.worst             1   34.882 167.96
## + perimeter.worst          1   35.322 172.95
## + radius.stderr            1   35.534 175.34
## + texture                  1   35.652 176.67
## + perimeter                1   35.787 178.18
## + area.worst               1   36.295 183.80
## + texture.worst            1   36.304 183.90
## + area.stderr              1   36.360 184.51
## + area                     1   36.600 187.13
## + perimeter.stderr         1   36.896 190.35
## + concavepoints            1   37.569 197.56
## + fractaldimension         1   37.991 202.02
## + texture.stderr           1   38.370 205.98
## + concavity                1   38.471 207.03
## + fractaldimension.worst   1   38.618 208.55
## + compactness.worst        1   38.760 210.02
## + compactness              1   39.101 213.51
## + compactness.stderr       1   39.148 213.99
## <none>                         39.401 214.56
## + smoothness               1   39.215 214.67
## + symmetry.stderr          1   39.232 214.84
## + smoothness.worst         1   39.282 215.35
## + concavity.worst          1   39.333 215.87
## + fractaldimension.stderr  1   39.336 215.90
## + symmetry.worst           1   39.345 215.99
## + concavity.stderr         1   39.353 216.07
## + smoothness.stderr        1   39.374 216.29
## + symmetry                 1   39.390 216.45
## + concavepoints.stderr     1   39.394 216.49
## + id                       1   39.399 216.54
##
## Step:  AIC=163.48
## diagnosis ~ concavepoints.worst + radius
##
##                           Df Deviance    AIC
## + texture.worst            1   32.055 136.23
## + texture                  1   32.127 137.12
## + radius.stderr            1   32.851 146.01
## + texture.stderr           1   33.207 150.32
## + smoothness.worst         1   33.347 152.00
## + perimeter.stderr         1   33.636 155.44
## + smoothness.stderr        1   33.661 155.74
## + concavity                1   33.676 155.92
## + symmetry.worst           1   33.687 156.04
## + area.stderr              1   33.872 158.23
## + concavity.worst          1   33.876 158.28
## + concavepoints            1   33.946 159.10
## + symmetry.stderr          1   33.981 159.51
## + symmetry                 1   33.990 159.62
## + smoothness               1   34.120 161.14
## + fractaldimension.worst   1   34.206 162.15
## + concavity.stderr         1   34.211 162.21
## + fractaldimension.stderr  1   34.317 163.44
```

```
## + radius.worst             1   34.319 163.46
## <none>                         34.493 163.48
## + perimeter                1   34.386 164.24
## + fractaldimension         1   34.401 164.42
## + perimeter.worst          1   34.427 164.72
## + area                     1   34.447 164.94
## + id                       1   34.473 165.25
## + compactness              1   34.481 165.34
## + area.worst               1   34.487 165.41
## + concavepoints.stderr     1   34.489 165.43
## + compactness.worst        1   34.489 165.43
## + compactness.stderr       1   34.492 165.47
##
## Step:  AIC=136.23
## diagnosis ~ concavepoints.worst + radius + texture.worst
##
##                           Df Deviance    AIC
## + radius.stderr            1   30.267 115.33
## + perimeter.stderr         1   31.132 126.57
## + smoothness.worst         1   31.159 126.92
## + concavepoints            1   31.177 127.14
## + concavity                1   31.219 127.69
## + smoothness               1   31.223 127.73
## + smoothness.stderr        1   31.241 127.97
## + area.stderr              1   31.307 128.81
## + symmetry                 1   31.376 129.69
## + symmetry.stderr          1   31.420 130.25
## + symmetry.worst           1   31.464 130.81
## + concavity.stderr         1   31.644 133.08
## + fractaldimension.stderr  1   31.726 134.12
## + concavity.worst          1   31.759 134.53
## + fractaldimension         1   31.780 134.80
## + texture.stderr           1   31.808 135.15
## + fractaldimension.worst   1   31.826 135.38
## <none>                         32.055 136.23
## + concavepoints.stderr     1   31.935 136.74
## + texture                  1   31.971 137.19
## + compactness              1   31.978 137.27
## + perimeter                1   31.979 137.28
## + area                     1   32.000 137.54
## + radius.worst             1   32.002 137.57
## + id                       1   32.011 137.68
## + compactness.worst        1   32.030 137.93
## + compactness.stderr       1   32.041 138.06
## + perimeter.worst          1   32.050 138.17
## + area.worst               1   32.053 138.21
##
## Step:  AIC=115.33
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr
##
##                           Df Deviance    AIC
## + area.stderr              1   29.228 103.40
## + smoothness.worst         1   29.246 103.64
## + symmetry.worst           1   29.441 106.29
```

```
## + perimeter.stderr         1   29.529 107.49
## + area.worst               1   29.720 110.05
## + perimeter                1   29.753 110.50
## + area                     1   29.796 111.07
## + concavity.worst          1   29.843 111.69
## + smoothness               1   29.852 111.83
## + fractaldimension.worst   1   29.858 111.90
## + perimeter.worst          1   29.894 112.38
## + symmetry                 1   30.040 114.33
## + concavity                1   30.047 114.42
## + radius.worst             1   30.113 115.30
## <none>                         30.267 115.33
## + smoothness.stderr        1   30.144 115.70
## + compactness.stderr       1   30.146 115.73
## + concavity.stderr         1   30.153 115.83
## + concavepoints            1   30.203 116.49
## + symmetry.stderr          1   30.207 116.54
## + concavepoints.stderr     1   30.208 116.55
## + texture.stderr           1   30.214 116.63
## + fractaldimension         1   30.221 116.73
## + id                       1   30.231 116.85
## + fractaldimension.stderr  1   30.246 117.05
## + texture                  1   30.252 117.13
## + compactness              1   30.255 117.18
## + compactness.worst        1   30.266 117.32
##
## Step:  AIC=103.4
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr
##
##                           Df Deviance     AIC
## + smoothness.worst         1   28.169  90.662
## + perimeter.stderr         1   28.473  94.951
## + symmetry.worst           1   28.547  95.983
## + concavepoints.stderr     1   28.777  99.188
## + concavity.worst          1   28.867 100.437
## + smoothness               1   28.938 101.412
## + fractaldimension.worst   1   28.957 101.676
## + compactness.stderr       1   28.990 102.125
## <none>                         29.228 103.398
## + concavepoints            1   29.087 103.471
## + texture.stderr           1   29.095 103.571
## + concavity                1   29.116 103.861
## + compactness              1   29.133 104.091
## + texture                  1   29.140 104.185
## + smoothness.stderr        1   29.147 104.281
## + radius.worst             1   29.161 104.475
## + perimeter                1   29.168 104.570
## + symmetry                 1   29.184 104.794
## + id                       1   29.202 105.043
## + concavity.stderr         1   29.206 105.089
## + area                     1   29.207 105.103
## + fractaldimension.stderr  1   29.224 105.335
## + symmetry.stderr          1   29.226 105.358
```

```
## + area.worst               1   29.228 105.387
## + fractaldimension         1   29.228 105.393
## + compactness.worst        1   29.228 105.394
## + perimeter.worst          1   29.228 105.398
##
## Step:  AIC=90.66
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst
##
##                           Df Deviance    AIC
## + symmetry.worst           1   27.655 85.322
## + perimeter.stderr         1   27.683 85.722
## + concavity.worst          1   27.783 87.166
## + compactness              1   27.914 89.039
## + concavepoints.stderr     1   27.927 89.227
## <none>                         28.169 90.662
## + fractaldimension         1   28.050 90.985
## + compactness.stderr       1   28.071 91.272
## + concavity.stderr         1   28.073 91.311
## + fractaldimension.worst   1   28.089 91.527
## + smoothness               1   28.093 91.588
## + concavity                1   28.094 91.604
## + texture.stderr           1   28.100 91.692
## + radius.worst             1   28.107 91.790
## + concavepoints            1   28.116 91.919
## + id                       1   28.130 92.112
## + symmetry.stderr          1   28.142 92.287
## + smoothness.stderr        1   28.142 92.291
## + perimeter                1   28.148 92.374
## + texture                  1   28.156 92.483
## + area.worst               1   28.162 92.573
## + symmetry                 1   28.164 92.592
## + perimeter.worst          1   28.166 92.618
## + compactness.worst        1   28.167 92.642
## + fractaldimension.stderr  1   28.167 92.646
## + area                     1   28.168 92.652
##
## Step:  AIC=85.32
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst
##
##                           Df Deviance    AIC
## + perimeter.stderr         1   27.106 79.323
## + compactness              1   27.286 81.958
## + concavity.worst          1   27.387 83.437
## + symmetry                 1   27.405 83.701
## + fractaldimension         1   27.512 85.245
## <none>                         27.655 85.322
## + concavity.stderr         1   27.519 85.349
## + concavepoints.stderr     1   27.559 85.934
## + compactness.stderr       1   27.566 86.035
## + symmetry.stderr          1   27.573 86.137
## + concavepoints            1   27.582 86.266
## + compactness.worst        1   27.592 86.408
```

```
## + smoothness               1   27.603 86.572
## + concavity                1   27.606 86.609
## + fractaldimension.worst   1   27.620 86.814
## + radius.worst             1   27.631 86.968
## + id                       1   27.632 86.993
## + perimeter                1   27.635 87.031
## + area.worst               1   27.636 87.049
## + texture.stderr           1   27.637 87.057
## + perimeter.worst          1   27.649 87.231
## + texture                  1   27.654 87.300
## + area                     1   27.655 87.319
## + fractaldimension.stderr  1   27.655 87.322
## + smoothness.stderr        1   27.655 87.322
##
## Step:  AIC=79.32
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr
##
##                           Df Deviance    AIC
## + concavity.worst          1   26.755 76.122
## + symmetry                 1   26.930 78.714
## + concavity                1   26.957 79.115
## <none>                         27.106 79.323
## + compactness              1   26.972 79.343
## + area.worst               1   26.980 79.458
## + concavepoints            1   26.986 79.555
## + concavity.stderr         1   26.993 79.648
## + fractaldimension.worst   1   27.023 80.104
## + fractaldimension         1   27.075 80.862
## + smoothness               1   27.084 80.994
## + id                       1   27.089 81.065
## + perimeter                1   27.089 81.071
## + fractaldimension.stderr  1   27.090 81.082
## + concavepoints.stderr     1   27.093 81.130
## + area                     1   27.097 81.193
## + symmetry.stderr          1   27.099 81.220
## + radius.worst             1   27.103 81.269
## + compactness.stderr       1   27.103 81.274
## + compactness.worst        1   27.104 81.293
## + smoothness.stderr        1   27.105 81.304
## + texture.stderr           1   27.106 81.316
## + texture                  1   27.106 81.322
## + perimeter.worst          1   27.106 81.323
##
## Step:  AIC=76.12
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst
##
##                           Df Deviance    AIC
## + compactness              1   26.347 71.987
## + compactness.worst        1   26.491 74.169
## + symmetry                 1   26.583 75.541
## + compactness.stderr       1   26.601 75.814
```

```
## <none>                          26.755 76.122
## + fractaldimension         1   26.630 76.248
## + area.worst               1   26.652 76.587
## + concavepoints            1   26.664 76.760
## + perimeter                1   26.729 77.732
## + id                       1   26.734 77.802
## + concavepoints.stderr     1   26.734 77.810
## + fractaldimension.stderr  1   26.742 77.929
## + smoothness               1   26.747 78.000
## + symmetry.stderr          1   26.748 78.019
## + area                     1   26.749 78.036
## + texture.stderr           1   26.752 78.070
## + perimeter.worst          1   26.754 78.107
## + texture                  1   26.754 78.110
## + concavity                1   26.754 78.110
## + concavity.stderr         1   26.755 78.114
## + smoothness.stderr        1   26.755 78.118
## + radius.worst             1   26.755 78.121
## + fractaldimension.worst   1   26.755 78.121
##
## Step:  AIC=71.99
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness
##
##                           Df Deviance    AIC
## + concavepoints            1   25.868 66.671
## + concavity                1   26.158 71.114
## + area.worst               1   26.194 71.656
## <none>                         26.347 71.987
## + fractaldimension.worst   1   26.267 72.778
## + smoothness               1   26.294 73.192
## + compactness.worst        1   26.299 73.253
## + fractaldimension.stderr  1   26.299 73.258
## + id                       1   26.315 73.508
## + symmetry                 1   26.318 73.551
## + concavity.stderr         1   26.322 73.607
## + fractaldimension         1   26.327 73.685
## + texture                  1   26.334 73.794
## + smoothness.stderr        1   26.336 73.818
## + radius.worst             1   26.337 73.834
## + compactness.stderr       1   26.340 73.879
## + perimeter.worst          1   26.342 73.908
## + perimeter                1   26.342 73.909
## + texture.stderr           1   26.345 73.950
## + symmetry.stderr          1   26.345 73.955
## + area                     1   26.346 73.968
## + concavepoints.stderr     1   26.347 73.983
##
## Step:  AIC=66.67
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness + concavepoints
##
```

```
##                            Df Deviance    AIC
## + fractaldimension.worst    1   25.585 64.286
## + area.worst                1   25.642 65.174
## + perimeter                 1   25.668 65.566
## + area                      1   25.669 65.588
## <none>                          25.868 66.671
## + fractaldimension.stderr   1   25.789 67.450
## + symmetry                  1   25.809 67.754
## + concavity.stderr          1   25.825 68.009
## + radius.worst              1   25.826 68.010
## + fractaldimension          1   25.832 68.113
## + perimeter.worst           1   25.836 68.168
## + id                        1   25.841 68.254
## + symmetry.stderr           1   25.841 68.258
## + texture.stderr            1   25.849 68.377
## + texture                   1   25.863 68.592
## + compactness.worst         1   25.863 68.598
## + smoothness                1   25.864 68.604
## + concavity                 1   25.867 68.655
## + concavepoints.stderr      1   25.867 68.656
## + compactness.stderr        1   25.868 68.671
## + smoothness.stderr         1   25.868 68.671
##
## Step:  AIC=64.29
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness + concavepoints + fractaldimension.worst
##
##                            Df Deviance    AIC
## + area.worst                1   25.319 62.105
## + area                      1   25.409 63.521
## + perimeter                 1   25.429 63.840
## <none>                          25.585 64.286
## + concavity.stderr          1   25.521 65.279
## + symmetry                  1   25.536 65.507
## + fractaldimension          1   25.538 65.541
## + radius.worst              1   25.540 65.568
## + perimeter.worst           1   25.553 65.786
## + id                        1   25.562 65.926
## + concavepoints.stderr      1   25.567 65.999
## + compactness.worst         1   25.568 66.006
## + concavity                 1   25.570 66.044
## + texture.stderr            1   25.574 66.100
## + texture                   1   25.580 66.205
## + symmetry.stderr           1   25.582 66.227
## + fractaldimension.stderr   1   25.582 66.236
## + compactness.stderr        1   25.583 66.248
## + smoothness.stderr         1   25.584 66.269
## + smoothness                1   25.585 66.285
##
## Step:  AIC=62.1
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness + concavepoints + fractaldimension.worst +
```

```
##     area.worst
##
##                            Df Deviance    AIC
## + radius.worst              1   25.051 59.863
## + perimeter.worst           1   25.109 60.787
## <none>                          25.319 62.105
## + fractaldimension          1   25.231 62.719
## + symmetry                  1   25.232 62.735
## + perimeter                 1   25.233 62.748
## + texture.stderr            1   25.258 63.147
## + id                        1   25.285 63.566
## + compactness.stderr        1   25.287 63.608
## + symmetry.stderr           1   25.288 63.615
## + concavity.stderr          1   25.299 63.800
## + smoothness                1   25.304 63.878
## + area                      1   25.310 63.966
## + concavepoints.stderr      1   25.315 64.041
## + smoothness.stderr         1   25.315 64.045
## + compactness.worst         1   25.317 64.074
## + concavity                 1   25.317 64.081
## + fractaldimension.stderr   1   25.318 64.096
## + texture                   1   25.319 64.100
##
## Step:  AIC=59.86
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness + concavepoints + fractaldimension.worst +
##     area.worst + radius.worst
##
##                            Df Deviance    AIC
## + perimeter                 1   24.577 54.235
## <none>                          25.051 59.863
## + concavity.stderr          1   24.959 60.386
## + compactness.worst         1   24.995 60.964
## + concavity                 1   24.996 60.982
## + area                      1   25.004 61.116
## + symmetry                  1   25.023 61.418
## + compactness.stderr        1   25.031 61.538
## + id                        1   25.031 61.548
## + texture.stderr            1   25.036 61.616
## + fractaldimension.stderr   1   25.036 61.620
## + smoothness                1   25.036 61.624
## + concavepoints.stderr      1   25.038 61.649
## + fractaldimension          1   25.044 61.749
## + texture                   1   25.047 61.803
## + smoothness.stderr         1   25.048 61.819
## + perimeter.worst           1   25.049 61.836
## + symmetry.stderr           1   25.050 61.846
##
## Step:  AIC=54.23
## diagnosis ~ concavepoints.worst + radius + texture.worst + radius.stderr +
##     area.stderr + smoothness.worst + symmetry.worst + perimeter.stderr +
##     concavity.worst + compactness + concavepoints + fractaldimension.worst +
##     area.worst + radius.worst + perimeter
```

```
##
##                           Df Deviance    AIC
## <none>                         24.577 54.235
## + concavity.stderr         1   24.467 54.456
## + smoothness.stderr        1   24.512 55.191
## + concavepoints.stderr     1   24.533 55.522
## + fractaldimension.stderr  1   24.540 55.644
## + symmetry                 1   24.547 55.759
## + texture                  1   24.550 55.805
## + perimeter.worst          1   24.554 55.864
## + compactness.worst        1   24.557 55.920
## + concavity                1   24.559 55.945
## + id                       1   24.563 56.009
## + area                     1   24.564 56.027
## + smoothness               1   24.564 56.031
## + fractaldimension         1   24.566 56.065
## + symmetry.stderr          1   24.573 56.184
## + texture.stderr           1   24.575 56.206
## + compactness.stderr       1   24.575 56.209
```

The forward model takes a null model(which is a model without any feature) and only considers the intercept as a starting point and then progress towards the full model (with 30 features) by adding features. It can be seen here that the final model (forward) considers more features than the backward model. The forward model considers 15 features instead of 14 (in the backwards model)

```
#Summary

summary(Model_B)
```

```
##
## Call:
## glm(formula = diagnosis ~ radius + perimeter + compactness +
##     concavepoints + radius.stderr + smoothness.stderr + compactness.stderr +
##     concavity.stderr + radius.worst + texture.worst + area.worst +
##     concavity.worst + symmetry.worst + fractaldimension.worst,
##     data = train_breast_cancer)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -1.00848  -0.17672  -0.02864   0.14058   0.95019
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)           -2.3003927  0.2425482  -9.484  < 2e-16 ***
## radius                 0.0743984  0.0172705   4.308 2.10e-05 ***
## perimeter             -0.0111032  0.0034525  -3.216 0.001410 **
## compactness           -2.5826629  0.7529731  -3.430 0.000669 ***
## concavepoints          5.3127566  1.2107301   4.388 1.48e-05 ***
## radius.stderr          0.4256226  0.1007265   4.226 2.98e-05 ***
## smoothness.stderr     16.9805981  5.7165359   2.970 0.003161 **
## compactness.stderr    -3.8819567  1.5987020  -2.428 0.015633 *
## concavity.stderr       0.9488969  0.5530813   1.716 0.087032 .
## radius.worst           0.1408605  0.0314660   4.477 1.00e-05 ***
## texture.worst          0.0105318  0.0023600   4.463 1.07e-05 ***
## area.worst            -0.0009868  0.0001837  -5.371 1.36e-07 ***
```

```
## concavity.worst         0.3504861  0.1710681   2.049 0.041160 *
## symmetry.worst          0.8536208  0.2889478   2.954 0.003327 **
## fractaldimension.worst  4.7503948  1.4559903   3.263 0.001203 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 0.06404781)
##
##     Null deviance: 93.358  on 398  degrees of freedom
## Residual deviance: 24.594  on 384  degrees of freedom
## AIC: 52.522
##
## Number of Fisher Scoring iterations: 2
```

```
summary(Model_S)
```

```
##
## Call:
## glm(formula = diagnosis ~ concavepoints.worst + radius + texture.worst +
##     radius.stderr + area.stderr + smoothness.worst + symmetry.worst +
##     perimeter.stderr + concavity.worst + compactness + concavepoints +
##     fractaldimension.worst + area.worst + radius.worst + perimeter,
##     data = train_breast_cancer)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9743  -0.1720  -0.0246   0.1354   0.9356
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)            -2.2713307  0.2519678  -9.014  < 2e-16 ***
## concavepoints.worst    -0.7037566  0.7687075  -0.916  0.36050
## radius                  0.0856111  0.0174251   4.913 1.33e-06 ***
## texture.worst           0.0108587  0.0023721   4.578 6.37e-06 ***
## radius.stderr           0.9152699  0.3103114   2.950  0.00338 **
## area.stderr            -0.0007198  0.0023919  -0.301  0.76362
## smoothness.worst        2.4703766  0.8976430   2.752  0.00620 **
## symmetry.worst          0.7768531  0.2873158   2.704  0.00716 **
## perimeter.stderr       -0.0503778  0.0308309  -1.634  0.10308
## concavity.worst         0.4276025  0.1579741   2.707  0.00710 **
## compactness            -2.9706608  0.7141464  -4.160 3.94e-05 ***
## concavepoints           5.8623031  1.3875906   4.225 2.99e-05 ***
## fractaldimension.worst  3.3772683  1.4952962   2.259  0.02447 *
## area.worst             -0.0008448  0.0002321  -3.640  0.00031 ***
## radius.worst            0.1106887  0.0346149   3.198  0.00150 **
## perimeter              -0.0102155  0.0037572  -2.719  0.00685 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 0.06416889)
##
##     Null deviance: 93.358  on 398  degrees of freedom
## Residual deviance: 24.577  on 383  degrees of freedom
## AIC: 54.235
##
```

	Coefficients		Coefficients
smoothness.stderr	16.9805981	concavepoints	5.8623031
concavepoints	5.3127566	fractaldimension.worst	3.3772683
fractaldimension.worst	4.7503948	compactness	-2.9706608
compactness.stderr	-3.8819567	smoothness.worst	2.4703766
compactness	-2.5826629	(Intercept)	-2.2713307
(Intercept)	-2.3003927	radius.stderr	0.9152699
concavity.stderr	0.9488969	symmetry.worst	0.7768531
symmetry.worst	0.8536208	concavepoints.worst	-0.7037566
radius.stderr	0.4256226	concavity.worst	0.4276025
concavity.worst	0.3504861	radius.worst	0.1106887
radius.worst	0.1408605	radius	0.0856111
radius	0.0743984	perimeter.stderr	-0.0503778
perimeter	-0.0111032	texture.worst	0.0108587
texture.worst	0.0105318	perimeter	-0.0102155
area.worst	-0.0009868	area.worst	-0.0008448
		area.stderr	-0.0007198

```
## Number of Fisher Scoring iterations: 2
```

```
#Regression Coeifficients in decreasing order

modelB.coef1 <-Model_B$coefficients
sort_modelB.coef1<- order(abs(modelB.coef1), decreasing = TRUE)

modelS.coef1 <-Model_S$coefficients
sort_modelS.coef1<- order(abs(modelS.coef1), decreasing = TRUE)


kable(list(modelB.coef1[sort_modelB.coef1], modelS.coef1[sort_modelS.coef1]),col.names = "Coefficients"
```

We can see that the most important features in common are: smoothness.worst, concavity.worst, compactness.worst, radius.stderr, radius.worst, texture.stderr, radius, texture.worst, perimeter, area.worst

The forward model considers the following features that are not present in the backwards model: concavity, perimeter.stderr, perimeter.worst,area.stderr

The backwards model considers the following features that are not present in the forward model: concavepoints, concavepoints.wors. Moreover, we can also see the intercept value ~ -2 almost equal for backwards and forwards model. It is not exactly the same. The intecept value is for example for the equation $y = mx + c$ when $y = 0$ for $x = -c/m$. So, similar to equation of line, just as the x intercept is $-c/m$, in our case when the expected outcome when all the features are 0 - is that the tumour is benign.

We can also see a noticable difference between the backward and forward model. The AIC in backward model is

The AIC in the forward and the backward model are different, but not by a great amount. The AIC in the backward model is 52.52 while the AIC in the forward model is 54.23. The difference between them is a reflection of the number of features considered for each model.

Problem 1.d (3 points)

Compare the goodness of fit of model B and model S in an appropriate way.

```
cat("deviance of model B = ", Model_B$deviance, "\n") #cat eye
```

```
## deviance of model B =  24.59436
```

```
cat("deviance of model S = ", Model_S$deviance, "\n")
```

```
## deviance of model S =  24.57668
```

```
#It just means that adding additional terms to null model is reasonable

pchisq(Model_B$null.deviance - Model_B$deviance, df =15, lower.tail =FALSE)
```

```
## [1] 7.40918e-09
```

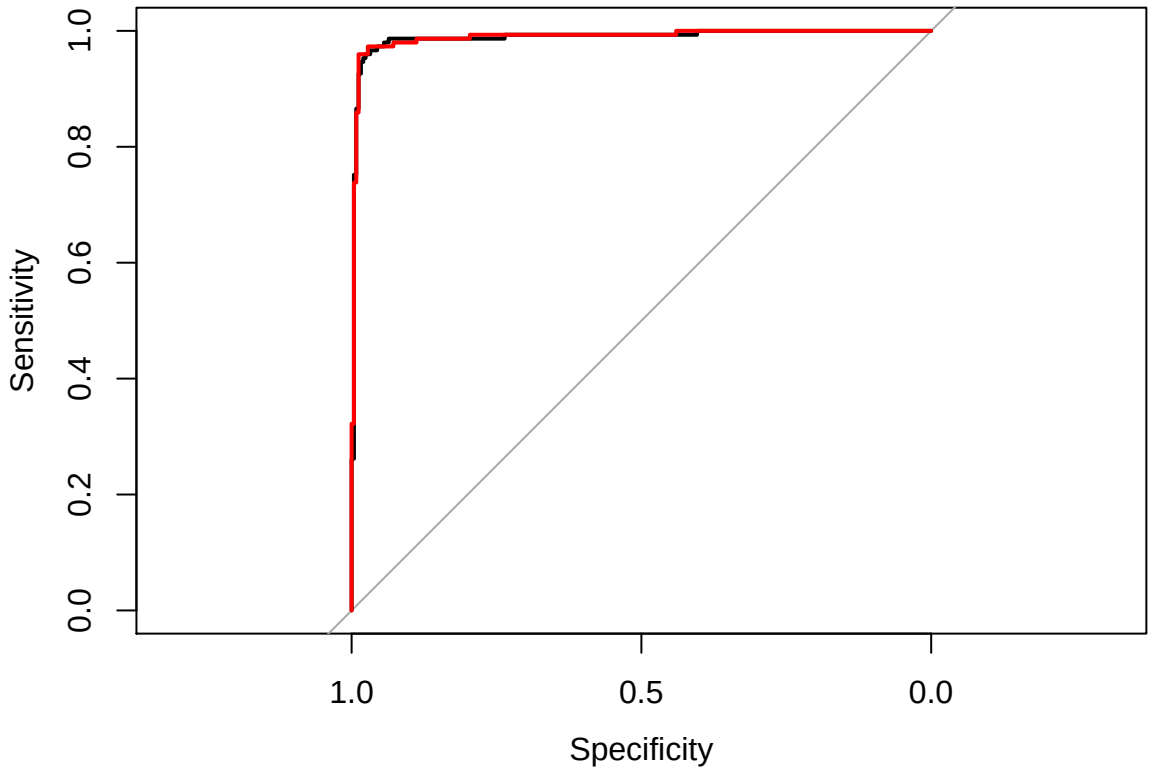
```
pchisq(Model_S$null.deviance - Model_S$deviance, df = 16, lower.tail = FALSE)
```

```
## [1] 1.629431e-08
```

Problem 1.e (2 points)

Compute the training AUC for model B and model S.

```
library(pROC)

train.AUC.model_B = roc(train_breast_cancer$diagnosis, Model_B$fitted.values, plot =TRUE)

train.AUC.model_S = roc(train_breast_cancer$diagnosis, Model_S$fitted.values, plot = TRUE, add= TRUE,co
```

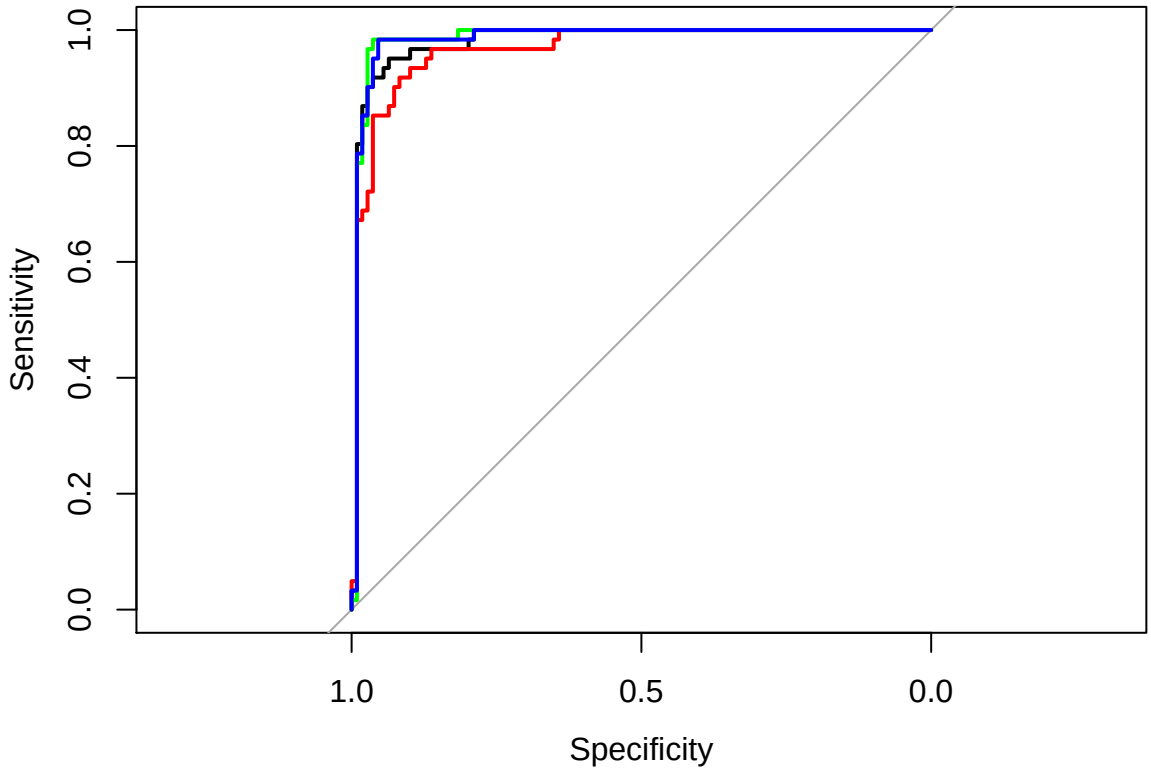


Problem 1.f (6 points)

Use the four models to predict the outcome for the observations in the test set (use the lambda at 1 standard error for the penalised models). Plot the ROC curves of these models (on the sameplot, using different

colours) and report their test AUCs. Compare the training AUCs obtained in problems 1.b and 1.e with the test AUCs and discuss the fit of the different models.

```
#Lasso model

pred_lasso = predict(fit.lasso, newx = as.matrix(test_breast_cancer[,-c(1,2)]),s="lambda.1se")

#Ridge Regression model

pred_ridge = predict(fit.ridge, newx = as.matrix(test_breast_cancer[,-c(1,2)]),s="lambda.1se")

#Model B

pred_modelB = predict(Model_B, newdata = test_breast_cancer, type = "response")

#Model S

pred_modelS = predict(Model_S, newdata = test_breast_cancer, type = "response")

#Now we plot the ROC curves

AUC_lasso = roc(test_breast_cancer$diagnosis, pred_lasso, plot =TRUE, col = "black")$auc
AUC_ridge = roc(test_breast_cancer$diagnosis, pred_ridge, plot =TRUE, col = "red",add= TRUE)$auc
AUC_modelB = roc(test_breast_cancer$diagnosis, pred_modelB, plot =TRUE, col = "green",add= TRUE)$auc
AUC_modelS =  roc(test_breast_cancer$diagnosis, pred_modelS, plot =TRUE, col = "blue",add= TRUE)$auc
```



```
#Compare the AUCs

training_AUC = c(AUC.lambda1se.lasso, AUC.lambda1se.ridge,train.AUC.model_B$auc, train.AUC.model_S$auc)

testing_AUC = c(AUC_lasso, AUC_ridge, AUC_modelB, AUC_modelS)

Final_models = c("Lasso Model", "Ridge Regression Model", "Model B", "Model S")

# We make a table and voila!

table = data.table(Final_models, training_AUC, testing_AUC)
kable(table)
```

Final_models	training_AUC	testing_AUC
Lasso Model	0.9780000	0.9798466
Ridge Regression Model	0.9690000	0.9658595
Model B	0.9886980	0.9846593
Model S	0.9894228	0.9837570

We can see that the Area Under the Curve(AUC)'s obtained for all 4 models are similar, all have auc $>$ 0.95, which tells that they can all distinguish between tumors - benign and malignant. For the training and testing AUC's we can see that AUC's are fairly similar between training and testing for Ridge Regression Model, Model B and Model S. We can also see that Model S has higher training AUC than Model B and subsequently higher than Lasso and Rigde, it falls behind Model B when we find testing AUC. Thus, the best model is the backward model for this particular case as it relates better to expected task of the model which is to determine whether a tumor is malignant or not.

Problem 2 (40 points)

File GDM.raw.txt (available from the accompanying zip folder on Learn) contains 176 SNPs to be studied for association with incidence of gestational diabetes (a form of diabetes that is specific to pregnant women). SNP names are given in the form "rs1234_X" where "rs1234" is the official identifier (rsID), and "X" (one of A, C, G, T) is the reference allele.

Problem 2.a (3 points)

Read file GDM.raw.txt into a data table named gdm.dt. Impute missing values in gdm.dt according to SNP-wise median allele count.

```
GDM <-fread("assignment2/GDM.raw.txt")

gdm.dt <- data.table(GDM)

#Impute to median function(Inspired from Lab4)

for (colnm in colnames(gdm.dt,-1)) {
gdm.dt[[colnm]][is.na(gdm.dt[[colnm]])] <-
median(gdm.dt[[colnm]], na.rm = T)
}

gdm.dt
```

```
##        ID   sex pheno rs7513574_T rs1627238_A rs1171278_C rs1137100_A
```

```
##   1:    1 FALSE     0           1           0           0           2
##   2:    2 FALSE     0           0           0           0           1
##   3:    4 FALSE     1           2           1           1           1
##   4:    5 FALSE     1           0           1           1           1
##   5:    6 FALSE     1           0           1           1           1
##  ---
## 785: 1054 FALSE     0           0           1           1           1
## 786: 1055 FALSE     0           0           0           0           0
## 787: 1056 FALSE     1           1           0           0           1
## 788: 1058 FALSE     0           1           0           0           1
## 789: 1059 FALSE     1           1           0           0           1
##      rs2568958_A rs1514175_A rs1555543_C rs10923931_C rs516636_A rs574367_G
##   1:           0           1           2            0          0          0
##   2:           0           0           1            0          1          0
##   3:           1           1           2            0          0          0
##   4:           0           2           2            1          0          0
##   5:           1           0           0            0          0          0
##  ---
## 785:           1           1           2            0          1          1
## 786:           0           0           2            0          1          1
## 787:           1           0           0            0          1          1
## 788:           1           0           2            1          0          0
## 789:           0           1           1            0          0          0
##      rs543874_C rs7554506_A rs340874_G rs2867125_A rs6548238_A rs7561317_C
##   1:          0           0          0           0           0           0
##   2:          1           0          1           0           0           0
##   3:          0           0          1           0           0           0
##   4:          0           0          1           0           0           0
##   5:          0           0          0           0           0           0
##  ---
## 785:          1           0          1           0           0           0
## 786:          1           1          0           0           0           0
## 787:          1           0          1           1           1           1
## 788:          0           1          2           0           0           0
## 789:          0           0          2           1           1           1
##      rs6545814_T rs713586_C rs11899863_C rs7578597_C rs887912_C rs243021_C
##   1:           0          0            0           0          0          1
##   2:           0          0            0           0          0          1
##   3:           0          0            0           0          1          1
##   4:           1          1            1           0          0          0
##   5:           1          1            1           1          0          0
##  ---
## 785:           0          0            0           0          0          1
## 786:           1          1            0           0          0          0
## 787:           0          1            0           0          0          1
## 788:           0          2            0           1          0          1
## 789:           1          1            0           0          0          2
##      rs2890652_T rs2925757_C rs3923113_C rs13389219_T rs7578326_A rs2943641_A
##   1:           0           0           0            1           0           1
##   2:           0           0           0            0           1           0
##   3:           0           0           1            1           1           0
##   4:           0           0           0            0           0           0
##   5:           0           0           0            0           0           0
##  ---
```

```
## 785:           1           0           1           0           1           0
## 786:           0           1           0           0           1           0
## 787:           0           0           1           0           0           0
## 788:           0           0           0           0           1           0
## 789:           0           1           1           0           2           0
##      rs1801282_C rs6780569_C rs831571_T rs4607103_G rs13078807_T rs11708067_G
##   1:           0           0          0           1           0           1
##   2:           0           0          0           1           0           0
##   3:           0           0          0           0           0           1
##   4:           1           0          0           0           0           2
##   5:           0           1          0           1           0           0
##  ---
## 785:           0           0          0           0           0           2
## 786:           0           0          0           1           0           0
## 787:           0           0          0           0           0           1
## 788:           0           1          0           2           0           0
## 789:           0           0          0           0           0           1
##      rs187230_A rs4402960_T rs1470579_C rs7647305_G rs9816226_C rs266729_G
##   1:          1           0           0           0           0         1
##   2:          1           0           0           1           0         0
##   3:          0           2           2           1           0         2
##   4:          1           0           0           0           0         0
##   5:          1           0           0           0           0         0
##  ---
## 785:          1           1           1           0           0         0
## 786:          2           0           1           1           0         0
## 787:          0           0           0           0           0         0
## 788:          2           0           0           2           1         0
## 789:          0           0           0           0           0         1
##      rs1501299_C rs16861329_C rs6815464_A rs4688985_A rs1801214_A rs10938397_T
##   1:           1            0           0           1           2            0
##   2:           2            1           0           0           0            0
##   3:           1            1           1           0           0            0
##   4:           2            1           0           0           0            0
##   5:           2            1           0           0           0            0
##  ---
## 785:           1            1           1           0           0            1
## 786:           0            1           1           1           2            1
## 787:           0            0           0           0           0            0
## 788:           1            0           1           0           0            0
## 789:           1            1           2           0           1            0
##      rs2227306_G rs2886920_G rs13107325_T rs459193_G rs2112347_A rs4457053_C
##   1:           1           1            0          0           0          2
##   2:           1           1            0          0           1          0
##   3:           1           1            0          1           1          1
##   4:           0           0            0          0           0          1
##   5:           0           0            0          1           0          1
##  ---
## 785:           0           0            0          1           1          1
## 786:           1           1            0          0           1          1
## 787:           1           1            0          0           0          0
## 788:           0           0            0          0           0          0
## 789:           0           0            0          0           0          2
##      rs261967_G rs4836133_A rs7754840_G rs7756992_A rs9356744_C rs2206734_T
```

```
##   1:          2           0           0           0           0           0
##   2:          0           1           0           0           0           0
##   3:          0           0           0           0           0           0
##   4:          1           1           1           1           1           0
##   5:          1           2           0           0           0           0
##  ---
## 785:         0           1           1           1           1           1
## 786:         1           0           1           1           1           0
## 787:         0           0           1           1           1           1
## 788:         1           2           1           1           1           1
## 789:         2           0           1           0           0           0
##      rs1052248_G rs11575839_C rs206936_G rs9470794_A rs1535500_T rs987237_C
##   1:           1            0          1           0           1          1
##   2:           1            0          1           0           2          2
##   3:           0            0          0           0           2          0
##   4:           1            0          1           0           1          1
##   5:           1            1          1           0           1          0
##  ---
## 785:          1            0          1           0           2          1
## 786:          0            0          0           0           0          1
## 787:          0            0          2           0           0          2
## 788:          0            0          1           0           0          0
## 789:          1            0          1           1           2          0
##      rs9395950_T rs17168486_T rs2191349_T rs6954897_G rs864745_A rs1635852_C
##   1:           0            2           1           1          0           0
##   2:           0            0           1           0          1           1
##   3:           0            1           1           0          1           1
##   4:           0            2           1           0          0           0
##   5:           1            1           2           0          0           0
##  ---
## 785:          0            2           1           0          2           2
## 786:          0            0           1           1          1           1
## 787:          0            2           2           0          1           1
## 788:          0            0           1           0          0           0
## 789:          0            0           1           1          1           1
##      rs849134_G rs4607517_A rs6467136_T rs2167270_G rs972283_A rs516946_C
##   1:          1           1           0           2          1          0
##   2:          1           2           1           1          1          0
##   3:          1           0           1           2          2          1
##   4:          0           0           2           1          0          0
##   5:          0           0           0           2          1          0
##  ---
## 785:         2           0           0           0          1          0
## 786:         1           1           1           1          1          1
## 787:         1           1           0           1          0          0
## 788:         0           1           2           1          1          1
## 789:         1           0           0           1          1          0
##      rs896854_C rs13266634_G rs3802177_A rs7041847_G rs17584499_T rs2383208_A
##   1:          0            1           1           1            1           0
##   2:          1            1           1           1            0           0
##   3:          1            1           1           1            1           0
##   4:          2            1           1           0            2           0
##   5:          1            1           1           2            1           0
##  ---
```

```
## 785:          0            0           0           0            2           0
## 786:          0            0           0           0            1           0
## 787:          0            0           0           0            0           0
## 788:          1            1           1           2            0           0
## 789:          1            1           1           1            1           0
##      rs10965250_T rs10811661_A rs2183825_T rs824248_G rs11142387_A rs13292136_A
##   1:            0            0           1          1            2            0
##   2:            0            0           0          0            1            0
##   3:            0            0           0          1            1            0
##   4:            0            0           1          0            0            0
##   5:            0            0           1          0            1            1
##  ---
## 785:           0            0           0          0            1            1
## 786:           0            0           0          0            1            1
## 787:           0            0           0          1            1            2
## 788:           0            0           0          1            0            1
## 789:           0            0           0          0            1            0
##      rs2796441_T rs12779790_T rs10882066_C rs1111875_A rs5015480_G rs7087591_T
##   1:           1            0           0           1           1           1
##   2:           0            1           1           1           0           0
##   3:           2            1           1           2           0           0
##   4:           0            1           0           2           0           0
##   5:           0            1           2           0           0           0
##  ---
## 785:           1            0           0           2           0           0
## 786:           1            0           1           1           0           0
## 787:           0            1           1           0           1           1
## 788:           1            0           1           1           0           1
## 789:           0            0           0           2           0           0
##      rs7901695_T rs4506565_T rs7903146_C rs12243326_A rs2334499_T rs10770141_A
##   1:           0           0           0            1           1            1
##   2:           0           0           0            0           0            1
##   3:           0           0           0            0           1            1
##   4:           0           0           0            0           1            0
##   5:           0           0           0            0           1            1
##  ---
## 785:           0           0           0            0           1            0
## 786:           0           0           0            0           2            1
## 787:           0           0           0            0           1            0
## 788:           1           1           1            1           1            1
## 789:           0           0           0            0           0            1
##      rs231362_T rs2237892_C rs163184_T rs2237897_T rs4929949_C rs5215_C
##   1:          1           2          2           2           1        1
##   2:          0           2          2           2           1        1
##   3:          1           0          0           0           1        0
##   4:          1           0          1           1           2        1
##   5:          1           0          1           0           1        2
##  ---
## 785:          0           0          1           0           1        0
## 786:          0           1          1           1           0        0
## 787:          1           1          1           1           2        0
## 788:          0           1          1           1           0        1
## 789:          1           0          0           0           0        2
##      rs2056246_A rs10488683_A rs685249_T rs508924_C rs4923461_T rs6265_G
```

```
##   1:           2           0          2          2          1        1
##   2:           1           1          1          1          0        0
##   3:           1           1          1          1          0        0
##   4:           0           1          0          0          0        0
##   5:           2           0          2          2          0        0
##  ---
## 785:          1           1          1          1          1        0
## 786:          0           1          0          0          0        0
## 787:          1           0          1          1          0        0
## 788:          1           0          1          1          0        0
## 789:          1           0          1          1          1        1
##      rs10767664_C rs2030323_C rs3817334_T rs10838738_G rs1552224_T rs1387153_A
##   1:            1           1           0           0           0           1
##   2:            0           0           0           0           0           0
##   3:            0           0           0           0           0           1
##   4:            0           0           1           1           0           1
##   5:            0           0           0           0           0           0
##  ---
## 785:           0           0           1           1           0           2
## 786:           0           0           2           2           0           0
## 787:           0           0           1           1           0           0
## 788:           0           0           1           0           0           0
## 789:           1           1           0           0           0           1
##      rs10830962_T rs10830963_A rs2041139_T rs73040004_C rs10842994_G
##   1:            1           0           0           0           0
##   2:            0           0           0           1           0
##   3:            1           1           0           0           0
##   4:            1           1           0           0           0
##   5:            0           0           1           1           0
##  ---
## 785:           1           1           0           0           1
## 786:           1           0           0           1           0
## 787:           0           0           0           0           0
## 788:           0           0           0           1           0
## 789:           2           1           0           1           1
##      rs7138803_C rs1531343_T rs7961581_C rs7957197_A rs4771122_G rs1359790_A
##   1:           1           0           1           0           1           0
##   2:           1           0           1           0           0           1
##   3:           0           0           0           0           1           2
##   4:           0           0           0           1           0           2
##   5:           0           0           0           0           0           1
##  ---
## 785:          0           0           0           1           1           1
## 786:          0           0           0           1           1           1
## 787:          0           0           0           1           1           2
## 788:          1           0           0           1           1           1
## 789:          1           0           1           0           1           2
##      rs11847697_A rs10150332_A rs1884082_G rs7172432_G rs2241423_G rs12898654_T
##   1:            0           0           0           1           2           1
##   2:            0           0           0           2           0           0
##   3:            0           0           1           1           0           0
##   4:            0           0           0           1           0           0
##   5:            0           0           0           1           0           0
##  ---
```

```
## 785:            0            0           1           1           1           1
## 786:            0            0           0           2           0           0
## 787:            0            1           1           2           1           1
## 788:            0            1           1           1           2           0
## 789:            0            0           0           0           1           0
##      rs7178572_G rs7177055_A rs11634397_A rs2028299_C rs8042680_A rs7359397_G
##   1:           0           0            1           0           1           0
##   2:           1           1            1           0           0           1
##   3:           0           0            1           0           1           0
##   4:           2           2            2           0           0           1
##   5:           0           0            0           0           0           1
##  ---
## 785:           1           2            1           0           2           1
## 786:           0           1            2           1           0           2
## 787:           0           0            2           0           0           1
## 788:           0           0            0           1           2           1
## 789:           0           0            0           0           0           2
##      rs1421085_T rs1558902_C rs1121980_G rs17817449_T rs8050136_A rs9939609_A
##   1:           0           0           0           0           0           0
##   2:           1           1           1           1           1           1
##   3:           0           0           0           0           0           0
##   4:           1           1           1           1           1           1
##   5:           0           0           0           0           0           0
##  ---
## 785:           1           1           1           0           0           0
## 786:           0           0           0           0           0           0
## 787:           1           1           2           1           1           1
## 788:           2           2           2           2           2           2
## 789:           0           0           0           0           0           0
##      rs9941349_A rs12149832_A rs11642841_G rs6499500_C rs7202877_T rs4523957_G
##   1:           0            0            0           0           0           1
##   2:           1            1            1           0           2           1
##   3:           0            0            0           1           0           0
##   4:           1            1            1           0           0           1
##   5:           0            0            0           2           1           2
##  ---
## 785:           0            0            0           0           0           1
## 786:           0            0            0           1           0           0
## 787:           2            1            0           2           0           2
## 788:           2            2            2           0           1           1
## 789:           0            0            0           1           0           1
##      rs391300_C rs75493593_C rs75418188_T rs13342232_A rs13342692_C
##   1:          1           0            0           0            0
##   2:          1           1            1           1            1
##   3:          0           0            0           0            0
##   4:          1           0            0           0            0
##   5:          2           0            0           0            0
##  ---
## 785:          0           1            1           2            2
## 786:          0           0            0           0            0
## 787:          1           1            1           1            1
## 788:          1           0            0           0            0
## 789:          2           1            1           1            1
##      rs117767867_T rs757210_T rs4430796_T rs7501939_C rs2331841_C rs6567160_G
```

```
##   1:             0          1           1           1           0           0
##   2:             1          1           1           1           0           0
##   3:             0          1           1           1           0           0
##   4:             0          0           0           0           1           0
##   5:             0          1           1           1           1           0
##  ---
## 785:             1          1           1           1           1           1
## 786:             0          1           1           1           1           1
## 787:             1          0           1           0           0           0
## 788:             0          0           0           0           1           0
## 789:             1          0           0           0           1           0
##      rs571312_G rs17782313_T rs12970134_C rs1423096_T rs3786897_A rs29941_T
##   1:          0            0           1           0           0         1
##   2:          0            0           0           0           0         1
##   3:          0            0           0           0           0         1
##   4:          0            0           0           0           0         2
##   5:          0            0           0           0           0         0
##  ---
## 785:          1            1           2           0           0         1
## 786:          1            1           1           0           1         1
## 787:          0            0           1           0           0         0
## 788:          0            0           1           0           0         0
## 789:          1            1           1           0           1         1
##      rs8108269_T rs2287019_A rs3810291_T rs6017317_G rs1800961_G rs5945326_C
##   1:           0           0           0           1           0           1
##   2:           0           0           2           0           0           0
##   3:           1           0           1           0           0           1
##   4:           2           0           1           2           0           2
##   5:           0           0           0           2           0           0
##  ---
## 785:           0           0           2           1           0           0
## 786:           1           1           2           0           0           1
## 787:           1           0           2           0           0           0
## 788:           1           1           0           0           0           1
## 789:           0           0           0           0           0           0
```

Problem 2.b (8 points)

Write function univ.glm.test <- function(x, y, order = FALSE) where x is a data table of SNPs, y is a binary outcome vector, and order is a boolean. The function should fit a logistic regression model for each SNP in x, and return a data table containing SNP names, regression coefficients, odds ratios, standard errors and p-values. If order is set to TRUE, the output data table should be ordered by increasing p-value.

```r
#We make a univ.glm.test
univ.glm.test <- function(x, y, order = FALSE) {
  if (dim(x)[1]  != length(y)){
    stop("Length of x and y do not match - check dimensions")

  }
  else{
    n = dim(x)[2]
    output = data.table(
      "SNP_name " = character(),
      "beta" = numeric(),
      "odds_ratio" = numeric(),
```

```
      "standard_error" = numeric(),
      "p_value" = numeric()
    )

    for(i in 1:n){
    regr = glm(y~x[[i]], family = binomial(link = "logit"))
    regr.sum = coef(summary(regr))
    output = rbind(output,
                   list(names(x)[i],
                   regr.sum[2,1],
                   exp(regr.sum[2,1]),
                   regr.sum[2,2],
                   regr.sum[2,4]))

  }

  }
  if(order){
    output = output[order(p.value)]
  }

  return(output)
}
```

Problem 2.c (5 points)

Using function univ.glm.test(), run an association study for all the SNPs in gdm.dt against having gestational diabetes (column "pheno"). For the SNP that is most strongly associated to increased risk of gestational diabetes and the one with most significant protective effect, report the summary statistics from the GWAS as well as the 95% and 99% confidence intervals on the odds ratio.

```
#Association Study

x = gdm.dt[,-c(1,2,3)]
dim(x)[2]
```

```
## [1] 176
```

```
pheno = gdm.dt[[3]]

final = univ.glm.test(x = x, y = pheno)

#Representaton of our our association study

head(final)
```

```
##      SNP_name         beta odds_ratio standard_error   p_value
## 1: rs7513574_T 0.002157494   1.002160      0.1051372 0.9836280
## 2: rs1627238_A 0.114637864   1.121467      0.1138224 0.3138559
## 3: rs1171278_C 0.121409445   1.129087      0.1138073 0.2860628
## 4: rs1137100_A 0.060104751   1.061948      0.1104238 0.5862285
## 5: rs2568958_A 0.149379896   1.161114      0.1233800 0.2259989
## 6: rs1514175_A 0.056229626   1.057841      0.1052359 0.5931203
```

```
#The most strongly associated SNP to increased risk of gestational diabetes
```

```
index = which(final$odds_ratio == max(final$odds_ratio))
strongest_assos = final[index, ]

# Calculate confidence intervals - 95% and 99%

reg_coeff_risk <- strongest_assos$beta
std.reg_coeff_risk = strongest_assos$standard_error
confint_95_risk = round(exp(reg_coeff_risk +1.96* reg_coeff_risk*c(-1,1)),3)
confint_99_risk = round(exp(reg_coeff_risk +2.576*reg_coeff_risk*c(-1,1)),3)

#We need to check which SNP which reduce the risk of gestational diabetes, it means we need to find SNP

# We will check for SNPs with odds <1
newindex = which(final$odds_ratio <1)
best = final[newindex,]

# Select the SNP with lowest p value
index3 = which(best$p_value == min(best$p_value))
best_SNP = best[index3]


#We now find the confidence interval for odds ratio

beta2 = best_SNP$beta
standard_error2 = best_SNP$standard_error
new_confidence_interval1 = round(exp(beta2 +1.96*standard_error2 *c(-1,1)),3)
new_confidence_interval2 = round(exp(beta2 +2.576*standard_error2 *c(-1,1)),3)

#Output


cat(" SNP most strongly associated to increased risk of gestational     diabetes is", strongest_assos$SN
```

```
##  SNP most strongly associated to increased risk of gestational     diabetes is rs1423096_T
##  odds ratio is 1.91758
##  p value 0.03977583
##  95% Confidence Inteval =  0.535 6.87
##  99% Confidence Interval =  0.358 10.26
```

```
cat("\n SNPs with most protective effect is", best_SNP$SNP_name, "\n odds_ratio = ", best_SNP$odds_ratio
```

```
##
##  SNPs with most protective effect is rs2237897_T
##  odds_ratio =  0.6443936
##  p_value =  9.530178e-05
##  95% Confidence Inteval =  0.517 0.804
##  99% Confidence Interval =  0.482 0.861
```

We can see that SNP rs1423096_T has the highest odds ratio (1.91758) and hence is the most strongly associated to increased risk of gestational diabetes. In fact, this SNP increases the odds of having gestational diabetes by about 92!. The SNP with most significant protective effect is rs2237897_T and it reduced the risk of diabetes by about 35%. ### Problem 2.d (4points)

Merge your GWAS results with the table of gene names provided in file GDM.annot.txt (available from the accompanying zip folder on Learn). For SNPs that have p-value $< 10^{-4}$ (hit SNPs) report SNP name, effect

allele, chromosome number and corresponding gene name. Separately, report for each 'hit SNP' the names of the genes that are within a 1Mb window from the SNP position on the chromosome. Note: That's genes that fall within +/- 1,000,000 positions using the 'pos' column in the dataset.

```
#Read the gene name data file
gene_names = fread("assignment2/GDM.annot.txt")

#create a new matrix
final[,c("snp", "allele"):=tstrsplit(`SNP_name `, "_", fixed = TRUE)]


#create a merged data table using inner join
merged.dt = merge(gene_names, final)


#Hit SNP
hit.SNP = merged.dt[p_value<1e-4]

#Output table with SNP name, allele, chromosome number, gene name for hit_SNPs

kable(hit.SNP[,c("snp", "beta","allele","chrom", "gene")])
```

snp	beta	allele	chrom	gene
rs12243326	0.6454198	A	10	TCF7L2
rs2237897	-0.4394456	T	11	KCNQ1

```
#Separately, report for each 'hit SNP' the names of the genes that are within a 1Mb window from the SNP


#1,000,000 positions = 1e6

threshold <- 1e6

hit.snp_window <- data.table()

for (i in hit.SNP$snp){
  idx = which(hit.SNP$snp == i)
  window_values <- merged.dt[(merged.dt$pos>= hit.SNP$pos[idx] - threshold) & (merged.dt$pos<= hit.SNP$p
  hit.snp_window <- rbind(hit.snp_window, window_values)
}

# Display the genes that fall within this window
kable(data.table(hit.snp_window$gene), col.names = "Thereshold below 1,000,000")
```

Thereshold below 1,000,000
TCF7L2
TCF7L2
TCF7L2
TCF7L2
TH
KCNQ1
CACNA2D4
KCNQ1

Thereshold below 1,000,000
KCNQ1
KCNQ1
SMG6
SMG6

Problem 2.e (8 points)

Build a weighted genetic risk score that includes all SNPs with p-value $< 10^{-4}$, a score with all SNPs with p-value $< 10^{-3}$, and a score that only includes SNPs on the FTO gene (hint: ensure that the ordering of SNPs is respected). Add the three scores as columns to the gdm.dt data table. Fit the three scores in separate logistic regression models to test their association with gestational diabetes, and for each report odds ratio, 95% confidence interval and p-value.

```
#Weighted genetic risk score

#This is our score 1(1e-4)
gdm.grs = gdm.dt[, .SD, .SDcols = merged.dt[p_value <1e-4]$`SNP_name `]
snp.grs = merged.dt[p_value <1e-4]
weighted.score1 = as.matrix(gdm.grs)%*% snp.grs$beta

#This is our score 2(1e-3)
gdm.grs2 = gdm.dt[, .SD, .SDcols = merged.dt[p_value <1e-3]$`SNP_name `]
snp.grs2 = merged.dt[p_value <1e-3]
weighted.score2 = as.matrix(gdm.grs2)%*% snp.grs2$beta

#This is our score 3 (FTO gene)
gdm.grs3 = gdm.dt[, .SD, .SDcols = merged.dt[gene =="FTO"]$`SNP_name `]
snp.grs3 = merged.dt[gene == "FTO"]
weighted.score3 = as.matrix(gdm.grs3)%*% snp.grs3$beta
```

```
# We can automate the process
if(!("score1.V1" %in% colnames(gdm.dt))){

  helper = data.table(score1 = weighted.score1,
                      score2 = weighted.score2,
                      score3 = weighted.score3)

  gdm.dt = cbind(gdm.dt, helper)
}


 head(gdm.dt)
```

```
##    ID   sex pheno rs7513574_T rs1627238_A rs1171278_C rs1137100_A rs2568958_A
## 1:  1 FALSE     0           1           0           0           2           0
## 2:  2 FALSE     0           0           0           0           1           0
## 3:  4 FALSE     1           2           1           1           1           1
## 4:  5 FALSE     1           0           1           1           1           0
## 5:  6 FALSE     1           0           1           1           1           1
## 6:  7 FALSE     0           1           1           1           0           0
##    rs1514175_A rs1555543_C rs10923931_C rs516636_A rs574367_G rs543874_C
## 1:           1           2            0          0          0          0
## 2:           0           1            0          1          0          1
```

```
## 3:           1           2           0          0          0          0
## 4:           2           2           1          0          0          0
## 5:           0           0           0          0          0          0
## 6:           0           0           0          2          2          2
##    rs7554506_A rs340874_G rs2867125_A rs6548238_A rs7561317_C rs6545814_T
## 1:           0          0           0          0          0          0
## 2:           0          1           0          0          0          0
## 3:           0          1           0          0          0          0
## 4:           0          1           0          0          0          1
## 5:           0          0           0          0          0          1
## 6:           0          0           0          0          0          0
##    rs713586_C rs11899863_C rs7578597_C rs887912_C rs243021_C rs2890652_T
## 1:          0           0           0          0          1          0
## 2:          0           0           0          0          1          0
## 3:          0           0           0          1          1          0
## 4:          1           1           0          0          0          0
## 5:          1           1           1          0          0          0
## 6:          0           0           0          0          0          0
##    rs2925757_C rs3923113_C rs13389219_T rs7578326_A rs2943641_A rs1801282_C
## 1:           0           0           1           0           1           0
## 2:           0           0           0           1           0           0
## 3:           0           1           1           1           0           0
## 4:           0           0           0           0           0           1
## 5:           0           0           0           0           0           0
## 6:           0           0           0           0           0           0
##    rs6780569_C rs831571_T rs4607103_G rs13078807_T rs11708067_G rs187230_A
## 1:           0          0           1            0           1          1
## 2:           0          0           1            0           0          1
## 3:           0          0           0            0           1          0
## 4:           0          0           0            0           2          1
## 5:           1          0           1            0           0          1
## 6:           0          0           0            0           1          1
##    rs4402960_T rs1470579_C rs7647305_G rs9816226_C rs266729_G rs1501299_C
## 1:           0           0           0           0          1          1
## 2:           0           0           1           0          0          2
## 3:           2           2           1           0          2          1
## 4:           0           0           0           0          0          2
## 5:           0           0           0           0          0          2
## 6:           1           1           0           0          0          0
##    rs16861329_C rs6815464_A rs4688985_A rs1801214_A rs10938397_T rs2227306_G
## 1:            0           0           1           2           0          1
## 2:            1           0           0           0           0          1
## 3:            1           1           0           0           0          1
## 4:            1           0           0           0           0          0
## 5:            1           0           0           0           0          0
## 6:            1           0           0           0           0          1
##    rs2886920_G rs13107325_T rs459193_G rs2112347_A rs4457053_C rs261967_G
## 1:           1            0          0           0          2          2
## 2:           1            0          0           1          0          0
## 3:           1            0          1           1          1          0
## 4:           0            0          0           0          1          1
## 5:           0            0          1           0          1          1
## 6:           1            0          0           1          0          0
##    rs4836133_A rs7754840_G rs7756992_A rs9356744_C rs2206734_T rs1052248_G
```

```
## 1:           0           0           0           0           0           1
## 2:           1           0           0           0           0           1
## 3:           0           0           0           0           0           0
## 4:           1           1           1           1           0           1
## 5:           2           0           0           0           0           1
## 6:           0           0           0           0           0           0
##    rs11575839_C rs206936_G rs9470794_A rs1535500_T rs987237_C rs9395950_T
## 1:            0          1           0           1          1           0
## 2:            0          1           0           2          2           0
## 3:            0          0           0           2          0           0
## 4:            0          1           0           1          1           0
## 5:            1          1           0           1          0           1
## 6:            0          0           0           0          0           0
##    rs17168486_T rs2191349_T rs6954897_G rs864745_A rs1635852_C rs849134_G
## 1:            2           1           1          0           0          1
## 2:            0           1           0          1           1          1
## 3:            1           1           0          1           1          1
## 4:            2           1           0          0           0          0
## 5:            1           2           0          0           0          0
## 6:            0           1           0          1           1          1
##    rs4607517_A rs6467136_T rs2167270_G rs972283_A rs516946_C rs896854_C
## 1:           1           0           2          1          0          0
## 2:           2           1           1          1          0          1
## 3:           0           1           2          2          1          1
## 4:           0           2           1          0          0          2
## 5:           0           0           2          1          0          1
## 6:           0           0           2          0          1          0
##    rs13266634_G rs3802177_A rs7041847_G rs17584499_T rs2383208_A rs10965250_T
## 1:            1           1           1            1           0            0
## 2:            1           1           1            0           0            0
## 3:            1           1           1            1           0            0
## 4:            1           1           0            2           0            0
## 5:            1           1           2            1           0            0
## 6:            0           0           1            0           0            0
##    rs10811661_A rs2183825_T rs824248_G rs11142387_A rs13292136_A rs2796441_T
## 1:            0           1          1            2           0           1
## 2:            0           0          0            1           0           0
## 3:            0           0          1            1           0           2
## 4:            0           1          0            0           0           0
## 5:            0           1          0            1           1           0
## 6:            0           1          0            1           0           0
##    rs12779790_T rs10882066_C rs1111875_A rs5015480_G rs7087591_T rs7901695_T
## 1:            0            0           1           1           1           0
## 2:            1            1           1           0           0           0
## 3:            1            1           2           0           0           0
## 4:            1            0           2           0           0           0
## 5:            1            2           0           0           0           0
## 6:            1            0           1           1           1           0
##    rs4506565_T rs7903146_C rs12243326_A rs2334499_T rs10770141_A rs231362_T
## 1:           0           0            1           1            1          1
## 2:           0           0            0           0            1          0
## 3:           0           0            0           1            1          1
## 4:           0           0            0           1            0          1
## 5:           0           0            0           1            1          1
```

```
## 6:           0           0           0           1           0          0
##    rs2237892_C rs163184_T rs2237897_T rs4929949_C rs5215_C rs2056246_A
## 1:           2          2           2           1        1           2
## 2:           2          2           2           1        1           1
## 3:           0          0           0           1        0           1
## 4:           0          1           1           2        1           0
## 5:           0          1           0           1        2           2
## 6:           2          2           2           1        1           1
##    rs10488683_A rs685249_T rs508924_C rs4923461_T rs6265_G rs10767664_C
## 1:            0          2          2           1        1            1
## 2:            1          1          1           0        0            0
## 3:            1          1          1           0        0            0
## 4:            1          0          0           0        0            0
## 5:            0          2          2           0        0            0
## 6:            1          1          1           0        0            0
##    rs2030323_C rs3817334_T rs10838738_G rs1552224_T rs1387153_A rs10830962_T
## 1:           1           0           0           0           1            1
## 2:           0           0           0           0           0            0
## 3:           0           0           0           0           1            1
## 4:           0           1           1           0           1            1
## 5:           0           0           0           0           0            0
## 6:           0           1           1           2           0            0
##    rs10830963_A rs2041139_T rs73040004_C rs10842994_G rs7138803_C rs1531343_T
## 1:            0           0            0           0           1           0
## 2:            0           0            1           0           1           0
## 3:            1           0            0           0           0           0
## 4:            1           0            0           0           0           0
## 5:            0           1            1           0           0           0
## 6:            0           0            0           0           1           1
##    rs7961581_C rs7957197_A rs4771122_G rs1359790_A rs11847697_A rs10150332_A
## 1:           1           0           1           0           0            0
## 2:           1           0           0           1           0            0
## 3:           0           0           1           2           0            0
## 4:           0           1           0           2           0            0
## 5:           0           0           0           1           0            0
## 6:           0           0           0           1           0            1
##    rs1884082_G rs7172432_G rs2241423_G rs12898654_T rs7178572_G rs7177055_A
## 1:           0           1           2            1           0           0
## 2:           0           2           0            0           1           1
## 3:           1           1           0            0           0           0
## 4:           0           1           0            0           2           2
## 5:           0           1           0            0           0           0
## 6:           0           1           1            1           0           0
##    rs11634397_A rs2028299_C rs8042680_A rs7359397_G rs1421085_T rs1558902_C
## 1:            1           0           1           0           0           0
## 2:            1           0           0           1           1           1
## 3:            1           0           1           0           0           0
## 4:            2           0           0           1           1           1
## 5:            0           0           0           1           0           0
## 6:            1           0           0           0           0           0
##    rs1121980_G rs17817449_T rs8050136_A rs9939609_A rs9941349_A rs12149832_A
## 1:           0            0           0           0           0            0
## 2:           1            1           1           1           1            1
## 3:           0            0           0           0           0            0
```

```
## 4:           1            1           1           1           1            1
## 5:           0            0           0           0           0            0
## 6:           0            0           0           0           0            0
##    rs11642841_G rs6499500_C rs7202877_T rs4523957_G rs391300_C rs75493593_C
## 1:            0           0           0           1          1            0
## 2:            1           0           2           1          1            1
## 3:            0           1           0           0          0            0
## 4:            1           0           0           1          1            0
## 5:            0           2           1           2          2            0
## 6:            0           1           0           0          0            1
##    rs75418188_T rs13342232_A rs13342692_C rs117767867_T rs757210_T rs4430796_T
## 1:            0            0           0             0          1           1
## 2:            1            1           1             1          1           1
## 3:            0            0           0             0          1           1
## 4:            0            0           0             0          0           0
## 5:            0            0           0             0          1           1
## 6:            1            1           1             1          1           1
##    rs7501939_C rs2331841_C rs6567160_G rs571312_G rs17782313_T rs12970134_C
## 1:           1           0           0          0            0            1
## 2:           1           0           0          0            0            0
## 3:           1           0           0          0            0            0
## 4:           0           1           0          0            0            0
## 5:           1           1           0          0            0            0
## 6:           1           0           0          0            0            0
##    rs1423096_T rs3786897_A rs29941_T rs8108269_T rs2287019_A rs3810291_T
## 1:           0           0         1           0           0           0
## 2:           0           0         1           0           0           2
## 3:           0           0         1           1           0           1
## 4:           0           0         2           2           0           1
## 5:           0           0         0           0           0           0
## 6:           0           0         2           1           1           0
##    rs6017317_G rs1800961_G rs5945326_C  score1.V1  score2.V1 score3.V1
## 1:           1           0           1 -0.2334714 -1.0420490 0.0000000
## 2:           0           0           0 -0.8788912 -1.6874688 0.4740752
## 3:           0           0           1  0.0000000  0.0000000 0.0000000
## 4:           2           0           2 -0.4394456 -0.4394456 0.4740752
## 5:           2           0           0  0.0000000  0.0000000 0.0000000
## 6:           1           1           0 -0.8788912 -1.6874688 0.0000000
```

```r
# Linear Regression Model
fit1 = glm(pheno ~score1.V1, family = binomial(link = "logit"), data = gdm.dt)

fit2 = glm(pheno ~score2.V1, family = binomial(link = "logit"), data = gdm.dt)

fit3 = glm(pheno ~score3.V1, family = binomial(link = "logit"), data = gdm.dt)

fit_all = c(fit1, fit2, fit3)
```

```r
# Find odds ratio, 95% confidence interval and p-value

beta1 = fit1$coefficients[2]
beta2 = fit2$coefficients[2]
beta3 = fit3$coefficients[2]

Standard_error_beta1 = coef(summary(fit1))[2,2]
```

```
Standard_error_beta2 = coef(summary(fit2))[2,2]
Standard_error_beta3 = coef(summary(fit3))[2,2]

#Confidence Intervals

Confidence_interval1  = round(exp(beta1 +1.96*Standard_error_beta1 *c(-1,1)),3)
Confidence_interval2 = round(exp(beta2 +1.96*Standard_error_beta2 *c(-1,1)),3)
Confidence_interval3 = round(exp(beta3 +1.96*Standard_error_beta3 *c(-1,1)),3)

#p_value

p_value1 = coef(summary(fit1))[2,4]
p_value2 = coef(summary(fit2))[2,4]
p_value3 = coef(summary(fit3))[2,4]


#Data table

temp = data.table(Score = c("score1", "score2", "score3"), Odds_ratio = c(exp(beta1), exp(beta2), exp(b
Confidence_interval =c(Confidence_interval1, Confidence_interval2, Confidence_interval3), p_value = c(p

kable(temp)
```

Score	Odds_ratio	Confidence_interval	p_value
score1	2.729433	1.915	0.0000000
score2	1.451854	3.890	0.0000000
score3	1.413857	1.279	0.2151883
score1	2.729433	1.648	0.0000000
score2	1.451854	0.818	0.0000000
score3	1.413857	2.445	0.2151883

Problem 2.f (4 points)

File GDM.test.txt (available from the accompanying zip folder on Learn) contains genotypes of another 40 pregnant women with and without gestational diabetes (assume that the reference allele is the same one that was specified in file GDM.raw.txt). Read the file into variable gdm.test. For the set of patients in gdm.test, compute the three genetic risk scores as defined in problem 2.e using the same set of SNPs and corresponding weights. Add the three scores as columns to gdm.test (hint: use the same columnnames as before).

```
#Read the data file
gdm_test = fread("assignment2/GDM.test.txt")


#We need to compute the three genetic risk scores that are defined in previous problem using the same s

previous_snp1 = colnames(gdm.grs)
previous_snp1_updated = substr(previous_snp1, 1, nchar(previous_snp1)-2)
gdm_test.grs1 = gdm_test[,..previous_snp1_updated]
#previous weights
weight1 = snp.grs$beta
#Score
score_1 = as.matrix(gdm_test.grs1) %*% weight1
```

```r
previous_snp2 = colnames(gdm.grs2)
previous_snp2_updated = substr(previous_snp2, 1, nchar(previous_snp2)-2)
gdm_test.grs2 = gdm_test[,..previous_snp2_updated]
#previous weights
weight2 = snp.grs2$beta
#Score
score_2= as.matrix(gdm_test.grs2) %*% weight2

previous_snp3 = colnames(gdm.grs3)
previous_snp3_updated = substr(previous_snp3, 1, nchar(previous_snp3)-2)
gdm_test.grs3 = gdm_test[,..previous_snp3_updated]
#previous weights
weight3 = snp.grs3$beta
#Score
score_3 = as.matrix(gdm_test.grs3) %*% weight3

table2 = data.table(score1 = score_1, score2 = score_2, score3 = score_3)
table2
```

```
##      score1.V1   score2.V1  score3.V1
##  1: -0.2334714 -1.04204900 0.00000000
##  2: -0.8788912 -1.68746877 0.47407518
##  3:  0.0000000  0.00000000 0.00000000
##  4: -0.4394456 -0.43944560 0.47407518
##  5:  0.0000000  0.00000000 0.00000000
##  6: -0.8788912 -1.68746877 0.00000000
##  7: -0.8788912 -1.68746877 0.27165422
##  8: -0.4394456 -0.38084043 0.00000000
##  9:  0.0000000  0.00000000 0.42167485
## 10: -0.4394456 -0.84373439 0.00000000
## 11:  0.6454198  2.09874671 0.47407518
## 12:  0.0000000  0.00000000 0.00000000
## 13:  0.0000000  1.91622090 0.00000000
## 14:  0.0000000  0.46289396 0.47407518
## 15:  0.6454198  2.56164067 0.00000000
## 16:  0.0000000  0.00000000 0.00000000
## 17:  0.0000000  0.05860517 0.00000000
## 18: -0.4394456 -0.84373439 0.47407518
## 19:  0.0000000  0.00000000 0.00000000
## 20:  0.6454198  2.56164067 0.35996658
## 21:  0.0000000 -0.40428879 0.00000000
## 22:  0.0000000  1.45332694 0.00000000
## 23: -0.8788912 -1.68746877 0.41243741
## 24:  0.0000000  0.00000000 0.94815036
## 25:  0.0000000  0.00000000 0.47407518
## 26: -0.4394456 -0.84373439 0.09115614
## 27:  0.0000000  1.45332694 0.47407518
## 28: -0.8788912 -1.22457481 0.00000000
## 29: -0.4394456 -0.84373439 0.00000000
## 30:  0.8513939  3.27033610 0.53578345
## 31:  0.0000000  0.00000000 0.47407518
## 32:  0.0000000  0.00000000 0.00000000
## 33: -0.4394456 -0.84373439 0.06170827
## 34:  0.0000000  0.00000000 0.00000000
```

```
## 35: -0.4394456 -0.38084043 0.00000000
## 36:  0.6454198  3.02453463 0.00000000
## 37: -0.4394456  1.07248652 0.00000000
## 38:  0.0000000  0.00000000 0.47407518
## 39: -0.8788912 -1.68746877 0.47407518
## 40: -0.4394456 -0.84373439 0.00000000
##      score1.V1   score2.V1  score3.V1
```

```
#Add the three scores as columns to gdm.test

gdm.test=cbind(gdm_test, table2)
```

Problem 2.g (4 points)

Use the logistic regression models fitted in problem 2.e to predict the outcome of patients in gdm.test. Compute the test log-likelihood for the predicted probabilities from the three genetic risk score models.

```
pred1 = predict(fit1,newdata = data.frame(score1.V1 = gdm.test$score1.V1), type = "response")

pred2 = predict(fit2, newdata = data.frame(score2.V1 = gdm.test$score2.V1), type = "response")

pred3 = predict(fit3,newdata = data.frame(score3.V1 = gdm.test$score3.V1), type = "response")

pheno = gdm_test$pheno

# Log-Likelihood

sum(pheno*log(pred1) + (1-pheno)* log(1-pred1))
```

```
## [1] -25.06824
```

```
sum(pheno*log(pred2) + (1-pheno)* log(1-pred2))
```

```
## [1] -24.77693
```

```
sum(pheno*log(pred3) + (1-pheno)* log(1-pred3))
```

```
## [1] -28.05355
```

Problem 2.h (4points)

File GDM.study2.txt (available from the accompanying zip folder on Learn) contains the summary statistics from a different study on the same set of SNPs. Perform a meta-analysis with the results obtained in problem 2.c (hint: remember that the effect alleles should correspond) and produce a summary of the meta-analysis results for the set of SNPs with meta-analysis p-value $< 10^{-4}$ sorted by increasing p-value.

In this question, we call the data frame from GDM.study 'gwas1' is study 1 and from the results obtained in Q2c we have 'gwas2' which is study 2. We perform a meta -analysis. We merge the results to increase the statistical power and reduce the false-true values.

```
gwas1 = fread("assignment2/GDM.study2.txt")
gwas2 = final

gwas1 = gwas1[order(snp)]
gwas2 = gwas2[order(snp)]

all.equal(gwas1, gwas2)
```

```
## [1] "Different number of columns" "Different column names"
```

```
not_flipped = gwas1$effect.allele == gwas2$allele
flipped = gwas1$effect.allele != gwas2$allele

table(not_flipped, flipped)
```

```
##            flipped
## not_flipped FALSE TRUE
##       FALSE     0   29
##       TRUE    147    0
```

It can be seen that effect of SNP's which were identified to have there alleles flipped(29), need to have their direction of effect swapped in one of the studies before entering the meta-analysis. Here the sign for the second study 'gwas' are swapped.

The above representation is called a Confusion matrix https://en.wikipedia.org/wiki/Confusion_matrix

```
beta1 = gwas1$beta
beta2 = gwas2$beta
beta2[flipped] = -beta2[flipped]
```

We perfrom a fixed effect meta data analysis by nverse variance wieghing. From the weights assinged to the two studies, it can be seen that the second study is powered.

```
weight_gwas1 = 1/ gwas1$se
weight_gwas2 = 1/ gwas2$standard_error

head(weight_gwas1)
```

```
## [1] 2.472423 3.023486 2.630492 2.658881 3.229661 1.824545
```

```
head(weight_gwas2)
```

```
## [1] 8.428829 9.795745 6.953573 7.149981 8.984663 5.691510
```

```
beta_meta_analysis = (weight_gwas1*beta1 + weight_gwas2*beta2)/(weight_gwas1 + weight_gwas2)
standard_error_meta_analysis = sqrt(1 / weight_gwas1 + weight_gwas2)


p_value_meta_analysis = 2* pnorm(abs(beta_meta_analysis/standard_error_meta_analysis), lower.tail = F)

summary = merge(gwas1, gwas2, by = "snp")[,c("snp", "effect.allele", "other.allele")]
summary = cbind(summary, data.table(beta_meta_analysis = beta_meta_analysis, standard_error_meta_analysis
```

Problem 3 (33 points)

File nika.csv (available from the accompanying zip folder on Learn) contains data for 144 breast cancer patients. The dataset contains a binary outcome variable ("Event", indicating the insurgence of further complications after operation), covariates describing the tumour and the age of the patient, and gene expressions for 70 genes found to be prognostic of survival.

Problem 3.a (6 points)

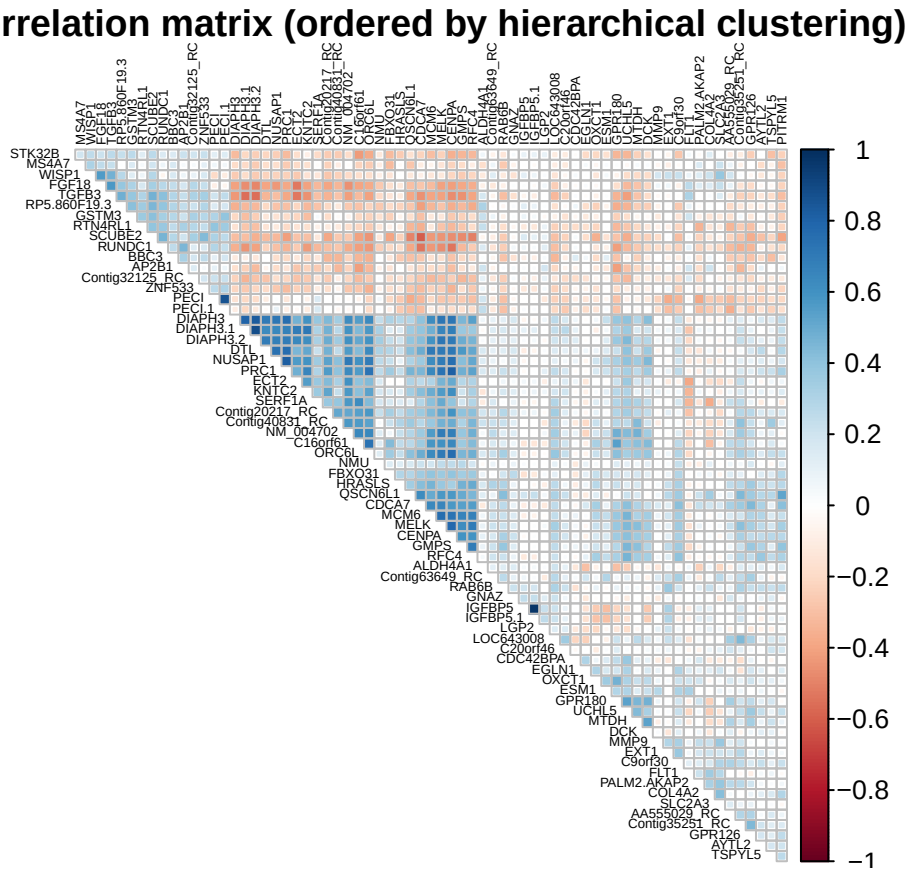
Compute the matrix of correlations between the gene expression variables, and display it so that a block structure is highlighted. Discuss what you observe. Write some code to identify the unique pairs of (distinct) variables that have correlation coefficient greater than 0.80 in absolute value and report their correlation coefficients.

```
#install.packages("corrplot")
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
nika.dt <- fread("assignment2/nki.csv", stringsAsFactors = T)

genes.dt <- subset(nika.dt, select = -c(1, 6))

# Gene variables
numcols <- sapply(genes.dt, is.numeric)
cor.nika <- genes.dt[, ..numcols] %>% #subset of numeric columns
            cor(use="pairwise.complete")

genes <- subset(nika.dt, select = -c(1, 2, 3, 4, 5,6))
```

```
# Correlation plot

corrplot(cor.nika, order="hclust", diag=FALSE, tl.col="black", tl.cex = 0.45, method = "square" , title=
```



It's a strain to eyes to be reading and assimilating a correlation plot with 70 genes, so it may be better to get the unique set of pairs with a correlation greater than absolute 0.8

```
# Find the unique set of pairs with correlation greater than 0.8
gene_1 = c()
gene_2 = c()
corr = c()
```

```
for (i in 1:dim(cor.nika)[1]){
  for (j in 1:dim(cor.nika)[2]){

    if(abs(cor.nika[i,j]) > 0.8 & cor.nika[i,j] !=1){
      corr <- c(corr, cor.nika[i,j])
      gene_1 <- c(gene_1, rownames(cor.nika)[i])
      gene_2 <- c(gene_2, colnames(cor.nika)[j])
    }
  }
}

gene.corr <- data.table(gene_1[!duplicated(corr,which=T)], gene_2[!duplicated(corr,which=T)], corr[!dupl

setnames(gene.corr, c("gene_1", "gene_2", "corr"))

gene.corr
```

```
##      gene_1   gene_2      corr
## 1:   DIAPH3 DIAPH3.1 0.8031368
## 2:   DIAPH3 DIAPH3.2 0.8338591
## 3:   NUSAP1     PRC1 0.8298356
## 4: DIAPH3.1 DIAPH3.2 0.8868741
## 5:     PECI   PECI.1 0.8697836
## 6:   IGFBP5 IGFBP5.1 0.9775030
## 7:     PRC1    CENPA 0.8175424
```

Problem 3.b (8 points)

Run PCA (only over the columns containing gene expressions), in order to derive a patient-wise summary of all gene expressions (dimensionality reduction). Decide which components to keep and justify your decision. Test if those principal components are associated with the outcome in unadjusted logistic regression models and in models adjusted for age, estrogen receptor and grade. Justify the difference in results between unadjusted and adjusted models.

```
# Run PCA over the gene variables

pca.vars <- prcomp(genes, center = T, scale = T)

# Display the summary of the PCA and the percentage explained
summary(pca.vars)
```

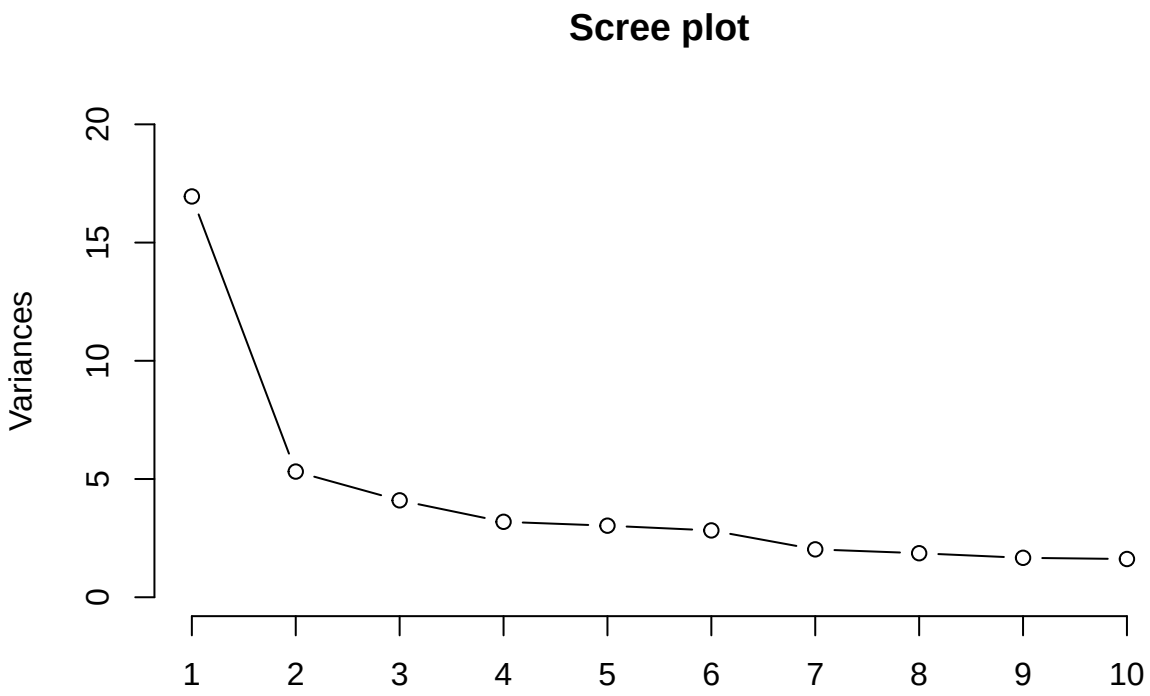
```
## Importance of components:
##                           PC1     PC2     PC3     PC4     PC5     PC6     PC7
## Standard deviation     4.1171 2.30541 2.02437 1.78597 1.73982 1.68091 1.42309
## Proportion of Variance 0.2422 0.07593 0.05854 0.04557 0.04324 0.04036 0.02893
## Cumulative Proportion  0.2422 0.31808 0.37662 0.42219 0.46543 0.50580 0.53473
##                           PC8     PC9   PC10    PC11    PC12    PC13    PC14
## Standard deviation     1.36441 1.29119 1.2715 1.24741 1.18388 1.15101 1.13883
## Proportion of Variance 0.02659 0.02382 0.0231 0.02223 0.02002 0.01893 0.01853
## Cumulative Proportion  0.56132 0.58514 0.6082 0.63046 0.65049 0.66941 0.68794
##                           PC15    PC16    PC17    PC18    PC19    PC20    PC21
## Standard deviation     1.09473 1.07016 1.04187 1.00234 0.99086 0.94095 0.93322
## Proportion of Variance 0.01712 0.01636 0.01551 0.01435 0.01403 0.01265 0.01244
## Cumulative Proportion  0.70506 0.72142 0.73693 0.75128 0.76531 0.77796 0.79040
##                           PC22    PC23    PC24    PC25    PC26    PC27    PC28
```

```
## Standard deviation     0.90727 0.89675 0.88859 0.86019 0.84462 0.82782 0.82368
## Proportion of Variance 0.01176 0.01149 0.01128 0.01057 0.01019 0.00979 0.00969
## Cumulative Proportion  0.80216 0.81364 0.82492 0.83549 0.84569 0.85548 0.86517
##                           PC29    PC30    PC31    PC32    PC33    PC34   PC35
## Standard deviation     0.78694 0.75594 0.73942 0.70569 0.69414 0.67129 0.6639
## Proportion of Variance 0.00885 0.00816 0.00781 0.00711 0.00688 0.00644 0.0063
## Cumulative Proportion  0.87401 0.88218 0.88999 0.89710 0.90399 0.91042 0.9167
##                           PC36    PC37    PC38    PC39    PC40    PC41    PC42
## Standard deviation     0.63815 0.61964 0.59947 0.58447 0.57195 0.55097 0.53820
## Proportion of Variance 0.00582 0.00549 0.00513 0.00488 0.00467 0.00434 0.00414
## Cumulative Proportion  0.92254 0.92802 0.93316 0.93804 0.94271 0.94705 0.95118
##                           PC43    PC44    PC45    PC46    PC47    PC48    PC49
## Standard deviation     0.52029 0.51211 0.49533 0.48712 0.47079 0.44565 0.41879
## Proportion of Variance 0.00387 0.00375 0.00351 0.00339 0.00317 0.00284 0.00251
## Cumulative Proportion  0.95505 0.95880 0.96230 0.96569 0.96886 0.97170 0.97420
##                           PC50    PC51   PC52    PC53    PC54    PC55    PC56
## Standard deviation     0.40556 0.39328 0.3925 0.38502 0.36669 0.36205 0.33734
## Proportion of Variance 0.00235 0.00221 0.0022 0.00212 0.00192 0.00187 0.00163
## Cumulative Proportion  0.97655 0.97876 0.9810 0.98308 0.98500 0.98687 0.98850
##                           PC57    PC58    PC59    PC60    PC61    PC62    PC63
## Standard deviation     0.32150 0.30744 0.28898 0.28186 0.27274 0.25622 0.24118
## Proportion of Variance 0.00148 0.00135 0.00119 0.00113 0.00106 0.00094 0.00083
## Cumulative Proportion  0.98998 0.99133 0.99252 0.99365 0.99472 0.99565 0.99649
##                           PC64    PC65    PC66    PC67    PC68   PC69    PC70
## Standard deviation     0.23024 0.21442 0.19886 0.19371 0.17927 0.1677 0.09833
## Proportion of Variance 0.00076 0.00066 0.00056 0.00054 0.00046 0.0004 0.00014
## Cumulative Proportion  0.99724 0.99790 0.99846 0.99900 0.99946 0.9999 1.00000
```

```
perc.expl <- pca.vars$sdev^2 / sum(pca.vars$sdev^2)

cat("Sum of variance fraction explained in the first 2 components: ", sum(perc.expl[1:2]))
```

```
## Sum of variance fraction explained in the first 2 components:  0.3180793
```

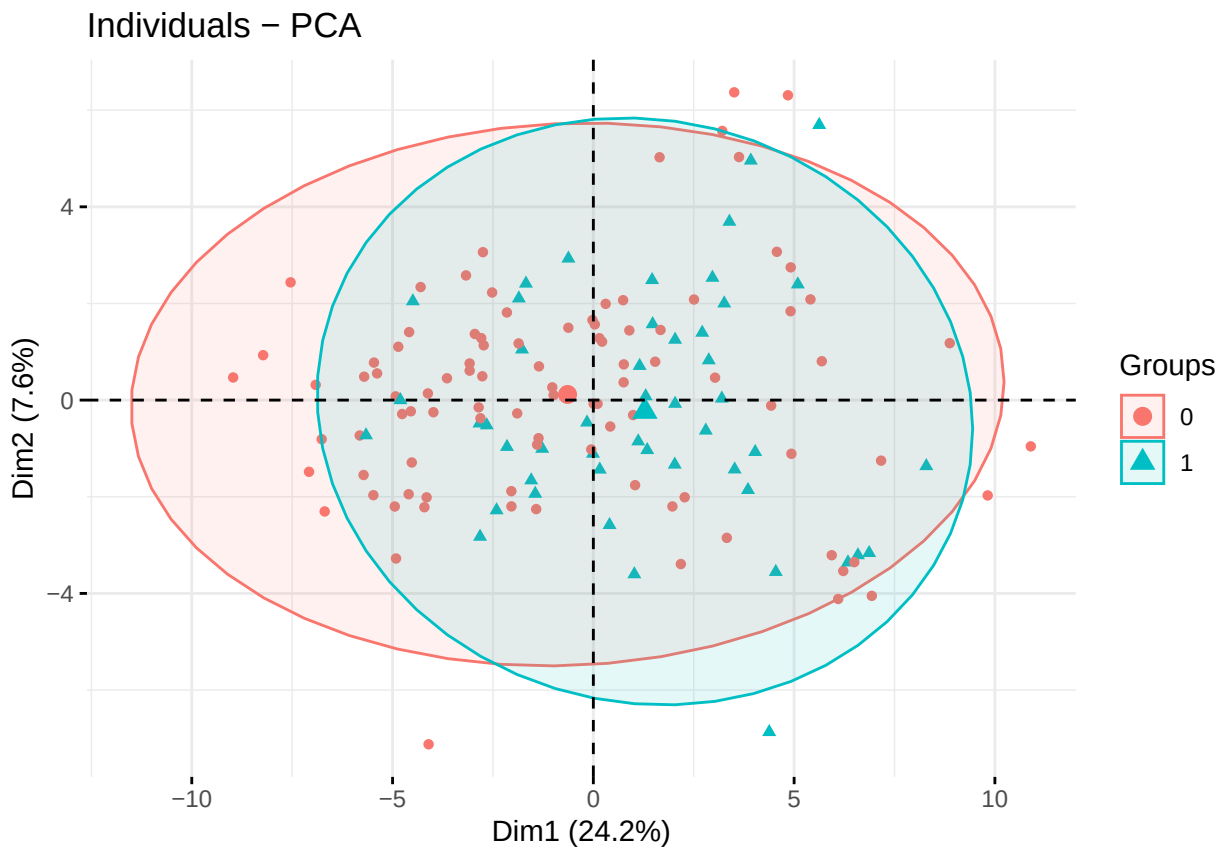
```
screeplot(pca.vars, main="Scree plot", ylim = c(0, 20), type = "lines")
```




```
#install.packages("factoextra")

library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
fviz_pca_ind(pca.vars, geom='point', habillage = nika.dt$Event, axes = c(1,2), addEllipses = T)
```




```
eig.val <- get_eigenvalue(pca.vars)
eig.val
```

```
##          eigenvalue variance.percent cumulative.variance.percent
## Dim.1  16.950630477      24.21518640                     24.21519
## Dim.2   5.314919533       7.59274219                     31.80793
## Dim.3   4.098066841       5.85438120                     37.66231
## Dim.4   3.189698174       4.55671168                     42.21902
## Dim.5   3.026989952       4.32427136                     46.54329
## Dim.6   2.825470593       4.03638656                     50.57968
## Dim.7   2.025198406       2.89314058                     53.47282
## Dim.8   1.861620769       2.65945824                     56.13228
## Dim.9   1.667183354       2.38169051                     58.51397
## Dim.10  1.616735711       2.30962244                     60.82359
## Dim.11  1.556029821       2.22289974                     63.04649
## Dim.12  1.401563584       2.00223369                     65.04872
## Dim.13  1.324831451       1.89261636                     66.94134
## Dim.14  1.296928607       1.85275515                     68.79410
## Dim.15  1.198430094       1.71204299                     70.50614
## Dim.16  1.145233578       1.63604797                     72.14219
## Dim.17  1.085492405       1.55070344                     73.69289
## Dim.18  1.004685341       1.43526477                     75.12816
## Dim.19  0.981805888       1.40257984                     76.53074
## Dim.20  0.885385811       1.26483687                     77.79557
## Dim.21  0.870892333       1.24413190                     79.03970
## Dim.22  0.823132792       1.17590399                     80.21561
```

```
## Dim.23  0.804167549       1.14881078                 81.36442
## Dim.24  0.789583860       1.12797694                 82.49240
## Dim.25  0.739933753       1.05704822                 83.54944
## Dim.26  0.713385022       1.01912146                 84.56857
## Dim.27  0.685290463       0.97898638                 85.54755
## Dim.28  0.678453263       0.96921895                 86.51677
## Dim.29  0.619274625       0.88467804                 87.40145
## Dim.30  0.571449209       0.81635601                 88.21780
## Dim.31  0.546735089       0.78105013                 88.99885
## Dim.32  0.498004401       0.71143486                 89.71029
## Dim.33  0.481834340       0.68833477                 90.39862
## Dim.34  0.450635905       0.64376558                 91.04239
## Dim.35  0.440732533       0.62961790                 91.67201
## Dim.36  0.407234079       0.58176297                 92.25377
## Dim.37  0.383954815       0.54850688                 92.80228
## Dim.38  0.359361159       0.51337308                 93.31565
## Dim.39  0.341605753       0.48800822                 93.80366
## Dim.40  0.327130293       0.46732899                 94.27099
## Dim.41  0.303572583       0.43367512                 94.70466
## Dim.42  0.289662625       0.41380375                 95.11847
## Dim.43  0.270705685       0.38672241                 95.50519
## Dim.44  0.262255168       0.37465024                 95.87984
## Dim.45  0.245355105       0.35050729                 96.23035
## Dim.46  0.237290159       0.33898594                 96.56933
## Dim.47  0.221642007       0.31663144                 96.88596
## Dim.48  0.198600225       0.28371461                 97.16968
## Dim.49  0.175382702       0.25054672                 97.42023
## Dim.50  0.164477755       0.23496822                 97.65519
## Dim.51  0.154669799       0.22095686                 97.87615
## Dim.52  0.154083522       0.22011932                 98.09627
## Dim.53  0.148237622       0.21176803                 98.30804
## Dim.54  0.134459604       0.19208515                 98.50012
## Dim.55  0.131078565       0.18725509                 98.68738
## Dim.56  0.113795404       0.16256486                 98.84994
## Dim.57  0.103363088       0.14766155                 98.99760
## Dim.58  0.094517355       0.13502479                 99.13263
## Dim.59  0.083507072       0.11929582                 99.25193
## Dim.60  0.079447516       0.11349645                 99.36542
## Dim.61  0.074387575       0.10626796                 99.47169
## Dim.62  0.065648420       0.09378346                 99.56547
## Dim.63  0.058168202       0.08309743                 99.64857
## Dim.64  0.053011627       0.07573090                 99.72430
## Dim.65  0.045976478       0.06568068                 99.78998
## Dim.66  0.039545228       0.05649318                 99.84648
## Dim.67  0.037522418       0.05360345                 99.90008
## Dim.68  0.032139494       0.04591356                 99.94599
## Dim.69  0.028136339       0.04019477                 99.98619
## Dim.70  0.009669034       0.01381291                100.00000
```

We can use the screeplot and the percentage of variance explained per principal score to see that the explained variances flatten after the 6th component. PC 7 does not offer representative benefit as it only captures 2.89% of variances. The number of components to take in this case is 6, and it captures only 50.57% of the variance in the dataset.

```
cat("Sum of variance fraction explained in the first 6 components: ", sum(perc.expl[1:6]))
```

```
## Sum of variance fraction explained in the first 6 components:  0.5057968
```

Next we test if the principal components are associated with the outcome in unadjusted logistic regression models and in models adjusted for age, estrogen receptor and grade. We try to see difference between between unadjusted and adjusted models.

```
# Unadjusted models using first 6 components

#pca.vars$rotation[,1:6]
sort(pca.vars$rotation[,1:6], decreasing = TRUE)
```

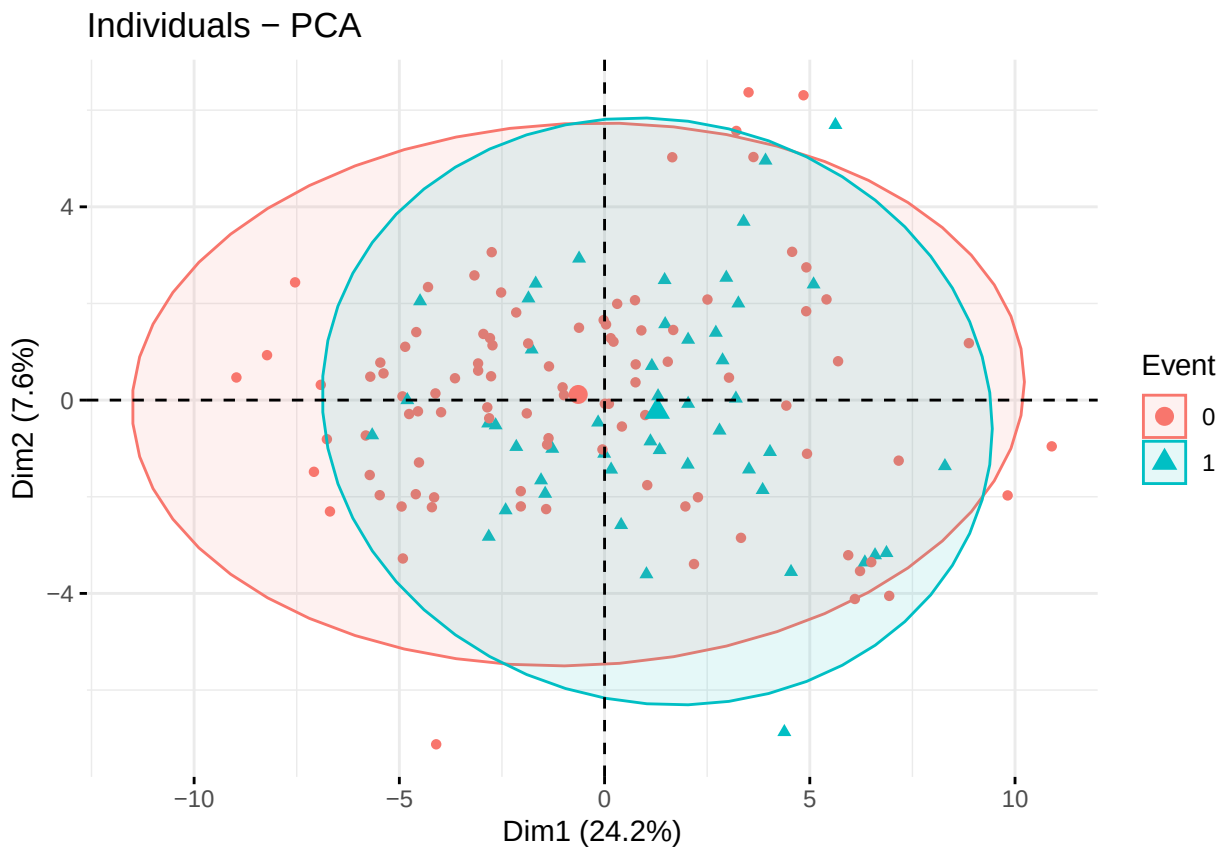
```
##   [1]  0.3442430971  0.3406638500  0.3358983996  0.2869099518  0.2741498286
##   [6]  0.2735517147  0.2608513132  0.2557049137  0.2389926207  0.2265872360
##  [11]  0.2212464501  0.2130017594  0.2086195626  0.2068466410  0.2034727145
##  [16]  0.2030517089  0.2016043958  0.1969747635  0.1963327099  0.1933070731
##  [21]  0.1920986998  0.1908166575  0.1898039069  0.1885517375  0.1874029536
##  [26]  0.1851384672  0.1837358335  0.1819548974  0.1800494978  0.1784956506
##  [31]  0.1782456346  0.1773430970  0.1763281341  0.1749786054  0.1741104887
##  [36]  0.1736822502  0.1716404556  0.1715154753  0.1707437491  0.1697652144
##  [41]  0.1686303726  0.1684569918  0.1680983395  0.1663381799  0.1631554727
##  [46]  0.1587895474  0.1573814759  0.1566911999  0.1562972776  0.1539292709
##  [51]  0.1529319373  0.1501226748  0.1490965522  0.1483733203  0.1479349438
##  [56]  0.1467843592  0.1445326689  0.1442508735  0.1439098043  0.1436662738
##  [61]  0.1427757343  0.1420421896  0.1417366415  0.1404533122  0.1393843829
##  [66]  0.1393430733  0.1386290007  0.1380494322  0.1351182323  0.1346748018
##  [71]  0.1339791738  0.1333589993  0.1316467275  0.1286967663  0.1246599899
##  [76]  0.1238424882  0.1196511512  0.1190371897  0.1189848342  0.1184843187
##  [81]  0.1184745831  0.1181467549  0.1179670127  0.1175955669  0.1156606899
##  [86]  0.1141499104  0.1137272813  0.1135092010  0.1116968620  0.1097833065
##  [91]  0.1089959406  0.1077256964  0.1047050366  0.1046336924  0.1043302905
##  [96]  0.1043230176  0.1024923724  0.1014278610  0.1012448534  0.1011789538
## [101]  0.1009219569  0.1008445992  0.1007144339  0.0999424439  0.0988758888
## [106]  0.0985944740  0.0977865410  0.0972108102  0.0970134275  0.0956991820
## [111]  0.0952477800  0.0950800793  0.0947355011  0.0942227144  0.0941549205
## [116]  0.0933513002  0.0930699553  0.0927535947  0.0916562314  0.0915298443
## [121]  0.0901622241  0.0894108432  0.0892738889  0.0872177816  0.0861005897
## [126]  0.0859579064  0.0853039238  0.0841854734  0.0825609280  0.0814046169
## [131]  0.0794549608  0.0791667324  0.0787477946  0.0784456057  0.0781714253
## [136]  0.0778619632  0.0762059574  0.0745523461  0.0741561477  0.0740684013
## [141]  0.0738513212  0.0735936355  0.0710250158  0.0701364365  0.0695562413
## [146]  0.0692354185  0.0685000932  0.0677967894  0.0677964596  0.0671004316
## [151]  0.0670245416  0.0668976117  0.0664466175  0.0664298184  0.0663736621
## [156]  0.0660144962  0.0657831751  0.0642346468  0.0635400088  0.0607395599
## [161]  0.0606665496  0.0592073479  0.0589421534  0.0580983024  0.0576346780
## [166]  0.0557111696  0.0535852797  0.0524366072  0.0519857264  0.0489663479
## [171]  0.0480302431  0.0479801666  0.0464490812  0.0458157100  0.0454787550
## [176]  0.0440020532  0.0413106216  0.0403210246  0.0399280105  0.0395841954
## [181]  0.0386316613  0.0384935879  0.0384886724  0.0382035817  0.0380386449
## [186]  0.0366942513  0.0366906476  0.0364844321  0.0357336263  0.0333474455
## [191]  0.0317606658  0.0312680549  0.0293191852  0.0282861960  0.0281517956
## [196]  0.0276447716  0.0274588025  0.0268125089  0.0254577515  0.0253620048
## [201]  0.0247219346  0.0244319019  0.0234775124  0.0224117008  0.0217969275
## [206]  0.0215088597  0.0205483737  0.0197512861  0.0181646059  0.0178186848
```

```
## [211]  0.0177045828  0.0160344732  0.0146473511  0.0121716411  0.0121017649
## [216]  0.0119219972  0.0116774861  0.0111093643  0.0105188497  0.0104454671
## [221]  0.0094890141  0.0073044335  0.0063829547  0.0059434556  0.0059405176
## [226]  0.0054914051  0.0050965890  0.0050548659  0.0038441201  0.0033321255
## [231]  0.0010551511  0.0008944012 -0.0006093136 -0.0021441075 -0.0040187571
## [236] -0.0050801629 -0.0053555754 -0.0069856554 -0.0071480900 -0.0073101448
## [241] -0.0084766665 -0.0090848969 -0.0093311289 -0.0104330295 -0.0111305191
## [246] -0.0113962160 -0.0124976161 -0.0148231739 -0.0154515822 -0.0157630246
## [251] -0.0173310527 -0.0186047962 -0.0194079820 -0.0208474770 -0.0217576865
## [256] -0.0219866504 -0.0235050957 -0.0240762763 -0.0253785488 -0.0274437738
## [261] -0.0285255113 -0.0285294498 -0.0294001236 -0.0298958140 -0.0299930292
## [266] -0.0304051869 -0.0314386259 -0.0316040720 -0.0316236369 -0.0328322784
## [271] -0.0332433186 -0.0356965735 -0.0361622331 -0.0377503266 -0.0380472630
## [276] -0.0383853213 -0.0386579949 -0.0395125232 -0.0402025377 -0.0405227793
## [281] -0.0405733974 -0.0408651180 -0.0417237206 -0.0417491424 -0.0429670586
## [286] -0.0442932114 -0.0445157104 -0.0460783364 -0.0465713920 -0.0470123342
## [291] -0.0470357892 -0.0472184671 -0.0480374259 -0.0488685998 -0.0507180593
## [296] -0.0508345614 -0.0511877651 -0.0533868773 -0.0543430559 -0.0543938110
## [301] -0.0550089541 -0.0559903244 -0.0568971334 -0.0581880869 -0.0583372386
## [306] -0.0590854121 -0.0604165164 -0.0613266746 -0.0618022461 -0.0648816501
## [311] -0.0658724583 -0.0660684550 -0.0674702599 -0.0692106384 -0.0696887489
## [316] -0.0719837146 -0.0728266442 -0.0774382448 -0.0780548231 -0.0822829333
## [321] -0.0836342891 -0.0853033573 -0.0856264299 -0.0871743655 -0.0881872900
## [326] -0.0882651606 -0.0882873796 -0.0883293992 -0.0883384278 -0.0886802997
## [331] -0.0897030870 -0.0921201665 -0.0936532236 -0.0941717728 -0.0947434784
## [336] -0.0963243094 -0.0969293204 -0.0973493143 -0.0982646424 -0.0984156491
## [341] -0.0994744357 -0.0999710514 -0.1004699520 -0.1014084934 -0.1020316191
## [346] -0.1036707888 -0.1041711455 -0.1045232104 -0.1053534461 -0.1094202429
## [351] -0.1104957647 -0.1107049016 -0.1134340040 -0.1145711686 -0.1151462115
## [356] -0.1156495955 -0.1166369780 -0.1181514497 -0.1198428774 -0.1221830135
## [361] -0.1222205142 -0.1227785872 -0.1251902335 -0.1266927597 -0.1271338467
## [366] -0.1288917231 -0.1327869860 -0.1339646937 -0.1341052149 -0.1348919302
## [371] -0.1362491972 -0.1379972807 -0.1392253120 -0.1396808862 -0.1409355101
## [376] -0.1421968620 -0.1429558764 -0.1453433915 -0.1481964178 -0.1492467766
## [381] -0.1530306606 -0.1532236024 -0.1539667995 -0.1570165721 -0.1601811193
## [386] -0.1604316899 -0.1609303332 -0.1622672401 -0.1634055337 -0.1650040160
## [391] -0.1652230522 -0.1686178165 -0.1718772025 -0.1735101231 -0.1812374583
## [396] -0.1838439016 -0.1838634827 -0.1870937182 -0.1875253329 -0.1882951412
## [401] -0.1925851256 -0.1976574345 -0.2017665757 -0.2032136236 -0.2063270511
## [406] -0.2083203559 -0.2156944640 -0.2168478951 -0.2208335772 -0.2244464234
## [411] -0.2278599061 -0.2304560650 -0.2351208068 -0.2373706527 -0.2391514123
## [416] -0.2401540716 -0.2417796477 -0.2484255464 -0.2485671432 -0.2989756618
```

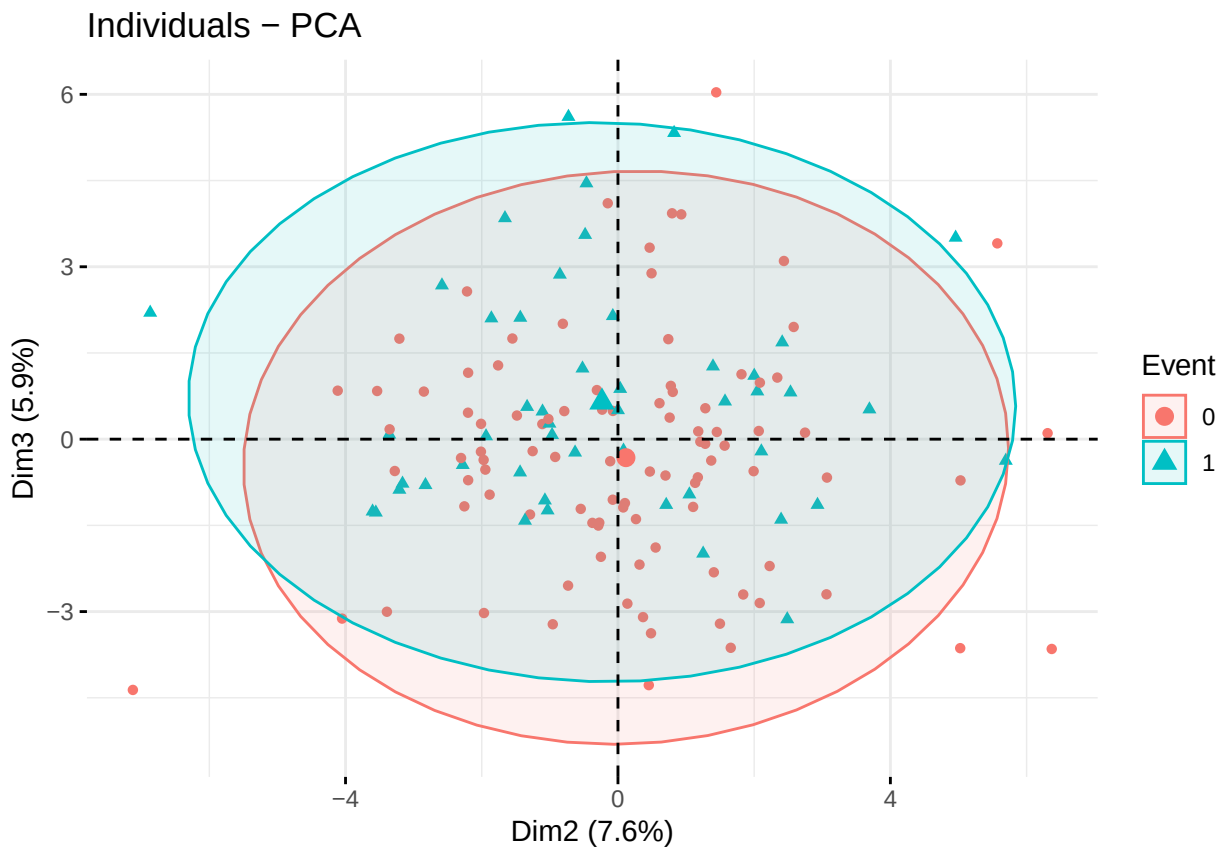
Problem 3.c (8 points)

Use plots to compare with the correlation structure observed in problem 2.a and to examine how well the dataset may explain your outcome. Discuss your findings and suggest any further steps if needed.

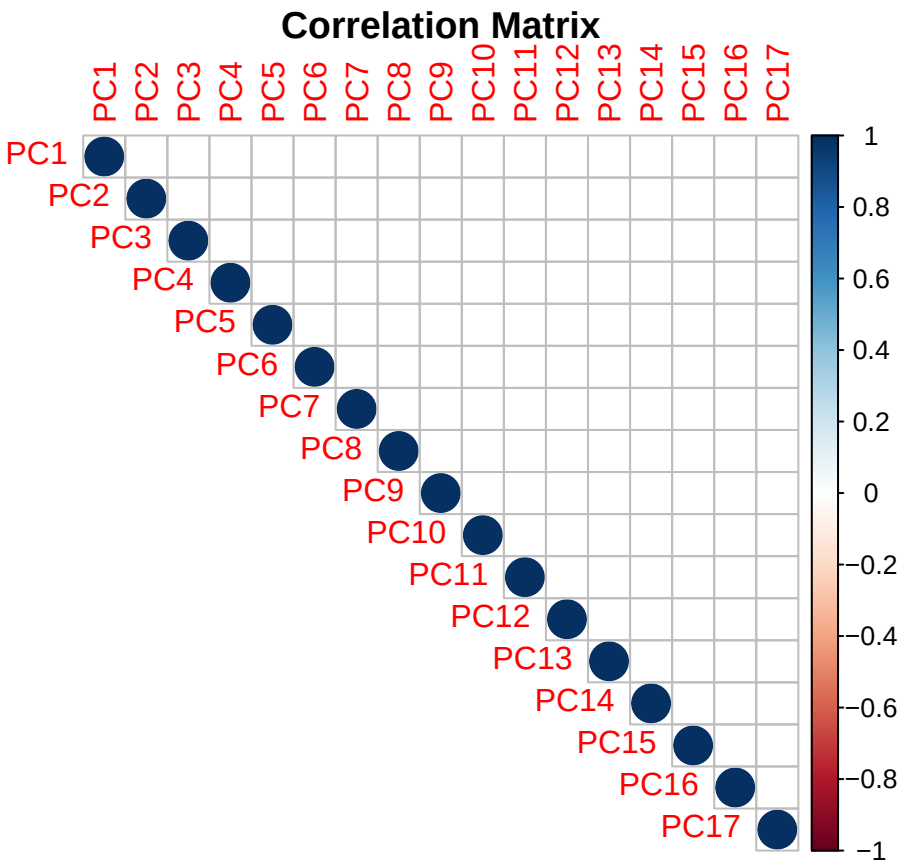
```
fviz_pca_ind(pca.vars, geom='point',col.ind = as.factor(nika.dt$Event), axes = c(1,2), addEllipses = T,
```



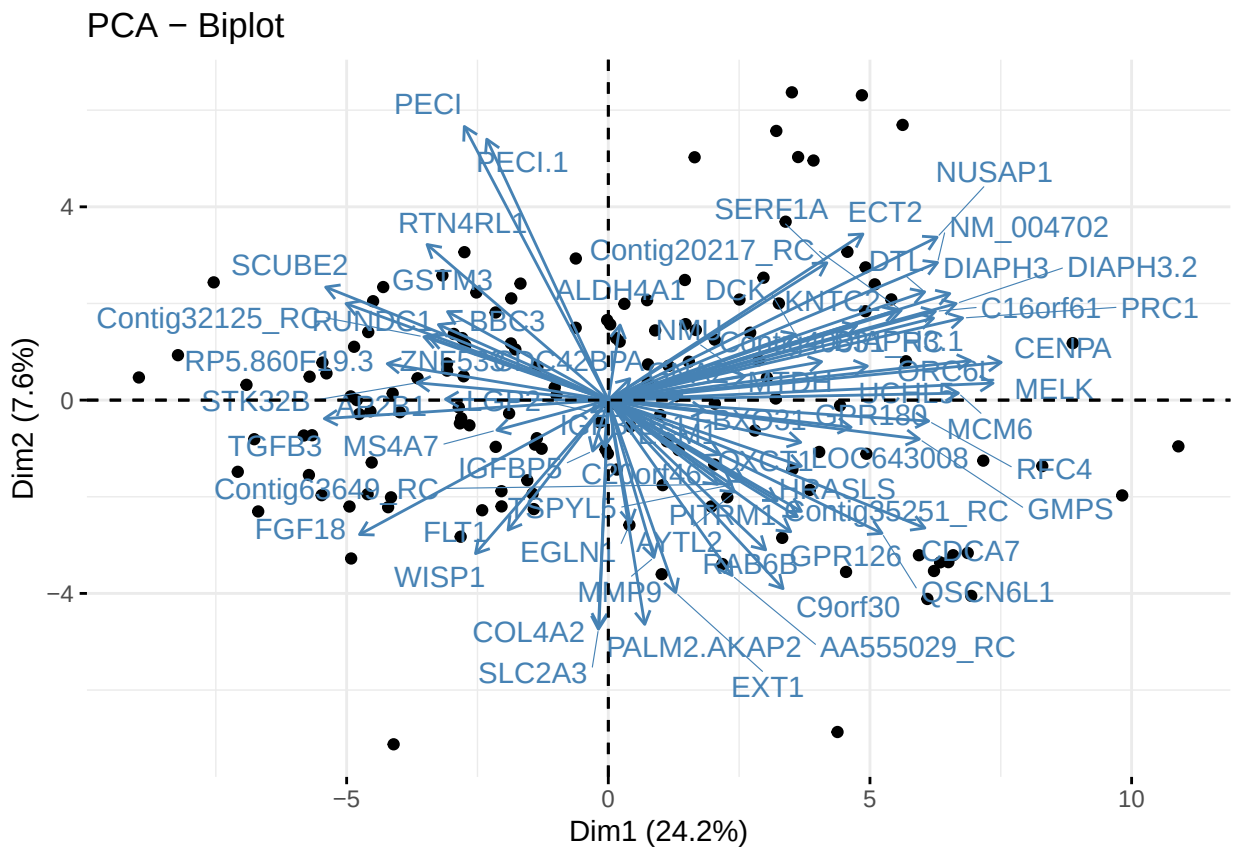

```
fviz_pca_ind(pca.vars, geom='point', axes = c(2,3), col.ind = as.factor(nika.dt$Event), addEllipses = T
```




```
num_pca = 17
cor.new = pca.vars$x[,1:num_pca] %>% cor(use = "pairwise.complete")
corrplot(cor.new, diag = TRUE, t1.col = "black", t1.cex =0.6, title = "Correlation Matrix", type = "upp
```




```
options(ggrepel.max.overlaps = Inf)
fviz_pca_biplot(pca.vars, geom ='point', repel = T)
```



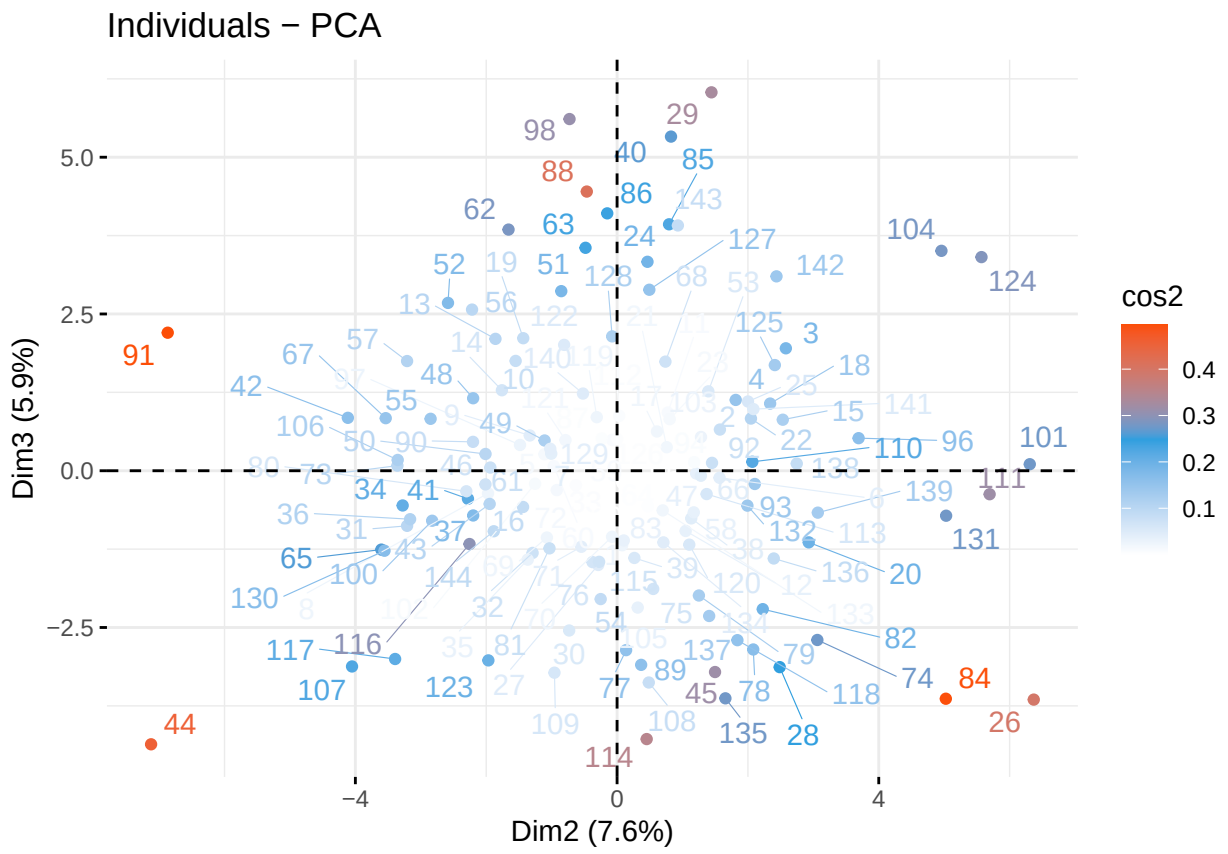
We can see that from our observations that the first component assings large positive values to gene expressions (ENPA, MELK, ORC6L, PRC1, and MCMG and large negative values to gene expression TGFB3, SCUBE2, RUNDC1, FGF18). It is fairly easy to see that these gene expressions have most influence on PC1. On the contrary, the second component analysis assigns large positive values to gene expression PEC, PECI.1, ECT2, and NSUAP1, and large negative values values to gene expressions SLC2A3, COL 4A2, and PALM2.AKAP2; this second set of gene expressions has most influence on PC 2.

From the biplot we can read the correlations between gene expressions.

Angles of arrows < 90 : Highly correlated Angles of arrows $= 90$: Not correlated Angles of arrows > 90 : Higly negatively correlated

Thus,observing the biplot we can consolidate our observations from Q2a. Angles are <90 between DIAPH3, DIAP3H3.1 and DIAPH3.2 in additon to PECI and PECI.1 or MELK, CENPA, ORCI6, and PRC1 and angles are >90 degrees between DIAPH3.1, DIAPH3.2 and TGFB3.

```
#Another helpful visualisation
fviz_pca_ind(pca.vars,axes = c(2,3), col.ind = "cos2",gradient.cols = c("white", "#2E9FDF", "#FC4E07"),
```



Problem 3.d (11 points)

Based on the models we examined in the labs, fit an appropriate model with the aim to provide the most accurate prognosis you can for patients. Discuss and justify your decisions.

```
set.seed(984065)

predictor_gene = as.matrix(nika.dt[,c(1,2,3,4,5,6)])
result = nika.dt$Event

#Make a splitting Index

Splitting_index_new  <- createDataPartition(result, p = 0.7)$Resample1

#Training and testing data set
x_train_nika.dt <- predictor_gene[Splitting_index_new,]
x_test_nika.dt <- predictor_gene[-Splitting_index_new,]
y_train_nika.dt <- result[Splitting_index_new]
length(y_train_nika.dt)
```

```
## [1] 101
```

```
y_test_nika.dt <- result[-Splitting_index_new ]

train_nika.dt = nika.dt[Splitting_index_new,]
test_nika.dt  = nika.dt[-Splitting_index_new, ]
```

```r
#fit.cv.lasso = cv.glmnet(x_train_nika.dt, y_train_nika.dt, alpha = 0, family = "binomial",type.measure

#fit.cv.ridge = cv.glmnet(x_train_nika.dt, y_train_nika.dt, alpha = 1,family = "binomial",type.measure

#Full and Null model

full_model_nika <- glm(Event ~., data = train_nika.dt, family = binomial(link = "logit"))

null_model_nika <- glm(Event ~ 1, data = train_nika.dt, family = binomial(link = "logit"))

#Forward and backward models
model.nika.forward <- stepAIC(null_model_nika, scope=list(upper=full_model_nika), direction="forward")
```

```
## Start:  AIC=132.35
## Event ~ 1
##
##                    Df Deviance    AIC
## + LymphNodes        1   122.49 126.49
## + NUSAP1            1   122.94 126.94
## + QSCN6L1           1   123.47 127.47
## + PRC1              1   123.76 127.76
## + EGLN1             1   124.39 128.39
## + Contig63649_RC    1   124.61 128.61
## + CENPA             1   124.97 128.97
## + LGP2              1   125.21 129.21
## + ORC6L             1   125.61 129.61
## + NM_004702         1   125.96 129.96
## + ZNF533            1   126.41 130.41
## + IGFBP5            1   126.42 130.42
## + MELK              1   126.64 130.64
## + IGFBP5.1          1   126.64 130.64
## + RFC4              1   126.79 130.79
## + GNAZ              1   127.39 131.39
## + ALDH4A1           1   127.42 131.42
## + Diam              1   127.50 131.50
## + MMP9              1   127.50 131.50
## + GMPS              1   127.54 131.54
## + PECI.1            1   127.55 131.55
## + MS4A7             1   127.70 131.70
## + STK32B            1   127.81 131.81
## + GPR180            1   127.82 131.82
## + COL4A2            1   127.83 131.83
## + UCHL5             1   127.94 131.94
## + DTL               1   128.02 132.02
## + ECT2              1   128.08 132.08
## + Age               1   128.15 132.15
## + C9orf30           1   128.17 132.17
## <none>                  130.35 132.35
## + CDCA7             1   128.38 132.38
## + RTN4RL1           1   128.48 132.48
## + DIAPH3.2          1   128.66 132.66
## + PECI              1   128.75 132.75
## + DIAPH3            1   128.94 132.94
```

```
## + SCUBE2            1   128.97 132.97
## + MCM6              1   129.06 133.06
## + Contig35251_RC    1   129.12 133.12
## + DIAPH3.1          1   129.12 133.12
## + FGF18             1   129.14 133.14
## + EstrogenReceptor  1   129.20 133.20
## + GSTM3             1   129.28 133.28
## + CDC42BPA          1   129.29 133.29
## + EXT1              1   129.33 133.33
## + GPR126            1   129.60 133.60
## + AP2B1             1   129.62 133.62
## + FLT1              1   129.68 133.68
## + Contig40831_RC    1   129.71 133.71
## + AA555029_RC       1   129.72 133.72
## + Contig32125_RC    1   129.73 133.73
## + SERF1A            1   129.74 133.74
## + Grade             2   127.79 133.79
## + RUNDC1            1   129.81 133.81
## + MTDH              1   129.86 133.86
## + ESM1              1   129.97 133.97
## + SLC2A3            1   130.01 134.01
## + OXCT1             1   130.03 134.03
## + TSPYL5            1   130.03 134.03
## + KNTC2             1   130.06 134.06
## + TGFB3             1   130.09 134.09
## + PALM2.AKAP2       1   130.09 134.09
## + NMU               1   130.10 134.10
## + RAB6B             1   130.18 134.18
## + DCK               1   130.22 134.22
## + C20orf46          1   130.24 134.24
## + C16orf61          1   130.25 134.25
## + FBXO31            1   130.29 134.29
## + WISP1             1   130.31 134.31
## + Contig20217_RC    1   130.31 134.31
## + RP5.860F19.3      1   130.32 134.32
## + BBC3              1   130.32 134.32
## + HRASLS            1   130.34 134.34
## + PITRM1            1   130.34 134.34
## + LOC643008         1   130.34 134.34
## + AYTL2             1   130.34 134.34
##
## Step:  AIC=126.49
## Event ~ LymphNodes
##
##                    Df Deviance    AIC
## + NUSAP1            1   116.22 122.22
## + QSCN6L1           1   116.90 122.90
## + EGLN1             1   117.40 123.40
## + CENPA             1   117.87 123.87
## + Contig63649_RC    1   118.04 124.04
## + PRC1              1   118.08 124.08
## + ORC6L             1   118.15 124.15
## + NM_004702         1   118.74 124.74
## + LGP2              1   119.08 125.08
```

```
## + MELK              1   119.12 125.12
## + GNAZ              1   119.13 125.13
## + IGFBP5            1   119.63 125.63
## + IGFBP5.1          1   119.66 125.66
## + ECT2              1   119.74 125.74
## + ZNF533            1   119.76 125.76
## + RFC4              1   119.76 125.76
## + ALDH4A1           1   119.80 125.80
## + UCHL5             1   119.82 125.82
## + GPR180            1   119.87 125.87
## + MS4A7             1   120.11 126.11
## + PECI.1            1   120.16 126.16
## + COL4A2            1   120.35 126.35
## <none>                  122.49 126.49
## + GMPS              1   120.54 126.54
## + FLT1              1   120.54 126.54
## + STK32B            1   120.74 126.74
## + FGF18             1   120.76 126.76
## + DTL               1   120.82 126.82
## + Contig35251_RC    1   121.00 127.00
## + DIAPH3.2          1   121.05 127.05
## + CDCA7             1   121.11 127.11
## + DIAPH3            1   121.13 127.13
## + C9orf30           1   121.16 127.16
## + MMP9              1   121.17 127.17
## + Contig32125_RC    1   121.17 127.17
## + PECI              1   121.20 127.20
## + DIAPH3.1          1   121.43 127.43
## + MCM6              1   121.44 127.44
## + RTN4RL1           1   121.48 127.48
## + PALM2.AKAP2       1   121.50 127.50
## + MTDH              1   121.50 127.50
## + EstrogenReceptor  1   121.53 127.53
## + Age               1   121.54 127.54
## + SCUBE2            1   121.54 127.54
## + TSPYL5            1   121.85 127.85
## + Diam              1   121.87 127.87
## + AP2B1             1   121.90 127.90
## + EXT1              1   121.90 127.90
## + Contig40831_RC    1   121.95 127.95
## + HRASLS            1   121.96 127.96
## + CDC42BPA          1   122.07 128.07
## + SLC2A3            1   122.12 128.12
## + AA555029_RC       1   122.12 128.12
## + SERF1A            1   122.12 128.12
## + TGFB3             1   122.13 128.13
## + GPR126            1   122.15 128.15
## + WISP1             1   122.17 128.17
## + GSTM3             1   122.18 128.18
## + PITRM1            1   122.21 128.21
## + Contig20217_RC    1   122.27 128.27
## + C20orf46          1   122.28 128.28
## + RAB6B             1   122.31 128.31
## + ESM1              1   122.31 128.31
```

```
## + RUNDC1            1   122.31 128.31
## + RP5.860F19.3      1   122.32 128.32
## + OXCT1             1   122.36 128.36
## + NMU               1   122.40 128.40
## + C16orf61          1   122.40 128.40
## + DCK               1   122.41 128.41
## + BBC3              1   122.45 128.45
## + LOC643008         1   122.45 128.45
## + AYTL2             1   122.48 128.48
## + FBXO31            1   122.49 128.49
## + KNTC2             1   122.49 128.49
## + Grade             2   121.30 129.30
##
## Step:  AIC=122.22
## Event ~ LymphNodes + NUSAP1
##
##                    Df Deviance    AIC
## + UCHL5             1   107.12 115.12
## + GPR180            1   108.82 116.82
## + Contig20217_RC    1   111.72 119.72
## + COL4A2            1   111.96 119.96
## + EGLN1             1   111.97 119.97
## + IGFBP5            1   112.30 120.30
## + IGFBP5.1          1   112.70 120.70
## + FLT1              1   112.74 120.74
## + KNTC2             1   112.77 120.77
## + PECI.1            1   113.03 121.03
## + LGP2              1   113.08 121.08
## + Contig63649_RC    1   113.11 121.11
## + SERF1A            1   113.57 121.57
## + QSCN6L1           1   113.70 121.70
## + C16orf61          1   113.73 121.73
## + PALM2.AKAP2       1   113.79 121.79
## + AP2B1             1   113.81 121.81
## + Contig32125_RC    1   113.88 121.88
## + GNAZ              1   114.03 122.03
## <none>                  116.22 122.22
## + RUNDC1            1   114.48 122.48
## + MMP9              1   114.53 122.53
## + PECI              1   114.66 122.66
## + Age               1   114.72 122.72
## + ALDH4A1           1   114.73 122.73
## + RP5.860F19.3      1   114.86 122.86
## + SLC2A3            1   114.89 122.89
## + ZNF533            1   114.95 122.95
## + RTN4RL1           1   115.22 123.22
## + EXT1              1   115.24 123.24
## + PITRM1            1   115.24 123.24
## + DIAPH3            1   115.29 123.29
## + CDC42BPA          1   115.31 123.31
## + DCK               1   115.35 123.35
## + TSPYL5            1   115.36 123.36
## + DTL               1   115.43 123.43
## + Contig35251_RC    1   115.48 123.48
```

```
## + HRASLS            1   115.49 123.49
## + DIAPH3.1          1   115.56 123.56
## + C9orf30           1   115.62 123.62
## + MS4A7             1   115.63 123.63
## + DIAPH3.2          1   115.66 123.66
## + Diam              1   115.67 123.67
## + FBXO31            1   115.68 123.68
## + NMU               1   115.68 123.68
## + STK32B            1   115.74 123.74
## + EstrogenReceptor  1   115.80 123.80
## + LOC643008         1   115.89 123.89
## + MCM6              1   115.91 123.91
## + C20orf46          1   115.91 123.91
## + AA555029_RC       1   115.93 123.93
## + ORC6L             1   115.97 123.97
## + AYTL2             1   115.99 123.99
## + CENPA             1   116.03 124.03
## + RFC4              1   116.04 124.04
## + TGFB3             1   116.04 124.04
## + CDCA7             1   116.09 124.09
## + WISP1             1   116.12 124.12
## + RAB6B             1   116.14 124.14
## + Contig40831_RC    1   116.14 124.14
## + GMPS              1   116.14 124.14
## + NM_004702         1   116.15 124.15
## + ECT2              1   116.16 124.16
## + ESM1              1   116.19 124.19
## + BBC3              1   116.19 124.19
## + GPR126            1   116.19 124.19
## + GSTM3             1   116.20 124.20
## + SCUBE2            1   116.20 124.20
## + MELK              1   116.21 124.21
## + OXCT1             1   116.22 124.22
## + MTDH              1   116.22 124.22
## + PRC1              1   116.22 124.22
## + FGF18             1   116.22 124.22
## + Grade             2   115.50 125.50
##
## Step:  AIC=115.12
## Event ~ LymphNodes + NUSAP1 + UCHL5
##
##                    Df Deviance    AIC
## + Contig63649_RC    1   101.42 111.42
## + PECI.1            1   102.59 112.59
## + RTN4RL1           1   102.62 112.62
## + QSCN6L1           1   103.16 113.16
## + PALM2.AKAP2       1   103.33 113.33
## + Contig20217_RC    1   103.79 113.79
## + GPR126            1   103.89 113.89
## + IGFBP5            1   104.15 114.15
## + KNTC2             1   104.21 114.21
## + GPR180            1   104.23 114.23
## + IGFBP5.1          1   104.62 114.62
## + COL4A2            1   104.73 114.73
```

```
## + Contig35251_RC    1   104.77 114.77
## + PECI              1   104.91 114.91
## + CDCA7             1   104.92 114.92
## + EstrogenReceptor  1   104.99 114.99
## <none>                  107.12 115.12
## + C16orf61          1   105.16 115.16
## + GMPS              1   105.21 115.21
## + STK32B            1   105.50 115.50
## + RFC4              1   105.56 115.56
## + FLT1              1   105.67 115.67
## + MMP9              1   105.70 115.70
## + MTDH              1   105.78 115.78
## + C9orf30           1   105.84 115.84
## + SERF1A            1   105.87 115.87
## + FBXO31            1   105.96 115.96
## + LGP2              1   106.09 116.09
## + GNAZ              1   106.14 116.14
## + Age               1   106.15 116.15
## + DIAPH3            1   106.20 116.20
## + EGLN1             1   106.22 116.22
## + MELK              1   106.23 116.23
## + SLC2A3            1   106.25 116.25
## + CENPA             1   106.25 116.25
## + EXT1              1   106.28 116.28
## + Contig32125_RC    1   106.30 116.30
## + SCUBE2            1   106.31 116.31
## + AP2B1             1   106.33 116.33
## + OXCT1             1   106.39 116.39
## + TSPYL5            1   106.39 116.39
## + AA555029_RC       1   106.41 116.41
## + ZNF533            1   106.46 116.46
## + Diam              1   106.61 116.61
## + DTL               1   106.76 116.76
## + DIAPH3.1          1   106.77 116.77
## + DCK               1   106.78 116.78
## + LOC643008         1   106.81 116.81
## + GSTM3             1   106.83 116.83
## + ESM1              1   106.83 116.83
## + PITRM1            1   106.84 116.84
## + ECT2              1   106.86 116.86
## + HRASLS            1   106.86 116.86
## + NM_004702         1   106.88 116.88
## + RP5.860F19.3      1   106.88 116.88
## + ORC6L             1   106.92 116.92
## + RUNDC1            1   106.93 116.93
## + WISP1             1   106.94 116.94
## + NMU               1   106.96 116.96
## + C20orf46          1   106.97 116.97
## + PRC1              1   106.97 116.97
## + FGF18             1   106.98 116.98
## + CDC42BPA          1   106.98 116.98
## + TGFB3             1   107.02 117.02
## + DIAPH3.2          1   107.02 117.02
## + BBC3              1   107.04 117.04
```

```
## + MS4A7             1   107.06 117.06
## + MCM6              1   107.07 117.07
## + RAB6B             1   107.08 117.08
## + ALDH4A1           1   107.08 117.08
## + Contig40831_RC    1   107.10 117.10
## + AYTL2             1   107.12 117.12
## + Grade             2   106.37 118.37
##
## Step:  AIC=111.42
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC
##
##                     Df Deviance    AIC
## + QSCN6L1           1   95.111 107.11
## + PALM2.AKAP2       1   97.450 109.45
## + Contig20217_RC    1   97.501 109.50
## + C16orf61          1   97.602 109.60
## + PECI.1            1   97.610 109.61
## + GPR180            1   97.939 109.94
## + RTN4RL1           1   98.026 110.03
## + KNTC2             1   98.256 110.26
## + COL4A2            1   98.806 110.81
## + IGFBP5.1          1   98.870 110.87
## + IGFBP5            1   98.878 110.88
## + DIAPH3            1   99.181 111.18
## + CDCA7             1   99.240 111.24
## + SERF1A            1   99.241 111.24
## <none>                 101.425 111.42
## + Contig32125_RC    1   99.521 111.52
## + EGLN1             1   99.639 111.64
## + GPR126            1   99.641 111.64
## + LOC643008         1   99.691 111.69
## + HRASLS            1   99.765 111.77
## + LGP2              1   99.806 111.81
## + GMPS              1   99.862 111.86
## + PECI              1   99.974 111.97
## + EstrogenReceptor  1   99.980 111.98
## + MTDH              1  100.161 112.16
## + STK32B            1  100.195 112.19
## + DIAPH3.1          1  100.216 112.22
## + SCUBE2            1  100.441 112.44
## + FBXO31            1  100.449 112.45
## + Contig35251_RC    1  100.453 112.45
## + RFC4              1  100.495 112.50
## + AP2B1             1  100.565 112.56
## + GNAZ              1  100.583 112.58
## + OXCT1             1  100.644 112.64
## + GSTM3             1  100.773 112.77
## + PRC1              1  100.845 112.84
## + MS4A7             1  100.892 112.89
## + FLT1              1  100.902 112.90
## + ECT2              1  100.906 112.91
## + DIAPH3.2          1  100.938 112.94
## + Age               1  100.960 112.96
## + ZNF533            1  100.965 112.97
```

```
## + AA555029_RC       1  101.011 113.01
## + DTL               1  101.025 113.03
## + RUNDC1            1  101.036 113.04
## + MMP9              1  101.058 113.06
## + CENPA             1  101.096 113.10
## + Diam              1  101.118 113.12
## + TGFB3             1  101.125 113.12
## + TSPYL5            1  101.181 113.18
## + MELK              1  101.186 113.19
## + RP5.860F19.3      1  101.194 113.19
## + C20orf46          1  101.213 113.21
## + Contig40831_RC    1  101.222 113.22
## + DCK               1  101.228 113.23
## + ESM1              1  101.261 113.26
## + NM_004702         1  101.299 113.30
## + NMU               1  101.339 113.34
## + EXT1              1  101.367 113.37
## + C9orf30           1  101.373 113.37
## + CDC42BPA          1  101.381 113.38
## + RAB6B             1  101.384 113.38
## + SLC2A3            1  101.386 113.39
## + BBC3              1  101.387 113.39
## + MCM6              1  101.390 113.39
## + ORC6L             1  101.407 113.41
## + WISP1             1  101.407 113.41
## + FGF18             1  101.414 113.41
## + AYTL2             1  101.415 113.42
## + PITRM1            1  101.416 113.42
## + ALDH4A1           1  101.424 113.42
## + Grade             2  101.242 115.24
##
## Step:  AIC=107.11
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1
##
##                     Df Deviance    AIC
## + Contig20217_RC     1   89.632 103.63
## + Contig32125_RC     1   90.066 104.07
## + HRASLS             1   90.237 104.24
## + C16orf61           1   90.248 104.25
## + KNTC2              1   90.595 104.59
## + LOC643008          1   91.016 105.02
## + PRC1               1   92.211 106.21
## + RAB6B              1   92.651 106.65
## + MCM6               1   92.848 106.85
## + LGP2               1   92.977 106.98
## + DIAPH3.1           1   92.986 106.99
## <none>                   95.111 107.11
## + GPR180             1   93.176 107.18
## + DIAPH3             1   93.270 107.27
## + FBXO31             1   93.377 107.38
## + RUNDC1             1   93.412 107.41
## + PITRM1             1   93.505 107.50
## + PALM2.AKAP2        1   93.584 107.58
## + DTL                1   93.585 107.58
```

```
## + SERF1A            1   93.620 107.62
## + MTDH              1   93.740 107.74
## + DIAPH3.2          1   93.757 107.76
## + PECI.1            1   93.870 107.87
## + IGFBP5            1   93.876 107.88
## + C20orf46          1   93.889 107.89
## + IGFBP5.1          1   93.931 107.93
## + MELK              1   93.952 107.95
## + EGLN1             1   94.013 108.01
## + GNAZ              1   94.152 108.15
## + TSPYL5            1   94.163 108.16
## + AP2B1             1   94.202 108.20
## + STK32B            1   94.212 108.21
## + RP5.860F19.3      1   94.221 108.22
## + RTN4RL1           1   94.266 108.27
## + BBC3              1   94.345 108.34
## + Contig40831_RC    1   94.367 108.37
## + ORC6L             1   94.422 108.42
## + CENPA             1   94.463 108.46
## + Diam              1   94.519 108.52
## + C9orf30           1   94.558 108.56
## + FGF18             1   94.622 108.62
## + FLT1              1   94.666 108.67
## + EXT1              1   94.694 108.69
## + ALDH4A1           1   94.749 108.75
## + OXCT1             1   94.764 108.76
## + COL4A2            1   94.803 108.80
## + Age               1   94.813 108.81
## + NMU               1   94.822 108.82
## + CDC42BPA          1   94.846 108.85
## + AYTL2             1   94.856 108.86
## + GPR126            1   94.870 108.87
## + ECT2              1   94.924 108.92
## + EstrogenReceptor  1   94.924 108.92
## + GSTM3             1   94.946 108.95
## + AA555029_RC       1   95.021 109.02
## + ESM1              1   95.041 109.04
## + SCUBE2            1   95.042 109.04
## + CDCA7             1   95.060 109.06
## + Contig35251_RC    1   95.062 109.06
## + NM_004702         1   95.074 109.07
## + MS4A7             1   95.082 109.08
## + MMP9              1   95.082 109.08
## + PECI              1   95.084 109.08
## + WISP1             1   95.093 109.09
## + SLC2A3            1   95.097 109.10
## + ZNF533            1   95.104 109.10
## + DCK               1   95.108 109.11
## + GMPS              1   95.108 109.11
## + TGFB3             1   95.108 109.11
## + RFC4              1   95.109 109.11
## + Grade             2   94.540 110.54
##
## Step:  AIC=103.63
```

```
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC
##
##                     Df Deviance    AIC
## + HRASLS             1   86.291 102.29
## + Contig32125_RC     1   86.742 102.74
## + MTDH               1   86.980 102.98
## + IGFBP5             1   87.294 103.29
## + STK32B             1   87.459 103.46
## + LGP2               1   87.471 103.47
## + GNAZ               1   87.491 103.49
## + LOC643008          1   87.546 103.55
## + MCM6               1   87.557 103.56
## + PITRM1             1   87.562 103.56
## + IGFBP5.1           1   87.618 103.62
## <none>                   89.632 103.63
## + C16orf61           1   87.638 103.64
## + KNTC2              1   87.696 103.70
## + EGLN1              1   88.039 104.04
## + C9orf30            1   88.102 104.10
## + RUNDC1             1   88.157 104.16
## + ECT2               1   88.251 104.25
## + PALM2.AKAP2        1   88.253 104.25
## + DTL                1   88.372 104.37
## + WISP1              1   88.420 104.42
## + C20orf46           1   88.421 104.42
## + GPR180             1   88.445 104.44
## + PECI.1             1   88.474 104.47
## + PRC1               1   88.498 104.50
## + RTN4RL1            1   88.691 104.69
## + DIAPH3             1   88.800 104.80
## + Diam               1   88.822 104.82
## + RAB6B              1   88.827 104.83
## + TSPYL5             1   88.877 104.88
## + SLC2A3             1   88.924 104.92
## + DIAPH3.1           1   88.961 104.96
## + AYTL2              1   88.965 104.97
## + RP5.860F19.3       1   89.049 105.05
## + GPR126             1   89.064 105.06
## + MELK               1   89.071 105.07
## + GSTM3              1   89.183 105.18
## + SERF1A             1   89.205 105.20
## + TGFB3              1   89.276 105.28
## + FBXO31             1   89.287 105.29
## + Contig35251_RC     1   89.298 105.30
## + EstrogenReceptor   1   89.308 105.31
## + GMPS               1   89.333 105.33
## + CDC42BPA           1   89.391 105.39
## + OXCT1              1   89.392 105.39
## + AP2B1              1   89.392 105.39
## + DIAPH3.2           1   89.408 105.41
## + ALDH4A1            1   89.414 105.41
## + Age                1   89.455 105.45
## + MS4A7              1   89.456 105.46
```

```
## + CDCA7             1   89.489 105.49
## + BBC3              1   89.524 105.52
## + EXT1              1   89.531 105.53
## + ESM1              1   89.557 105.56
## + NM_004702         1   89.579 105.58
## + ORC6L             1   89.596 105.60
## + SCUBE2            1   89.597 105.60
## + ZNF533            1   89.598 105.60
## + PECI              1   89.601 105.60
## + RFC4              1   89.605 105.61
## + CENPA             1   89.614 105.61
## + NMU               1   89.619 105.62
## + DCK               1   89.625 105.62
## + FLT1              1   89.628 105.63
## + COL4A2            1   89.628 105.63
## + MMP9              1   89.629 105.63
## + AA555029_RC       1   89.630 105.63
## + Contig40831_RC    1   89.630 105.63
## + FGF18             1   89.632 105.63
## + Grade             2   88.266 106.27
##
## Step:  AIC=102.29
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS
##
##                    Df Deviance    AIC
## + Contig32125_RC    1   82.590 100.59
## + MTDH              1   83.103 101.10
## + STK32B            1   83.661 101.66
## + PECI.1            1   84.222 102.22
## <none>                  86.291 102.29
## + GNAZ              1   84.420 102.42
## + C16orf61          1   84.451 102.45
## + IGFBP5            1   84.453 102.45
## + C20orf46          1   84.686 102.69
## + LOC643008         1   84.710 102.71
## + KNTC2             1   84.738 102.74
## + IGFBP5.1          1   84.931 102.93
## + LGP2              1   84.949 102.95
## + GPR126            1   84.970 102.97
## + GMPS              1   85.012 103.01
## + WISP1             1   85.082 103.08
## + CDCA7             1   85.098 103.10
## + SLC2A3            1   85.104 103.10
## + PITRM1            1   85.127 103.13
## + EGLN1             1   85.178 103.18
## + RUNDC1            1   85.257 103.26
## + C9orf30           1   85.375 103.38
## + OXCT1             1   85.389 103.39
## + RFC4              1   85.477 103.48
## + PRC1              1   85.486 103.49
## + ECT2              1   85.512 103.51
## + PALM2.AKAP2       1   85.559 103.56
## + MCM6              1   85.559 103.56
```

```
## + DTL               1   85.587 103.59
## + DIAPH3.1          1   85.591 103.59
## + AP2B1             1   85.689 103.69
## + RTN4RL1           1   85.690 103.69
## + SERF1A            1   85.743 103.74
## + GSTM3             1   85.782 103.78
## + GPR180            1   85.792 103.79
## + Diam              1   85.816 103.82
## + Contig35251_RC    1   85.851 103.85
## + MS4A7             1   85.860 103.86
## + TGFB3             1   85.875 103.88
## + RAB6B             1   85.943 103.94
## + Age               1   85.965 103.97
## + TSPYL5            1   85.977 103.98
## + DIAPH3.2          1   86.020 104.02
## + MELK              1   86.076 104.08
## + FBXO31            1   86.092 104.09
## + DIAPH3            1   86.096 104.10
## + AYTL2             1   86.116 104.12
## + NM_004702         1   86.137 104.14
## + ESM1              1   86.158 104.16
## + RP5.860F19.3      1   86.162 104.16
## + AA555029_RC       1   86.167 104.17
## + EstrogenReceptor  1   86.194 104.19
## + ALDH4A1           1   86.218 104.22
## + FLT1              1   86.225 104.22
## + CDC42BPA          1   86.236 104.24
## + SCUBE2            1   86.238 104.24
## + NMU               1   86.259 104.26
## + DCK               1   86.266 104.27
## + BBC3              1   86.269 104.27
## + EXT1              1   86.276 104.28
## + CENPA             1   86.277 104.28
## + FGF18             1   86.278 104.28
## + COL4A2            1   86.279 104.28
## + ZNF533            1   86.288 104.29
## + Contig40831_RC    1   86.288 104.29
## + PECI              1   86.288 104.29
## + MMP9              1   86.290 104.29
## + ORC6L             1   86.291 104.29
## + Grade             2   85.511 105.51
##
## Step:  AIC=100.59
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC
##
##                    Df Deviance     AIC
## + STK32B            1   79.253  99.253
## + GMPS              1   79.814  99.814
## + PECI.1            1   79.872  99.872
## + RUNDC1            1   80.054 100.054
## + IGFBP5            1   80.091 100.091
## + MTDH              1   80.221 100.221
## + GNAZ              1   80.270 100.270
```

```
## <none>                  82.590 100.590
## + IGFBP5.1          1   80.634 100.634
## + LGP2              1   80.685 100.685
## + WISP1             1   80.978 100.978
## + RFC4              1   81.030 101.030
## + KNTC2             1   81.125 101.125
## + LOC643008         1   81.144 101.144
## + C16orf61          1   81.212 101.212
## + PALM2.AKAP2       1   81.299 101.299
## + PITRM1            1   81.380 101.380
## + ECT2              1   81.381 101.381
## + GSTM3             1   81.496 101.496
## + CDCA7             1   81.530 101.530
## + SLC2A3            1   81.591 101.591
## + GPR126            1   81.647 101.647
## + C20orf46          1   81.651 101.651
## + RTN4RL1           1   81.681 101.681
## + AP2B1             1   81.781 101.781
## + C9orf30           1   81.809 101.809
## + SERF1A            1   81.951 101.951
## + OXCT1             1   81.971 101.971
## + MS4A7             1   82.024 102.024
## + MCM6              1   82.033 102.033
## + CDC42BPA          1   82.111 102.111
## + GPR180            1   82.114 102.114
## + TGFB3             1   82.131 102.131
## + PRC1              1   82.138 102.138
## + EGLN1             1   82.157 102.157
## + DIAPH3.1          1   82.173 102.173
## + Diam              1   82.244 102.244
## + DIAPH3.2          1   82.256 102.256
## + TSPYL5            1   82.288 102.288
## + RAB6B             1   82.317 102.317
## + FBXO31            1   82.363 102.363
## + DIAPH3            1   82.401 102.401
## + ZNF533            1   82.403 102.403
## + Contig35251_RC    1   82.408 102.408
## + Age               1   82.411 102.411
## + SCUBE2            1   82.412 102.412
## + DTL               1   82.431 102.431
## + MELK              1   82.444 102.444
## + ALDH4A1           1   82.454 102.454
## + DCK               1   82.478 102.478
## + ESM1              1   82.517 102.517
## + EstrogenReceptor  1   82.518 102.518
## + FGF18             1   82.528 102.528
## + FLT1              1   82.529 102.529
## + BBC3              1   82.529 102.529
## + Contig40831_RC    1   82.530 102.530
## + RP5.860F19.3      1   82.543 102.543
## + CENPA             1   82.547 102.547
## + AA555029_RC       1   82.557 102.557
## + NM_004702         1   82.558 102.558
## + PECI              1   82.565 102.565
```

```
## + ORC6L             1   82.570 102.570
## + MMP9              1   82.570 102.570
## + AYTL2             1   82.583 102.583
## + NMU               1   82.588 102.588
## + EXT1              1   82.589 102.589
## + COL4A2            1   82.590 102.590
## + Grade             2   82.193 104.193
##
## Step:  AIC=99.25
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B
##
##                    Df Deviance     AIC
## + LGP2              1   75.800  97.800
## + IGFBP5            1   76.123  98.123
## + C16orf61          1   76.225  98.225
## + RUNDC1            1   76.400  98.400
## + TSPYL5            1   76.484  98.484
## + IGFBP5.1          1   76.613  98.613
## + GMPS              1   76.961  98.961
## + MTDH              1   77.081  99.081
## <none>                  79.253  99.253
## + GNAZ              1   77.449  99.449
## + PRC1              1   77.523  99.523
## + SLC2A3            1   77.707  99.707
## + LOC643008         1   77.746  99.746
## + PALM2.AKAP2       1   77.758  99.758
## + PITRM1            1   77.850  99.850
## + KNTC2             1   77.911  99.911
## + ECT2              1   77.917  99.917
## + C20orf46          1   77.922  99.922
## + PECI.1            1   77.945  99.945
## + RFC4              1   77.960  99.960
## + AP2B1             1   77.967  99.967
## + C9orf30           1   78.037 100.037
## + EGLN1             1   78.072 100.072
## + RAB6B             1   78.105 100.105
## + EstrogenReceptor  1   78.128 100.128
## + CDC42BPA          1   78.131 100.131
## + GPR180            1   78.246 100.246
## + SERF1A            1   78.288 100.288
## + CENPA             1   78.406 100.406
## + WISP1             1   78.438 100.438
## + MCM6              1   78.504 100.504
## + FBXO31            1   78.586 100.586
## + RTN4RL1           1   78.610 100.610
## + OXCT1             1   78.620 100.620
## + DIAPH3            1   78.632 100.632
## + CDCA7             1   78.639 100.639
## + DIAPH3.1          1   78.803 100.803
## + Contig40831_RC    1   78.833 100.833
## + GPR126            1   78.934 100.934
## + GSTM3             1   78.977 100.977
## + MS4A7             1   78.988 100.988
```

```
## + DIAPH3.2          1   78.995 100.995
## + Contig35251_RC    1   79.047 101.047
## + FGF18             1   79.085 101.085
## + RP5.860F19.3      1   79.126 101.126
## + MMP9              1   79.138 101.138
## + ORC6L             1   79.147 101.147
## + NMU               1   79.148 101.148
## + TGFB3             1   79.156 101.156
## + FLT1              1   79.158 101.158
## + NM_004702         1   79.160 101.160
## + MELK              1   79.163 101.163
## + DTL               1   79.177 101.177
## + ZNF533            1   79.198 101.198
## + SCUBE2            1   79.211 101.211
## + Diam              1   79.230 101.230
## + DCK               1   79.238 101.238
## + AA555029_RC       1   79.240 101.240
## + BBC3              1   79.241 101.241
## + AYTL2             1   79.245 101.245
## + ESM1              1   79.245 101.245
## + Age               1   79.249 101.249
## + ALDH4A1           1   79.250 101.250
## + PECI              1   79.250 101.250
## + COL4A2            1   79.253 101.253
## + EXT1              1   79.253 101.253
## + Grade             2   78.535 102.535
##
## Step:  AIC=97.8
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2
##
##                    Df Deviance     AIC
## + PRC1              1   72.437  96.437
## + LOC643008         1   72.648  96.648
## + KNTC2             1   72.909  96.909
## + C20orf46          1   73.150  97.150
## + IGFBP5            1   73.167  97.167
## + C16orf61          1   73.397  97.397
## + IGFBP5.1          1   73.530  97.530
## + MTDH              1   73.645  97.645
## + TSPYL5            1   73.782  97.782
## <none>                  75.800  97.800
## + GMPS              1   73.824  97.824
## + RUNDC1            1   73.858  97.858
## + C9orf30           1   73.931  97.931
## + RAB6B             1   74.124  98.124
## + PITRM1            1   74.187  98.187
## + GPR180            1   74.243  98.243
## + GNAZ              1   74.259  98.259
## + SLC2A3            1   74.427  98.427
## + ECT2              1   74.430  98.430
## + PALM2.AKAP2       1   74.499  98.499
## + DIAPH3            1   74.540  98.540
## + WISP1             1   74.554  98.554
```

```
## + OXCT1             1   74.575  98.575
## + CDC42BPA          1   74.614  98.614
## + RTN4RL1           1   74.655  98.655
## + EGLN1             1   74.754  98.754
## + CDCA7             1   74.761  98.761
## + SERF1A            1   74.834  98.834
## + MCM6              1   74.843  98.843
## + RFC4              1   74.850  98.850
## + DIAPH3.1          1   74.881  98.881
## + PECI.1            1   74.936  98.936
## + AP2B1             1   75.041  99.041
## + FBXO31            1   75.123  99.123
## + CENPA             1   75.184  99.184
## + GPR126            1   75.234  99.234
## + MELK              1   75.256  99.256
## + MS4A7             1   75.422  99.422
## + DIAPH3.2          1   75.438  99.438
## + FGF18             1   75.445  99.445
## + GSTM3             1   75.507  99.507
## + SCUBE2            1   75.577  99.577
## + EXT1              1   75.590  99.590
## + EstrogenReceptor  1   75.619  99.619
## + DTL               1   75.665  99.665
## + RP5.860F19.3      1   75.669  99.669
## + Contig35251_RC    1   75.684  99.684
## + COL4A2            1   75.689  99.689
## + ORC6L             1   75.712  99.712
## + BBC3              1   75.713  99.713
## + PECI              1   75.725  99.725
## + ZNF533            1   75.738  99.738
## + TGFB3             1   75.741  99.741
## + ALDH4A1           1   75.747  99.747
## + AYTL2             1   75.749  99.749
## + Age               1   75.751  99.751
## + FLT1              1   75.763  99.763
## + MMP9              1   75.765  99.765
## + Diam              1   75.784  99.784
## + DCK               1   75.788  99.788
## + NMU               1   75.792  99.792
## + Contig40831_RC    1   75.794  99.794
## + AA555029_RC       1   75.798  99.798
## + ESM1              1   75.800  99.800
## + NM_004702         1   75.800  99.800
## + Grade             2   74.789 100.789
##
## Step:  AIC=96.44
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1
##
##                    Df Deviance    AIC
## + LOC643008         1   68.955 94.955
## + IGFBP5            1   69.874 95.874
## + C9orf30           1   69.932 95.932
```

```
## + GPR180            1   70.183 96.183
## + ECT2              1   70.231 96.231
## + MTDH              1   70.234 96.234
## + IGFBP5.1          1   70.245 96.245
## + C20orf46          1   70.372 96.372
## <none>                  72.437 96.437
## + GMPS              1   70.581 96.581
## + C16orf61          1   70.602 96.602
## + WISP1             1   70.672 96.672
## + SLC2A3            1   70.747 96.747
## + RUNDC1            1   70.910 96.910
## + RAB6B             1   71.027 97.027
## + KNTC2             1   71.151 97.151
## + CDCA7             1   71.157 97.157
## + CDC42BPA          1   71.246 97.246
## + BBC3              1   71.426 97.426
## + RTN4RL1           1   71.434 97.434
## + TSPYL5            1   71.452 97.452
## + GNAZ              1   71.499 97.499
## + EGLN1             1   71.552 97.552
## + EstrogenReceptor  1   71.578 97.578
## + OXCT1             1   71.600 97.600
## + RFC4              1   71.627 97.627
## + AP2B1             1   71.628 97.628
## + FBXO31            1   71.655 97.655
## + PALM2.AKAP2       1   71.683 97.683
## + PITRM1            1   71.715 97.715
## + SERF1A            1   71.802 97.802
## + MS4A7             1   71.835 97.835
## + EXT1              1   71.852 97.852
## + COL4A2            1   71.855 97.855
## + PECI              1   71.908 97.908
## + MCM6              1   71.918 97.918
## + FGF18             1   71.934 97.934
## + Age               1   71.962 97.962
## + PECI.1            1   71.984 97.984
## + RP5.860F19.3      1   72.127 98.127
## + Grade             2   70.135 98.135
## + MMP9              1   72.213 98.213
## + DCK               1   72.242 98.242
## + DIAPH3.1          1   72.256 98.256
## + SCUBE2            1   72.274 98.274
## + TGFB3             1   72.285 98.285
## + GSTM3             1   72.342 98.342
## + NM_004702         1   72.369 98.369
## + GPR126            1   72.369 98.369
## + NMU               1   72.371 98.371
## + DIAPH3            1   72.376 98.376
## + DTL               1   72.377 98.377
## + ALDH4A1           1   72.380 98.380
## + AA555029_RC       1   72.390 98.390
## + CENPA             1   72.392 98.392
## + MELK              1   72.398 98.398
## + ESM1              1   72.422 98.422
```

```
## + ZNF533            1   72.423 98.423
## + Contig35251_RC    1   72.426 98.426
## + Contig40831_RC    1   72.427 98.427
## + FLT1              1   72.431 98.431
## + AYTL2             1   72.432 98.432
## + Diam              1   72.434 98.434
## + ORC6L             1   72.436 98.436
## + DIAPH3.2          1   72.437 98.437
##
## Step:  AIC=94.96
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008
##
##                    Df Deviance    AIC
## + EGLN1             1   64.163 92.163
## + MTDH              1   64.328 92.328
## + C9orf30           1   66.011 94.011
## + IGFBP5            1   66.026 94.026
## + GMPS              1   66.257 94.257
## + ECT2              1   66.478 94.478
## + GNAZ              1   66.677 94.677
## + IGFBP5.1          1   66.717 94.717
## <none>                  68.955 94.955
## + CDCA7             1   66.981 94.981
## + RTN4RL1           1   66.989 94.989
## + SLC2A3            1   67.130 95.130
## + KNTC2             1   67.242 95.242
## + GPR180            1   67.266 95.266
## + C20orf46          1   67.524 95.524
## + Age               1   67.546 95.546
## + WISP1             1   67.572 95.572
## + RFC4              1   67.735 95.735
## + Contig35251_RC    1   67.772 95.772
## + NM_004702         1   67.901 95.901
## + RAB6B             1   68.081 96.081
## + TSPYL5            1   68.201 96.201
## + PALM2.AKAP2       1   68.203 96.203
## + TGFB3             1   68.248 96.248
## + PITRM1            1   68.261 96.261
## + BBC3              1   68.269 96.269
## + C16orf61          1   68.277 96.277
## + MELK              1   68.338 96.338
## + FGF18             1   68.350 96.350
## + MS4A7             1   68.375 96.375
## + EXT1              1   68.412 96.412
## + RUNDC1            1   68.428 96.428
## + PECI.1            1   68.437 96.437
## + FBXO31            1   68.450 96.450
## + SCUBE2            1   68.498 96.498
## + OXCT1             1   68.499 96.499
## + PECI              1   68.510 96.510
## + MCM6              1   68.511 96.511
## + Contig40831_RC    1   68.529 96.529
```

```
## + MMP9              1   68.538 96.538
## + GPR126            1   68.600 96.600
## + ORC6L             1   68.676 96.676
## + DCK               1   68.677 96.677
## + ZNF533            1   68.699 96.699
## + Diam              1   68.711 96.711
## + AA555029_RC       1   68.718 96.718
## + RP5.860F19.3      1   68.720 96.720
## + NMU               1   68.726 96.726
## + FLT1              1   68.776 96.776
## + CDC42BPA          1   68.783 96.783
## + AP2B1             1   68.786 96.786
## + COL4A2            1   68.812 96.812
## + GSTM3             1   68.825 96.825
## + ALDH4A1           1   68.865 96.865
## + DIAPH3.1          1   68.875 96.875
## + ESM1              1   68.881 96.881
## + EstrogenReceptor  1   68.899 96.899
## + CENPA             1   68.915 96.915
## + DTL               1   68.937 96.937
## + DIAPH3.2          1   68.952 96.952
## + AYTL2             1   68.953 96.953
## + SERF1A            1   68.954 96.954
## + DIAPH3            1   68.955 96.955
## + Grade             2   67.032 97.032
##
## Step:  AIC=92.16
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1
##
##                    Df Deviance    AIC
## + CDCA7             1   59.606 89.606
## + RTN4RL1           1   59.950 89.950
## + MTDH              1   60.717 90.717
## + PALM2.AKAP2       1   61.369 91.369
## + Age               1   61.396 91.396
## + ECT2              1   61.709 91.709
## + SCUBE2            1   61.809 91.809
## + MMP9              1   61.819 91.819
## + PECI.1            1   61.903 91.903
## + RFC4              1   61.909 91.909
## <none>                  64.163 92.163
## + IGFBP5            1   62.249 92.249
## + GMPS              1   62.280 92.280
## + GNAZ              1   62.434 92.434
## + IGFBP5.1          1   62.714 92.714
## + ZNF533            1   62.725 92.725
## + DCK               1   62.821 92.821
## + KNTC2             1   62.827 92.827
## + OXCT1             1   62.858 92.858
## + C16orf61          1   62.861 92.861
## + BBC3              1   62.910 92.910
## + C20orf46          1   62.982 92.982
```

```
## + TGFB3             1   63.222 93.222
## + COL4A2            1   63.226 93.226
## + Contig35251_RC    1   63.241 93.241
## + MELK              1   63.244 93.244
## + RAB6B             1   63.418 93.418
## + AA555029_RC       1   63.511 93.511
## + FBXO31            1   63.534 93.534
## + GPR180            1   63.536 93.536
## + C9orf30           1   63.559 93.559
## + NMU               1   63.653 93.653
## + GPR126            1   63.679 93.679
## + PITRM1            1   63.712 93.712
## + AP2B1             1   63.713 93.713
## + NM_004702         1   63.761 93.761
## + GSTM3             1   63.789 93.789
## + EXT1              1   63.807 93.807
## + CDC42BPA          1   63.817 93.817
## + MCM6              1   63.822 93.822
## + TSPYL5            1   63.875 93.875
## + Diam              1   63.889 93.889
## + WISP1             1   63.890 93.890
## + SLC2A3            1   63.924 93.924
## + MS4A7             1   63.933 93.933
## + EstrogenReceptor  1   63.944 93.944
## + ALDH4A1           1   63.961 93.961
## + AYTL2             1   63.969 93.969
## + CENPA             1   64.016 94.016
## + FGF18             1   64.040 94.040
## + PECI              1   64.044 94.044
## + DTL               1   64.046 94.046
## + RUNDC1            1   64.055 94.055
## + FLT1              1   64.092 94.092
## + SERF1A            1   64.092 94.092
## + ORC6L             1   64.111 94.111
## + DIAPH3.1          1   64.112 94.112
## + DIAPH3.2          1   64.119 94.119
## + Contig40831_RC    1   64.150 94.150
## + RP5.860F19.3      1   64.154 94.154
## + ESM1              1   64.159 94.159
## + DIAPH3            1   64.162 94.162
## + Grade             2   62.723 94.723
##
## Step:  AIC=89.61
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7
##
##                    Df Deviance    AIC
## + ECT2              1   55.172 87.172
## + IGFBP5            1   55.873 87.873
## + RTN4RL1           1   55.894 87.894
## + KNTC2             1   56.398 88.398
## + IGFBP5.1          1   56.695 88.695
## + CDC42BPA          1   56.810 88.810
```

```
## + GPR180            1   56.855 88.855
## <none>                  59.606 89.606
## + MCM6              1   57.679 89.679
## + PALM2.AKAP2       1   57.693 89.693
## + Age               1   57.845 89.845
## + FBXO31            1   57.873 89.873
## + RUNDC1            1   57.883 89.883
## + C9orf30           1   57.973 89.973
## + OXCT1             1   58.260 90.260
## + EXT1              1   58.287 90.287
## + BBC3              1   58.355 90.355
## + MTDH              1   58.462 90.462
## + ZNF533            1   58.479 90.479
## + SLC2A3            1   58.572 90.572
## + Diam              1   58.585 90.585
## + GNAZ              1   58.595 90.595
## + SCUBE2            1   58.637 90.637
## + MS4A7             1   58.645 90.645
## + RAB6B             1   58.741 90.741
## + MMP9              1   58.778 90.778
## + RFC4              1   58.797 90.797
## + C16orf61          1   58.903 90.903
## + PECI.1            1   58.915 90.915
## + PITRM1            1   58.920 90.920
## + COL4A2            1   58.941 90.941
## + Grade             2   56.956 90.956
## + RP5.860F19.3      1   58.979 90.979
## + C20orf46          1   59.031 91.031
## + Contig35251_RC    1   59.033 91.033
## + NM_004702         1   59.093 91.093
## + AP2B1             1   59.184 91.184
## + DCK               1   59.233 91.233
## + FGF18             1   59.281 91.281
## + GMPS              1   59.295 91.295
## + WISP1             1   59.359 91.359
## + ALDH4A1           1   59.370 91.370
## + DIAPH3            1   59.424 91.424
## + SERF1A            1   59.457 91.457
## + PECI              1   59.481 91.481
## + GPR126            1   59.491 91.491
## + TGFB3             1   59.496 91.496
## + EstrogenReceptor  1   59.502 91.502
## + DIAPH3.1          1   59.545 91.545
## + TSPYL5            1   59.566 91.566
## + DTL               1   59.571 91.571
## + NMU               1   59.587 91.587
## + GSTM3             1   59.595 91.595
## + DIAPH3.2          1   59.595 91.595
## + ORC6L             1   59.598 91.598
## + MELK              1   59.598 91.598
## + ESM1              1   59.599 91.599
## + Contig40831_RC    1   59.600 91.600
## + AA555029_RC       1   59.601 91.601
## + FLT1              1   59.603 91.603
```

```
## + AYTL2             1   59.604 91.604
## + CENPA             1   59.606 91.606
##
## Step:  AIC=87.17
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2
##
##                    Df Deviance    AIC
## + KNTC2             1   45.066 79.066
## + DIAPH3.1          1   50.011 84.011
## + GPR180            1   51.017 85.017
## + OXCT1             1   52.228 86.228
## + IGFBP5            1   52.335 86.335
## + C20orf46          1   52.380 86.380
## + MTDH              1   52.460 86.460
## + RTN4RL1           1   52.621 86.621
## + COL4A2            1   52.662 86.662
## + DIAPH3.2          1   52.680 86.680
## + PALM2.AKAP2       1   52.755 86.755
## + RUNDC1            1   52.829 86.829
## + RFC4              1   52.884 86.884
## + IGFBP5.1          1   52.992 86.992
## + Age               1   53.142 87.142
## <none>                  55.172 87.172
## + AP2B1             1   53.346 87.346
## + CDC42BPA          1   53.413 87.413
## + Diam              1   53.501 87.501
## + FLT1              1   53.608 87.608
## + BBC3              1   53.681 87.681
## + MCM6              1   53.684 87.684
## + C16orf61          1   54.017 88.017
## + SCUBE2            1   54.060 88.060
## + DCK               1   54.098 88.098
## + MMP9              1   54.211 88.211
## + AYTL2             1   54.280 88.280
## + GMPS              1   54.372 88.372
## + SLC2A3            1   54.410 88.410
## + GNAZ              1   54.526 88.526
## + SERF1A            1   54.542 88.542
## + ALDH4A1           1   54.557 88.557
## + ZNF533            1   54.583 88.583
## + DIAPH3            1   54.597 88.597
## + FBXO31            1   54.611 88.611
## + GSTM3             1   54.634 88.634
## + PECI              1   54.679 88.679
## + TGFB3             1   54.818 88.818
## + EstrogenReceptor  1   54.848 88.848
## + EXT1              1   54.859 88.859
## + RP5.860F19.3      1   54.865 88.865
## + MS4A7             1   54.945 88.945
## + CENPA             1   54.950 88.950
## + ORC6L             1   54.958 88.958
## + Grade             2   52.977 88.977
```

```
## + FGF18             1   54.979 88.979
## + NMU               1   54.981 88.981
## + RAB6B             1   55.002 89.002
## + AA555029_RC       1   55.017 89.017
## + C9orf30           1   55.021 89.021
## + NM_004702         1   55.025 89.025
## + WISP1             1   55.055 89.055
## + ESM1              1   55.057 89.057
## + GPR126            1   55.060 89.060
## + DTL               1   55.079 89.079
## + Contig35251_RC    1   55.112 89.112
## + Contig40831_RC    1   55.123 89.123
## + PECI.1            1   55.147 89.147
## + PITRM1            1   55.151 89.151
## + MELK              1   55.152 89.152
## + TSPYL5            1   55.161 89.161
##
## Step:  AIC=79.07
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2
##
##                   Df Deviance    AIC
## + Diam             1   41.043 77.043
## + GPR180           1   41.408 77.408
## + IGFBP5           1   41.906 77.906
## + GNAZ             1   42.090 78.090
## + IGFBP5.1         1   42.411 78.411
## + Age              1   42.631 78.631
## <none>                 45.066 79.066
## + C9orf30          1   43.093 79.093
## + PALM2.AKAP2      1   43.212 79.212
## + RTN4RL1          1   43.216 79.216
## + CDC42BPA         1   43.230 79.230
## + COL4A2           1   43.332 79.332
## + RAB6B            1   43.365 79.365
## + MELK             1   43.424 79.424
## + C16orf61         1   43.582 79.582
## + EXT1             1   43.590 79.590
## + RUNDC1           1   43.725 79.725
## + OXCT1            1   43.751 79.751
## + C20orf46         1   43.792 79.792
## + ZNF533           1   44.012 80.012
## + AP2B1            1   44.029 80.029
## + PECI             1   44.180 80.180
## + CENPA            1   44.185 80.185
## + RFC4             1   44.251 80.251
## + PITRM1           1   44.317 80.317
## + SLC2A3           1   44.406 80.406
## + AYTL2            1   44.407 80.407
## + ESM1             1   44.502 80.502
## + MCM6             1   44.563 80.563
## + Contig40831_RC   1   44.651 80.651
## + BBC3             1   44.658 80.658
```

```
## + DIAPH3.1          1   44.664 80.664
## + FBXO31            1   44.725 80.725
## + AA555029_RC       1   44.818 80.818
## + RP5.860F19.3      1   44.820 80.820
## + TSPYL5            1   44.832 80.832
## + SCUBE2            1   44.837 80.837
## + DTL               1   44.887 80.887
## + MTDH              1   44.912 80.912
## + TGFB3             1   44.936 80.936
## + MMP9              1   44.941 80.941
## + NM_004702         1   44.947 80.947
## + EstrogenReceptor  1   44.969 80.969
## + DIAPH3            1   44.990 80.990
## + FGF18             1   45.010 81.010
## + NMU               1   45.017 81.017
## + ORC6L             1   45.024 81.024
## + WISP1             1   45.027 81.027
## + DIAPH3.2          1   45.039 81.039
## + Contig35251_RC    1   45.043 81.043
## + DCK               1   45.051 81.051
## + FLT1              1   45.051 81.051
## + PECI.1            1   45.054 81.054
## + SERF1A            1   45.057 81.057
## + GMPS              1   45.059 81.059
## + GSTM3             1   45.060 81.060
## + ALDH4A1           1   45.061 81.061
## + MS4A7             1   45.063 81.063
## + GPR126            1   45.064 81.064
## + Grade             2   43.462 81.462
##
## Step:  AIC=77.04
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2 + Diam
##
##                    Df Deviance    AIC
## + GPR180            1   36.012 74.012
## + C9orf30           1   36.945 74.945
## + RTN4RL1           1   37.821 75.821
## + GNAZ              1   38.137 76.137
## + IGFBP5            1   38.319 76.319
## + EXT1              1   38.484 76.484
## + IGFBP5.1          1   38.669 76.669
## + ZNF533            1   38.944 76.944
## + RAB6B             1   38.960 76.960
## + COL4A2            1   39.030 77.030
## <none>                  41.043 77.043
## + Age               1   39.201 77.201
## + PALM2.AKAP2       1   39.236 77.236
## + FGF18             1   39.241 77.241
## + CENPA             1   39.269 77.269
## + TGFB3             1   39.470 77.470
## + C16orf61          1   39.601 77.601
## + CDC42BPA          1   39.708 77.708
```

```
## + PITRM1            1   39.736 77.736
## + WISP1             1   39.800 77.800
## + OXCT1             1   39.849 77.849
## + MCM6              1   40.200 78.200
## + C20orf46          1   40.221 78.221
## + RUNDC1            1   40.283 78.283
## + PECI              1   40.316 78.316
## + SLC2A3            1   40.359 78.359
## + AP2B1             1   40.377 78.377
## + RFC4              1   40.423 78.423
## + MTDH              1   40.452 78.452
## + DTL               1   40.535 78.535
## + AYTL2             1   40.588 78.588
## + MELK              1   40.603 78.603
## + TSPYL5            1   40.645 78.645
## + BBC3              1   40.654 78.654
## + Contig35251_RC    1   40.728 78.728
## + Contig40831_RC    1   40.781 78.781
## + MMP9              1   40.794 78.794
## + DCK               1   40.831 78.831
## + ESM1              1   40.862 78.862
## + AA555029_RC       1   40.894 78.894
## + SCUBE2            1   40.896 78.896
## + NMU               1   40.896 78.896
## + GSTM3             1   40.898 78.898
## + FBXO31            1   40.904 78.904
## + RP5.860F19.3      1   40.927 78.927
## + DIAPH3.1          1   40.949 78.949
## + ORC6L             1   40.996 78.996
## + NM_004702         1   41.002 79.002
## + SERF1A            1   41.004 79.004
## + PECI.1            1   41.007 79.007
## + GMPS              1   41.017 79.017
## + FLT1              1   41.021 79.021
## + EstrogenReceptor  1   41.023 79.023
## + DIAPH3            1   41.035 79.035
## + MS4A7             1   41.040 79.040
## + ALDH4A1           1   41.042 79.042
## + DIAPH3.2          1   41.043 79.043
## + GPR126            1   41.043 79.043
## + Grade             2   40.887 80.887
##
## Step:  AIC=74.01
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2 + Diam +
##     GPR180
##
##                    Df Deviance    AIC
## + RTN4RL1           1   28.698 68.698
## + PALM2.AKAP2       1   30.166 70.166
## + MMP9              1   30.857 70.857
## + IGFBP5            1   31.574 71.574
## + IGFBP5.1          1   32.053 72.053
```

```
## + MTDH              1   32.997 72.997
## + OXCT1             1   33.011 73.011
## + C9orf30           1   33.048 73.048
## + TSPYL5            1   33.053 73.053
## + NM_004702         1   33.228 73.228
## + PITRM1            1   33.569 73.569
## + Age               1   33.913 73.913
## + AA555029_RC       1   33.973 73.973
## <none>                  36.012 74.012
## + TGFB3             1   34.076 74.076
## + Contig40831_RC    1   34.102 74.102
## + GNAZ              1   34.416 74.416
## + EXT1              1   34.723 74.723
## + COL4A2            1   34.747 74.747
## + MELK              1   34.795 74.795
## + ZNF533            1   34.860 74.860
## + FLT1              1   34.880 74.880
## + RAB6B             1   34.935 74.935
## + FBXO31            1   34.996 74.996
## + C20orf46          1   35.015 75.015
## + CENPA             1   35.197 75.197
## + EstrogenReceptor  1   35.258 75.258
## + AYTL2             1   35.334 75.334
## + WISP1             1   35.361 75.361
## + RFC4              1   35.435 75.435
## + CDC42BPA          1   35.558 75.558
## + AP2B1             1   35.567 75.567
## + FGF18             1   35.575 75.575
## + ESM1              1   35.577 75.577
## + SCUBE2            1   35.601 75.601
## + DIAPH3            1   35.627 75.627
## + C16orf61          1   35.632 75.632
## + MCM6              1   35.648 75.648
## + PECI              1   35.690 75.690
## + DCK               1   35.702 75.702
## + GMPS              1   35.769 75.769
## + Contig35251_RC    1   35.863 75.863
## + ORC6L             1   35.867 75.867
## + ALDH4A1           1   35.889 75.889
## + DTL               1   35.898 75.898
## + GSTM3             1   35.933 75.933
## + RP5.860F19.3      1   35.933 75.933
## + DIAPH3.1          1   35.961 75.961
## + SERF1A            1   35.964 75.964
## + NMU               1   35.971 75.971
## + BBC3              1   35.991 75.991
## + PECI.1            1   36.002 76.002
## + DIAPH3.2          1   36.006 76.006
## + GPR126            1   36.009 76.009
## + SLC2A3            1   36.011 76.011
## + RUNDC1            1   36.012 76.012
## + MS4A7             1   36.012 76.012
## + Grade             2   35.559 77.559
##
```

```
## Step:  AIC=68.7
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2 + Diam +
##     GPR180 + RTN4RL1
##
##                     Df Deviance    AIC
## + IGFBP5             1   21.661 63.661
## + IGFBP5.1           1   21.839 63.839
## + PALM2.AKAP2        1   23.572 65.572
## + FLT1               1   24.567 66.568
## + TSPYL5             1   24.862 66.862
## + C16orf61           1   25.424 67.423
## + PITRM1             1   25.844 67.844
## + Age                1   26.041 68.041
## + MTDH               1   26.268 68.268
## + AP2B1              1   26.508 68.508
## + MMP9               1   26.664 68.664
## <none>                   28.698 68.698
## + AYTL2              1   26.898 68.898
## + RAB6B              1   26.932 68.932
## + DIAPH3             1   27.019 69.019
## + MELK               1   27.209 69.209
## + C20orf46           1   27.227 69.227
## + COL4A2             1   27.329 69.329
## + NMU                1   27.384 69.384
## + OXCT1              1   27.622 69.622
## + NM_004702          1   27.773 69.772
## + C9orf30            1   27.810 69.810
## + EXT1               1   27.842 69.842
## + ZNF533             1   27.907 69.907
## + Contig40831_RC     1   27.930 69.930
## + PECI               1   27.939 69.939
## + CENPA              1   27.941 69.941
## + TGFB3              1   27.953 69.953
## + GNAZ               1   27.969 69.969
## + WISP1              1   27.974 69.974
## + MCM6               1   28.043 70.043
## + FBXO31             1   28.104 70.104
## + FGF18              1   28.104 70.104
## + DIAPH3.1           1   28.162 70.162
## + Contig35251_RC     1   28.316 70.315
## + RFC4               1   28.316 70.316
## + MS4A7              1   28.372 70.372
## + DTL                1   28.457 70.457
## + SERF1A             1   28.495 70.495
## + DIAPH3.2           1   28.505 70.505
## + AA555029_RC        1   28.518 70.518
## + RP5.860F19.3       1   28.527 70.527
## + EstrogenReceptor   1   28.533 70.533
## + RUNDC1             1   28.550 70.551
## + SLC2A3             1   28.554 70.554
## + ESM1               1   28.561 70.561
## + CDC42BPA           1   28.591 70.591
```

```
## + ORC6L             1   28.597 70.597
## + DCK               1   28.610 70.610
## + ALDH4A1           1   28.643 70.643
## + GSTM3             1   28.658 70.658
## + GMPS              1   28.660 70.660
## + BBC3              1   28.666 70.666
## + PECI.1            1   28.686 70.686
## + GPR126            1   28.688 70.688
## + SCUBE2            1   28.692 70.692
## + Grade             2   27.638 71.638
##
## Step:  AIC=63.66
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2 + Diam +
##     GPR180 + RTN4RL1 + IGFBP5
##
##                     Df Deviance    AIC
## + PITRM1             1     0.00  44.00
## + MMP9               1     0.00  44.00
## + FLT1               1     0.00  44.00
## + Contig35251_RC     1     0.00  44.00
## + TSPYL5             1     0.00  44.00
## + ORC6L              1     0.00  44.00
## + OXCT1              1     0.00  44.00
## + PALM2.AKAP2        1     0.00  44.00
## + Contig40831_RC     1     0.00  44.00
## + FGF18              1     0.00  44.00
## + DTL                1     0.00  44.00
## + Grade              2     0.00  46.00
## + CENPA              1    15.88  59.88
## + C20orf46           1    17.21  61.21
## + CDC42BPA           1    18.77  62.77
## + FBXO31             1    19.03  63.03
## + RFC4               1    19.09  63.09
## + WISP1              1    19.53  63.53
## <none>                    21.66  63.66
## + EstrogenReceptor   1    19.82  63.82
## + PECI.1             1    20.29  64.29
## + DIAPH3             1    20.37  64.37
## + EXT1               1    20.51  64.51
## + C9orf30            1    20.76  64.76
## + C16orf61           1    20.84  64.84
## + TGFB3              1    20.88  64.88
## + NMU                1    20.89  64.89
## + SERF1A             1    21.03  65.03
## + DIAPH3.2           1    21.06  65.06
## + RP5.860F19.3       1    21.09  65.09
## + AA555029_RC        1    21.14  65.14
## + SCUBE2             1    21.29  65.29
## + AYTL2              1    21.33  65.33
## + COL4A2             1    21.37  65.37
## + AP2B1              1    21.38  65.38
## + ZNF533             1    21.38  65.38
```

```
## + ALDH4A1           1    21.41  65.41
## + MTDH              1    21.45  65.45
## + GMPS              1    21.45  65.45
## + PECI              1    21.46  65.46
## + GSTM3             1    21.48  65.48
## + DCK               1    21.50  65.50
## + RAB6B             1    21.51  65.51
## + Age               1    21.57  65.57
## + DIAPH3.1          1    21.58  65.58
## + ESM1              1    21.60  65.60
## + MCM6              1    21.60  65.60
## + SLC2A3            1    21.62  65.62
## + GNAZ              1    21.64  65.64
## + MS4A7             1    21.65  65.65
## + IGFBP5.1          1    21.66  65.66
## + RUNDC1            1    21.66  65.66
## + GPR126            1   432.52 476.52
## + NM_004702         1   432.52 476.52
## + MELK              1   792.96 836.96
## + BBC3              1   865.05 909.05
##
## Step:  AIC=44
## Event ~ LymphNodes + NUSAP1 + UCHL5 + Contig63649_RC + QSCN6L1 +
##     Contig20217_RC + HRASLS + Contig32125_RC + STK32B + LGP2 +
##     PRC1 + LOC643008 + EGLN1 + CDCA7 + ECT2 + KNTC2 + Diam +
##     GPR180 + RTN4RL1 + IGFBP5 + PITRM1
##
##                    Df Deviance    AIC
## <none>                   0.00  44.00
## + FGF18             1     0.00  46.00
## + OXCT1             1     0.00  46.00
## + MELK              1     0.00  46.00
## + WISP1             1     0.00  46.00
## + Contig35251_RC    1     0.00  46.00
## + ZNF533            1     0.00  46.00
## + DIAPH3            1     0.00  46.00
## + Age               1     0.00  46.00
## + FLT1              1     0.00  46.00
## + GPR126            1     0.00  46.00
## + CENPA             1     0.00  46.00
## + BBC3              1     0.00  46.00
## + DTL               1     0.00  46.00
## + TSPYL5            1     0.00  46.00
## + Contig40831_RC    1     0.00  46.00
## + C20orf46          1     0.00  46.00
## + C16orf61          1     0.00  46.00
## + PECI.1            1     0.00  46.00
## + DIAPH3.1          1     0.00  46.00
## + ESM1              1     0.00  46.00
## + ORC6L             1     0.00  46.00
## + COL4A2            1     0.00  46.00
## + MS4A7             1     0.00  46.00
## + TGFB3             1     0.00  46.00
## + PALM2.AKAP2       1     0.00  46.00
```

```
## + EstrogenReceptor  1     0.00  46.00
## + GNAZ              1     0.00  46.00
## + GMPS              1     0.00  46.00
## + MCM6              1     0.00  46.00
## + RUNDC1            1     0.00  46.00
## + ALDH4A1           1     0.00  46.00
## + DIAPH3.2          1     0.00  46.00
## + DCK               1     0.00  46.00
## + RFC4              1     0.00  46.00
## + GSTM3             1     0.00  46.00
## + MMP9              1     0.00  46.00
## + NMU               1     0.00  46.00
## + RP5.860F19.3      1     0.00  46.00
## + AP2B1             1     0.00  46.00
## + IGFBP5.1          1     0.00  46.00
## + SERF1A            1     0.00  46.00
## + SLC2A3            1     0.00  46.00
## + AYTL2             1     0.00  46.00
## + PECI              1     0.00  46.00
## + SCUBE2            1     0.00  46.00
## + EXT1              1     0.00  46.00
## + MTDH              1     0.00  46.00
## + C9orf30           1     0.00  46.00
## + AA555029_RC       1     0.00  46.00
## + RAB6B             1     0.00  46.00
## + CDC42BPA          1     0.00  46.00
## + FBXO31            1     0.00  46.00
## + Grade             2     0.00  48.00
## + NM_004702         1   648.79 694.79
```

```
#We rely on Q1, as model B and S performed the best, we will be moving forward with them for this quest
```

We can see that the AIC values for the forward model start from 132.35 and the lowest AIC obtained is 44

```
model.nika.backward <- stepAIC(full_model_nika, direction ="backward")
```

```
## Start:  AIC=154
## Event ~ Diam + LymphNodes + EstrogenReceptor + Grade + Age +
##     TSPYL5 + Contig63649_RC + DIAPH3 + NUSAP1 + AA555029_RC +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + Contig35251_RC + ECT2 + GMPS +
##     KNTC2 + WISP1 + CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 +
##     RAB6B + ZNF533 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     TGFB3 + MELK + COL4A2 + DTL + STK32B + DCK + FBXO31 + GPR126 +
##     SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 +
##     MCM6 + AP2B1 + C9orf30 + IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 +
##     NMU + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA +
##     EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                    Df   Deviance AIC
## - Grade             2 1.3930e-09 150
## - DIAPH3            1 1.3041e-09 152
## - EXT1              1 1.3043e-09 152
## - Contig35251_RC    1 1.3053e-09 152
```

```
## - EstrogenReceptor  1 1.3062e-09 152
## - FBXO31            1 1.3071e-09 152
## - COL4A2            1 1.3080e-09 152
## - NMU               1 1.3087e-09 152
## - CDC42BPA          1 1.3090e-09 152
## - ECT2              1 1.3091e-09 152
## - AA555029_RC       1 1.3096e-09 152
## - Age               1 1.3101e-09 152
## - C9orf30           1 1.3107e-09 152
## - CDCA7             1 1.3108e-09 152
## - SERF1A            1 1.3112e-09 152
## - GSTM3             1 1.3121e-09 152
## - ORC6L             1 1.3128e-09 152
## - RUNDC1            1 1.3132e-09 152
## - AP2B1             1 1.3134e-09 152
## - Contig20217_RC    1 1.3135e-09 152
## - ZNF533            1 1.3139e-09 152
## - GNAZ              1 1.3145e-09 152
## - RFC4              1 1.3146e-09 152
## - GMPS              1 1.3154e-09 152
## - MELK              1 1.3157e-09 152
## - UCHL5             1 1.3161e-09 152
## - GPR126            1 1.3176e-09 152
## - AYTL2             1 1.3179e-09 152
## - MTDH              1 1.3182e-09 152
## - RAB6B             1 1.3184e-09 152
## - TGFB3             1 1.3229e-09 152
## - ESM1              1 1.3255e-09 152
## - IGFBP5.1          1 1.3270e-09 152
## - BBC3              1 1.3297e-09 152
## - KNTC2             1 1.3321e-09 152
## - SCUBE2            1 1.3324e-09 152
## - DCK               1 1.3324e-09 152
## - DIAPH3.1          1 1.3346e-09 152
## - ALDH4A1           1 1.3354e-09 152
## - NUSAP1            1 1.3405e-09 152
## - Contig40831_RC    1 1.3441e-09 152
## - MS4A7             1 1.3479e-09 152
## - TSPYL5            1 1.3483e-09 152
## - CENPA             1 1.3484e-09 152
## - LGP2              1 1.3555e-09 152
## - IGFBP5            1 1.3573e-09 152
## - MCM6              1 1.3589e-09 152
## - DIAPH3.2          1 1.3624e-09 152
## - GPR180            1 1.3635e-09 152
## - DTL               1 1.3643e-09 152
## - RTN4RL1           1 1.3695e-09 152
## - MMP9              1 1.3745e-09 152
## - FLT1              1 1.3817e-09 152
## - SLC2A3            1 1.3946e-09 152
## - PECI              1 1.4000e-09 152
## - QSCN6L1           1 1.4034e-09 152
## - WISP1             1 1.4055e-09 152
## - C16orf61          1 1.4127e-09 152
```

```
## - NM_004702         1 1.4130e-09 152
## - OXCT1             1 1.4144e-09 152
## - Contig63649_RC    1 1.4181e-09 152
## - LymphNodes        1 1.4214e-09 152
## - HRASLS            1 1.4397e-09 152
## - RP5.860F19.3      1 1.4631e-09 152
## - PECI.1            1 1.4725e-09 152
## - C20orf46          1 1.4739e-09 152
## - FGF18             1 1.4786e-09 152
## - STK32B            1 1.4887e-09 152
## - Diam              1 1.5249e-09 152
## - LOC643008         1 1.5259e-09 152
## - PRC1              1 1.5595e-09 152
## - PALM2.AKAP2       1 1.5756e-09 152
## - PITRM1            1 1.5758e-09 152
## - EGLN1             1 1.6713e-09 152
## - Contig32125_RC    1 1.7465e-09 152
## <none>                1.3030e-09 154
##
## Step:  AIC=150
## Event ~ Diam + LymphNodes + EstrogenReceptor + Age + TSPYL5 +
##     Contig63649_RC + DIAPH3 + NUSAP1 + AA555029_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + GNAZ + OXCT1 +
##     MMP9 + RUNDC1 + Contig35251_RC + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + ZNF533 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + TGFB3 +
##     MELK + COL4A2 + DTL + STK32B + DCK + FBXO31 + GPR126 + SLC2A3 +
##     PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 +
##     AP2B1 + C9orf30 + IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + NMU +
##     PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 +
##     NM_004702 + ESM1 + C20orf46
##
##                    Df   Deviance AIC
## - C9orf30           1 1.3941e-09 148
## - TGFB3             1 1.3950e-09 148
## - AA555029_RC       1 1.3951e-09 148
## - NMU               1 1.3952e-09 148
## - COL4A2            1 1.3961e-09 148
## - Contig35251_RC    1 1.3973e-09 148
## - NUSAP1            1 1.3989e-09 148
## - EstrogenReceptor  1 1.3993e-09 148
## - FBXO31            1 1.3993e-09 148
## - GSTM3             1 1.3996e-09 148
## - ZNF533            1 1.3999e-09 148
## - IGFBP5.1          1 1.4011e-09 148
## - RUNDC1            1 1.4013e-09 148
## - MELK              1 1.4017e-09 148
## - ECT2              1 1.4030e-09 148
## - SERF1A            1 1.4033e-09 148
## - RFC4              1 1.4034e-09 148
## - Contig20217_RC    1 1.4038e-09 148
## - GMPS              1 1.4048e-09 148
## - UCHL5             1 1.4049e-09 148
```

```
## - ESM1              1 1.4071e-09 148
## - Age               1 1.4094e-09 148
## - AP2B1             1 1.4100e-09 148
## - CDC42BPA          1 1.4115e-09 148
## - BBC3              1 1.4124e-09 148
## - MS4A7             1 1.4135e-09 148
## - GNAZ              1 1.4155e-09 148
## - ORC6L             1 1.4162e-09 148
## - ALDH4A1           1 1.4168e-09 148
## - RAB6B             1 1.4179e-09 148
## - DIAPH3            1 1.4181e-09 148
## - FLT1              1 1.4188e-09 148
## - IGFBP5            1 1.4199e-09 148
## - RTN4RL1           1 1.4209e-09 148
## - DTL               1 1.4244e-09 148
## - AYTL2             1 1.4249e-09 148
## - SCUBE2            1 1.4269e-09 148
## - CDCA7             1 1.4289e-09 148
## - EXT1              1 1.4298e-09 148
## - KNTC2             1 1.4356e-09 148
## - GPR126            1 1.4379e-09 148
## - MCM6              1 1.4394e-09 148
## - DCK               1 1.4396e-09 148
## - DIAPH3.2          1 1.4409e-09 148
## - CENPA             1 1.4473e-09 148
## - MTDH              1 1.4473e-09 148
## - Contig40831_RC    1 1.4600e-09 148
## - PECI              1 1.4621e-09 148
## - DIAPH3.1          1 1.4678e-09 148
## - GPR180            1 1.4698e-09 148
## - QSCN6L1           1 1.4752e-09 148
## - C16orf61          1 1.4902e-09 148
## - Contig63649_RC    1 1.4912e-09 148
## - MMP9              1 1.4925e-09 148
## - LGP2              1 1.4933e-09 148
## - HRASLS            1 1.4946e-09 148
## - RP5.860F19.3      1 1.4955e-09 148
## - TSPYL5            1 1.4982e-09 148
## - C20orf46          1 1.5165e-09 148
## - WISP1             1 1.5291e-09 148
## - OXCT1             1 1.5329e-09 148
## - LymphNodes        1 1.5335e-09 148
## - NM_004702         1 1.5437e-09 148
## - SLC2A3            1 1.5488e-09 148
## - Diam              1 1.5581e-09 148
## - PECI.1            1 1.5919e-09 148
## - FGF18             1 1.6000e-09 148
## - PRC1              1 1.6017e-09 148
## - PALM2.AKAP2       1 1.6020e-09 148
## - LOC643008         1 1.6022e-09 148
## - PITRM1            1 1.6211e-09 148
## - STK32B            1 1.6744e-09 148
## - EGLN1             1 1.7683e-09 148
## - Contig32125_RC    1 1.8104e-09 148
```

```
## <none>                1.3930e-09 150
##
## Step:  AIC=148
## Event ~ Diam + LymphNodes + EstrogenReceptor + Age + TSPYL5 +
##     Contig63649_RC + DIAPH3 + NUSAP1 + AA555029_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + GNAZ + OXCT1 +
##     MMP9 + RUNDC1 + Contig35251_RC + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + ZNF533 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + TGFB3 +
##     MELK + COL4A2 + DTL + STK32B + DCK + FBXO31 + GPR126 + SLC2A3 +
##     PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 +
##     AP2B1 + IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + NMU + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                    Df   Deviance AIC
## - TGFB3             1 1.3959e-09 146
## - AA555029_RC       1 1.3960e-09 146
## - COL4A2            1 1.3977e-09 146
## - Contig35251_RC    1 1.3981e-09 146
## - NMU               1 1.3992e-09 146
## - NUSAP1            1 1.3996e-09 146
## - ZNF533            1 1.4000e-09 146
## - FBXO31            1 1.4007e-09 146
## - GSTM3             1 1.4009e-09 146
## - EstrogenReceptor  1 1.4014e-09 146
## - RUNDC1            1 1.4015e-09 146
## - IGFBP5.1          1 1.4025e-09 146
## - MELK              1 1.4027e-09 146
## - Contig20217_RC    1 1.4041e-09 146
## - SERF1A            1 1.4049e-09 146
## - RFC4              1 1.4049e-09 146
## - GMPS              1 1.4068e-09 146
## - ECT2              1 1.4069e-09 146
## - UCHL5             1 1.4070e-09 146
## - ESM1              1 1.4084e-09 146
## - Age               1 1.4096e-09 146
## - AP2B1             1 1.4120e-09 146
## - BBC3              1 1.4153e-09 146
## - GNAZ              1 1.4154e-09 146
## - CDC42BPA          1 1.4163e-09 146
## - MS4A7             1 1.4175e-09 146
## - ALDH4A1           1 1.4193e-09 146
## - DIAPH3            1 1.4196e-09 146
## - RAB6B             1 1.4202e-09 146
## - RTN4RL1           1 1.4220e-09 146
## - IGFBP5            1 1.4222e-09 146
## - FLT1              1 1.4222e-09 146
## - ORC6L             1 1.4241e-09 146
## - AYTL2             1 1.4259e-09 146
## - DTL               1 1.4282e-09 146
## - SCUBE2            1 1.4289e-09 146
## - EXT1              1 1.4326e-09 146
```

```
## - CDCA7             1 1.4353e-09 146
## - KNTC2             1 1.4396e-09 146
## - MCM6              1 1.4419e-09 146
## - DCK               1 1.4447e-09 146
## - GPR126            1 1.4478e-09 146
## - DIAPH3.2          1 1.4520e-09 146
## - CENPA             1 1.4521e-09 146
## - MTDH              1 1.4522e-09 146
## - Contig40831_RC    1 1.4631e-09 146
## - PECI              1 1.4666e-09 146
## - GPR180            1 1.4694e-09 146
## - DIAPH3.1          1 1.4748e-09 146
## - LGP2              1 1.4930e-09 146
## - QSCN6L1           1 1.4936e-09 146
## - C16orf61          1 1.4958e-09 146
## - HRASLS            1 1.4979e-09 146
## - MMP9              1 1.4987e-09 146
## - Contig63649_RC    1 1.4998e-09 146
## - RP5.860F19.3      1 1.5086e-09 146
## - TSPYL5            1 1.5276e-09 146
## - OXCT1             1 1.5320e-09 146
## - WISP1             1 1.5324e-09 146
## - C20orf46          1 1.5397e-09 146
## - SLC2A3            1 1.5495e-09 146
## - LymphNodes        1 1.5561e-09 146
## - NM_004702         1 1.5562e-09 146
## - Diam              1 1.5928e-09 146
## - PECI.1            1 1.5964e-09 146
## - PRC1              1 1.6024e-09 146
## - FGF18             1 1.6039e-09 146
## - PALM2.AKAP2       1 1.6104e-09 146
## - LOC643008         1 1.6128e-09 146
## - PITRM1            1 1.6308e-09 146
## - STK32B            1 1.6950e-09 146
## - EGLN1             1 1.8142e-09 146
## - Contig32125_RC    1 1.8203e-09 146
## <none>                1.3941e-09 148
##
## Step:  AIC=146
## Event ~ Diam + LymphNodes + EstrogenReceptor + Age + TSPYL5 +
##     Contig63649_RC + DIAPH3 + NUSAP1 + AA555029_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + GNAZ + OXCT1 +
##     MMP9 + RUNDC1 + Contig35251_RC + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + ZNF533 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + MELK + COL4A2 +
##     DTL + STK32B + DCK + FBXO31 + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + NMU + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                    Df   Deviance AIC
## - AA555029_RC       1 1.3972e-09 144
```

```
## - Contig35251_RC    1 1.3986e-09 144
## - EstrogenReceptor  1 1.4013e-09 144
## - NUSAP1            1 1.4020e-09 144
## - NMU               1 1.4022e-09 144
## - COL4A2            1 1.4024e-09 144
## - ZNF533            1 1.4025e-09 144
## - FBXO31            1 1.4029e-09 144
## - IGFBP5.1          1 1.4038e-09 144
## - RUNDC1            1 1.4045e-09 144
## - Contig20217_RC    1 1.4053e-09 144
## - MELK              1 1.4061e-09 144
## - GSTM3             1 1.4075e-09 144
## - ESM1              1 1.4082e-09 144
## - UCHL5             1 1.4083e-09 144
## - RFC4              1 1.4085e-09 144
## - Age               1 1.4131e-09 144
## - SERF1A            1 1.4136e-09 144
## - ECT2              1 1.4139e-09 144
## - GNAZ              1 1.4158e-09 144
## - AP2B1             1 1.4168e-09 144
## - CDC42BPA          1 1.4183e-09 144
## - MS4A7             1 1.4208e-09 144
## - GMPS              1 1.4226e-09 144
## - RAB6B             1 1.4236e-09 144
## - FLT1              1 1.4253e-09 144
## - BBC3              1 1.4258e-09 144
## - RTN4RL1           1 1.4292e-09 144
## - ALDH4A1           1 1.4295e-09 144
## - AYTL2             1 1.4297e-09 144
## - SCUBE2            1 1.4309e-09 144
## - IGFBP5            1 1.4330e-09 144
## - EXT1              1 1.4369e-09 144
## - ORC6L             1 1.4377e-09 144
## - DTL               1 1.4391e-09 144
## - DIAPH3            1 1.4422e-09 144
## - MCM6              1 1.4447e-09 144
## - KNTC2             1 1.4452e-09 144
## - DCK               1 1.4453e-09 144
## - CDCA7             1 1.4472e-09 144
## - DIAPH3.2          1 1.4541e-09 144
## - MTDH              1 1.4553e-09 144
## - Contig40831_RC    1 1.4629e-09 144
## - GPR126            1 1.4663e-09 144
## - PECI              1 1.4674e-09 144
## - GPR180            1 1.4748e-09 144
## - CENPA             1 1.4835e-09 144
## - C16orf61          1 1.4991e-09 144
## - QSCN6L1           1 1.5011e-09 144
## - HRASLS            1 1.5032e-09 144
## - Contig63649_RC    1 1.5078e-09 144
## - DIAPH3.1          1 1.5147e-09 144
## - RP5.860F19.3      1 1.5170e-09 144
## - MMP9              1 1.5222e-09 144
## - TSPYL5            1 1.5325e-09 144
```

```
## - WISP1             1 1.5395e-09 144
## - C20orf46          1 1.5442e-09 144
## - OXCT1             1 1.5519e-09 144
## - LymphNodes        1 1.5604e-09 144
## - SLC2A3            1 1.5682e-09 144
## - NM_004702         1 1.5686e-09 144
## - LGP2              1 1.5706e-09 144
## - Diam              1 1.6004e-09 144
## - PECI.1            1 1.6015e-09 144
## - PRC1              1 1.6069e-09 144
## - LOC643008         1 1.6122e-09 144
## - PALM2.AKAP2       1 1.6190e-09 144
## - FGF18             1 1.6485e-09 144
## - PITRM1            1 1.6590e-09 144
## - STK32B            1 1.7096e-09 144
## - EGLN1             1 1.8237e-09 144
## - Contig32125_RC    1 1.8660e-09 144
## <none>                1.3959e-09 146
##
## Step:  AIC=144
## Event ~ Diam + LymphNodes + EstrogenReceptor + Age + TSPYL5 +
##     Contig63649_RC + DIAPH3 + NUSAP1 + ALDH4A1 + QSCN6L1 + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 + RP5.860F19.3 +
##     C16orf61 + SCUBE2 + EXT1 + FLT1 + GNAZ + OXCT1 + MMP9 + RUNDC1 +
##     Contig35251_RC + ECT2 + GMPS + KNTC2 + WISP1 + CDC42BPA +
##     SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + ZNF533 + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + MELK + COL4A2 + DTL +
##     STK32B + DCK + FBXO31 + GPR126 + SLC2A3 + PECI.1 + ORC6L +
##     RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 +
##     HRASLS + PITRM1 + IGFBP5.1 + NMU + PALM2.AKAP2 + LGP2 + PRC1 +
##     Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                     Df   Deviance AIC
## - Contig35251_RC     1 1.4002e-09 142
## - EstrogenReceptor   1 1.4022e-09 142
## - FBXO31             1 1.4050e-09 142
## - ZNF533             1 1.4050e-09 142
## - IGFBP5.1           1 1.4056e-09 142
## - Contig20217_RC     1 1.4057e-09 142
## - COL4A2             1 1.4059e-09 142
## - NUSAP1             1 1.4061e-09 142
## - MELK               1 1.4075e-09 142
## - NMU                1 1.4078e-09 142
## - RUNDC1             1 1.4078e-09 142
## - RFC4               1 1.4091e-09 142
## - GSTM3              1 1.4098e-09 142
## - ESM1               1 1.4108e-09 142
## - Age                1 1.4162e-09 142
## - SERF1A             1 1.4162e-09 142
## - UCHL5              1 1.4167e-09 142
## - ECT2               1 1.4178e-09 142
## - GNAZ               1 1.4185e-09 142
## - CDC42BPA           1 1.4200e-09 142
## - MS4A7              1 1.4242e-09 142
```

```
## - AP2B1             1 1.4267e-09 142
## - GMPS              1 1.4268e-09 142
## - RAB6B             1 1.4271e-09 142
## - SCUBE2            1 1.4302e-09 142
## - RTN4RL1           1 1.4303e-09 142
## - BBC3              1 1.4305e-09 142
## - FLT1              1 1.4327e-09 142
## - IGFBP5            1 1.4336e-09 142
## - AYTL2             1 1.4343e-09 142
## - ALDH4A1           1 1.4349e-09 142
## - ORC6L             1 1.4393e-09 142
## - EXT1              1 1.4396e-09 142
## - DIAPH3            1 1.4476e-09 142
## - DCK               1 1.4478e-09 142
## - MCM6              1 1.4503e-09 142
## - KNTC2             1 1.4547e-09 142
## - DIAPH3.2          1 1.4565e-09 142
## - CDCA7             1 1.4634e-09 142
## - MTDH              1 1.4665e-09 142
## - PECI              1 1.4686e-09 142
## - Contig40831_RC    1 1.4698e-09 142
## - GPR126            1 1.4699e-09 142
## - DTL               1 1.4757e-09 142
## - CENPA             1 1.4855e-09 142
## - GPR180            1 1.4873e-09 142
## - C16orf61          1 1.5021e-09 142
## - QSCN6L1           1 1.5142e-09 142
## - RP5.860F19.3      1 1.5185e-09 142
## - Contig63649_RC    1 1.5209e-09 142
## - HRASLS            1 1.5243e-09 142
## - DIAPH3.1          1 1.5294e-09 142
## - TSPYL5            1 1.5333e-09 142
## - MMP9              1 1.5357e-09 142
## - C20orf46          1 1.5553e-09 142
## - WISP1             1 1.5564e-09 142
## - OXCT1             1 1.5677e-09 142
## - SLC2A3            1 1.5786e-09 142
## - LGP2              1 1.5871e-09 142
## - LymphNodes        1 1.5907e-09 142
## - Diam              1 1.6082e-09 142
## - NM_004702         1 1.6123e-09 142
## - LOC643008         1 1.6207e-09 142
## - PRC1              1 1.6215e-09 142
## - PALM2.AKAP2       1 1.6271e-09 142
## - FGF18             1 1.6485e-09 142
## - PECI.1            1 1.6597e-09 142
## - PITRM1            1 1.6646e-09 142
## - STK32B            1 1.7131e-09 142
## - EGLN1             1 1.8261e-09 142
## - Contig32125_RC    1 1.9091e-09 142
## <none>                1.3972e-09 144
##
## Step:  AIC=142
## Event ~ Diam + LymphNodes + EstrogenReceptor + Age + TSPYL5 +
```

```
##     Contig63649_RC + DIAPH3 + NUSAP1 + ALDH4A1 + QSCN6L1 + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 + RP5.860F19.3 +
##     C16orf61 + SCUBE2 + EXT1 + FLT1 + GNAZ + OXCT1 + MMP9 + RUNDC1 +
##     ECT2 + GMPS + KNTC2 + WISP1 + CDC42BPA + SERF1A + AYTL2 +
##     GSTM3 + GPR180 + RAB6B + ZNF533 + RTN4RL1 + UCHL5 + PECI +
##     MTDH + Contig40831_RC + MELK + COL4A2 + DTL + STK32B + DCK +
##     FBXO31 + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 +
##     LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 +
##     IGFBP5.1 + NMU + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                     Df   Deviance AIC
## - EstrogenReceptor   1 1.4036e-09 140
## - COL4A2             1 1.4073e-09 140
## - ZNF533             1 1.4076e-09 140
## - Contig20217_RC     1 1.4077e-09 140
## - MELK               1 1.4087e-09 140
## - NMU                1 1.4092e-09 140
## - FBXO31             1 1.4098e-09 140
## - IGFBP5.1           1 1.4100e-09 140
## - NUSAP1             1 1.4102e-09 140
## - ESM1               1 1.4107e-09 140
## - GSTM3              1 1.4109e-09 140
## - RFC4               1 1.4129e-09 140
## - RUNDC1             1 1.4140e-09 140
## - SERF1A             1 1.4182e-09 140
## - Age                1 1.4203e-09 140
## - ECT2               1 1.4215e-09 140
## - UCHL5              1 1.4239e-09 140
## - GNAZ               1 1.4250e-09 140
## - CDC42BPA           1 1.4273e-09 140
## - MS4A7              1 1.4282e-09 140
## - GMPS               1 1.4291e-09 140
## - AP2B1              1 1.4301e-09 140
## - RAB6B              1 1.4314e-09 140
## - BBC3               1 1.4361e-09 140
## - FLT1               1 1.4363e-09 140
## - SCUBE2             1 1.4371e-09 140
## - AYTL2              1 1.4372e-09 140
## - RTN4RL1            1 1.4372e-09 140
## - ALDH4A1            1 1.4376e-09 140
## - IGFBP5             1 1.4401e-09 140
## - DIAPH3             1 1.4465e-09 140
## - DCK                1 1.4509e-09 140
## - EXT1               1 1.4513e-09 140
## - ORC6L              1 1.4514e-09 140
## - DIAPH3.2           1 1.4643e-09 140
## - KNTC2              1 1.4643e-09 140
## - CDCA7              1 1.4684e-09 140
## - Contig40831_RC     1 1.4722e-09 140
## - PECI               1 1.4779e-09 140
## - MTDH               1 1.4890e-09 140
## - CENPA              1 1.4890e-09 140
## - MCM6               1 1.4978e-09 140
```

```
## - DTL               1 1.5002e-09 140
## - GPR180            1 1.5020e-09 140
## - GPR126            1 1.5126e-09 140
## - C16orf61          1 1.5158e-09 140
## - QSCN6L1           1 1.5200e-09 140
## - RP5.860F19.3      1 1.5343e-09 140
## - TSPYL5            1 1.5346e-09 140
## - DIAPH3.1          1 1.5392e-09 140
## - Contig63649_RC    1 1.5466e-09 140
## - MMP9              1 1.5479e-09 140
## - WISP1             1 1.5692e-09 140
## - C20orf46          1 1.5708e-09 140
## - OXCT1             1 1.5778e-09 140
## - SLC2A3            1 1.5821e-09 140
## - LGP2              1 1.5962e-09 140
## - NM_004702         1 1.6155e-09 140
## - HRASLS            1 1.6190e-09 140
## - Diam              1 1.6224e-09 140
## - PALM2.AKAP2       1 1.6278e-09 140
## - PRC1              1 1.6359e-09 140
## - LymphNodes        1 1.6365e-09 140
## - PECI.1            1 1.6662e-09 140
## - PITRM1            1 1.6715e-09 140
## - STK32B            1 1.7155e-09 140
## - LOC643008         1 1.7717e-09 140
## - FGF18             1 1.8005e-09 140
## - EGLN1             1 1.8628e-09 140
## - Contig32125_RC    1 1.9157e-09 140
## <none>                1.4002e-09 142
##
## Step:  AIC=140
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     NUSAP1 + ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC +
##     BBC3 + DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 +
##     FLT1 + GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 +
##     WISP1 + CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B +
##     ZNF533 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     MELK + COL4A2 + DTL + STK32B + DCK + FBXO31 + GPR126 + SLC2A3 +
##     PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 +
##     AP2B1 + IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + NMU + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - FBXO31          1 1.4100e-09 138
## - ZNF533          1 1.4106e-09 138
## - NUSAP1          1 1.4109e-09 138
## - COL4A2          1 1.4113e-09 138
## - MELK            1 1.4114e-09 138
## - NMU             1 1.4131e-09 138
## - RUNDC1          1 1.4162e-09 138
## - ESM1            1 1.4177e-09 138
## - GSTM3           1 1.4191e-09 138
## - IGFBP5.1        1 1.4192e-09 138
```

```
## - RFC4             1 1.4195e-09 138
## - Contig20217_RC   1 1.4206e-09 138
## - Age              1 1.4223e-09 138
## - ECT2             1 1.4229e-09 138
## - CDC42BPA         1 1.4269e-09 138
## - SERF1A           1 1.4285e-09 138
## - RAB6B            1 1.4326e-09 138
## - GNAZ             1 1.4345e-09 138
## - GMPS             1 1.4357e-09 138
## - UCHL5            1 1.4379e-09 138
## - AP2B1            1 1.4380e-09 138
## - MS4A7            1 1.4421e-09 138
## - AYTL2            1 1.4441e-09 138
## - ALDH4A1          1 1.4451e-09 138
## - BBC3             1 1.4475e-09 138
## - RTN4RL1          1 1.4477e-09 138
## - DIAPH3           1 1.4497e-09 138
## - EXT1             1 1.4518e-09 138
## - FLT1             1 1.4530e-09 138
## - ORC6L            1 1.4545e-09 138
## - DCK              1 1.4545e-09 138
## - IGFBP5           1 1.4563e-09 138
## - KNTC2            1 1.4651e-09 138
## - CDCA7            1 1.4743e-09 138
## - SCUBE2           1 1.4836e-09 138
## - PECI             1 1.4845e-09 138
## - MTDH             1 1.4890e-09 138
## - CENPA            1 1.4921e-09 138
## - DIAPH3.2         1 1.4971e-09 138
## - Contig40831_RC   1 1.5025e-09 138
## - GPR180           1 1.5026e-09 138
## - DTL              1 1.5120e-09 138
## - GPR126           1 1.5132e-09 138
## - C16orf61         1 1.5180e-09 138
## - MCM6             1 1.5285e-09 138
## - QSCN6L1          1 1.5335e-09 138
## - TSPYL5           1 1.5374e-09 138
## - DIAPH3.1         1 1.5427e-09 138
## - MMP9             1 1.5516e-09 138
## - RP5.860F19.3     1 1.5544e-09 138
## - WISP1            1 1.5695e-09 138
## - C20orf46         1 1.5767e-09 138
## - OXCT1            1 1.5804e-09 138
## - SLC2A3           1 1.5822e-09 138
## - LGP2             1 1.6027e-09 138
## - HRASLS           1 1.6213e-09 138
## - Contig63649_RC   1 1.6217e-09 138
## - PRC1             1 1.6419e-09 138
## - Diam             1 1.6475e-09 138
## - NM_004702        1 1.6498e-09 138
## - PITRM1           1 1.6746e-09 138
## - LymphNodes       1 1.6814e-09 138
## - PECI.1           1 1.6977e-09 138
## - STK32B           1 1.7194e-09 138
```

```
## - LOC643008       1 1.7869e-09 138
## - FGF18           1 1.8029e-09 138
## - PALM2.AKAP2     1 1.8122e-09 138
## - EGLN1           1 1.8928e-09 138
## - Contig32125_RC  1 1.9993e-09 138
## <none>              1.4036e-09 140
##
## Step:  AIC=138
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     NUSAP1 + ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC +
##     BBC3 + DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 +
##     FLT1 + GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 +
##     WISP1 + CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B +
##     ZNF533 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     MELK + COL4A2 + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + NMU + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - NMU             1 1.4174e-09 136
## - COL4A2          1 1.4175e-09 136
## - MELK            1 1.4176e-09 136
## - NUSAP1          1 1.4188e-09 136
## - ZNF533          1 1.4197e-09 136
## - IGFBP5.1        1 1.4203e-09 136
## - ECT2            1 1.4230e-09 136
## - ESM1            1 1.4240e-09 136
## - GSTM3           1 1.4241e-09 136
## - RUNDC1          1 1.4263e-09 136
## - Age             1 1.4275e-09 136
## - RFC4            1 1.4283e-09 136
## - SERF1A          1 1.4304e-09 136
## - RAB6B           1 1.4326e-09 136
## - CDC42BPA        1 1.4333e-09 136
## - Contig20217_RC  1 1.4335e-09 136
## - GNAZ            1 1.4343e-09 136
## - AP2B1           1 1.4383e-09 136
## - UCHL5           1 1.4395e-09 136
## - GMPS            1 1.4411e-09 136
## - AYTL2           1 1.4463e-09 136
## - MS4A7           1 1.4472e-09 136
## - BBC3            1 1.4498e-09 136
## - ALDH4A1         1 1.4501e-09 136
## - DIAPH3          1 1.4531e-09 136
## - EXT1            1 1.4535e-09 136
## - FLT1            1 1.4547e-09 136
## - ORC6L           1 1.4558e-09 136
## - IGFBP5          1 1.4596e-09 136
## - RTN4RL1         1 1.4672e-09 136
## - KNTC2           1 1.4709e-09 136
## - DCK             1 1.4730e-09 136
## - CDCA7           1 1.4750e-09 136
```

```
## - SCUBE2          1 1.4846e-09 136
## - PECI            1 1.4892e-09 136
## - DIAPH3.2        1 1.4976e-09 136
## - MTDH            1 1.4992e-09 136
## - Contig40831_RC  1 1.5046e-09 136
## - CENPA           1 1.5129e-09 136
## - DTL             1 1.5146e-09 136
## - GPR126          1 1.5149e-09 136
## - C16orf61        1 1.5239e-09 136
## - GPR180          1 1.5359e-09 136
## - MCM6            1 1.5419e-09 136
## - QSCN6L1         1 1.5453e-09 136
## - DIAPH3.1        1 1.5480e-09 136
## - TSPYL5          1 1.5533e-09 136
## - MMP9            1 1.5717e-09 136
## - RP5.860F19.3    1 1.5761e-09 136
## - C20orf46        1 1.5771e-09 136
## - SLC2A3          1 1.5907e-09 136
## - WISP1           1 1.5985e-09 136
## - LGP2            1 1.6040e-09 136
## - OXCT1           1 1.6073e-09 136
## - Contig63649_RC  1 1.6276e-09 136
## - PRC1            1 1.6493e-09 136
## - HRASLS          1 1.6517e-09 136
## - NM_004702       1 1.6780e-09 136
## - Diam            1 1.6790e-09 136
## - PITRM1          1 1.6905e-09 136
## - PECI.1          1 1.7155e-09 136
## - LymphNodes      1 1.7186e-09 136
## - STK32B          1 1.7244e-09 136
## - LOC643008       1 1.8305e-09 136
## - PALM2.AKAP2     1 1.8460e-09 136
## - FGF18           1 1.8707e-09 136
## - EGLN1           1 1.9133e-09 136
## - Contig32125_RC  1 2.0129e-09 136
## <none>              1.4100e-09 138
##
## Step:  AIC=136
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     NUSAP1 + ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC +
##     BBC3 + DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 +
##     FLT1 + GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 +
##     WISP1 + CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B +
##     ZNF533 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     MELK + COL4A2 + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + IGFBP5.1 + PALM2.AKAP2 + LGP2 +
##     PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 +
##     C20orf46
##
##                  Df   Deviance AIC
## - NUSAP1          1 1.4240e-09 134
## - ZNF533          1 1.4242e-09 134
## - IGFBP5.1        1 1.4260e-09 134
```

```
## - MELK            1 1.4265e-09 134
## - COL4A2          1 1.4310e-09 134
## - ECT2            1 1.4310e-09 134
## - ESM1            1 1.4315e-09 134
## - GSTM3           1 1.4338e-09 134
## - RAB6B           1 1.4365e-09 134
## - Age             1 1.4389e-09 134
## - SERF1A          1 1.4403e-09 134
## - RUNDC1          1 1.4414e-09 134
## - CDC42BPA        1 1.4415e-09 134
## - UCHL5           1 1.4423e-09 134
## - RFC4            1 1.4439e-09 134
## - Contig20217_RC  1 1.4439e-09 134
## - MS4A7           1 1.4498e-09 134
## - GNAZ            1 1.4502e-09 134
## - GMPS            1 1.4591e-09 134
## - BBC3            1 1.4593e-09 134
## - ORC6L           1 1.4595e-09 134
## - FLT1            1 1.4669e-09 134
## - AP2B1           1 1.4678e-09 134
## - AYTL2           1 1.4695e-09 134
## - RTN4RL1         1 1.4698e-09 134
## - IGFBP5          1 1.4707e-09 134
## - KNTC2           1 1.4761e-09 134
## - DIAPH3          1 1.4763e-09 134
## - EXT1            1 1.4772e-09 134
## - SCUBE2          1 1.4931e-09 134
## - PECI            1 1.4955e-09 134
## - DIAPH3.2        1 1.5027e-09 134
## - CDCA7           1 1.5037e-09 134
## - Contig40831_RC  1 1.5090e-09 134
## - ALDH4A1         1 1.5094e-09 134
## - MTDH            1 1.5124e-09 134
## - GPR126          1 1.5154e-09 134
## - DTL             1 1.5261e-09 134
## - C16orf61        1 1.5288e-09 134
## - CENPA           1 1.5300e-09 134
## - DCK             1 1.5394e-09 134
## - GPR180          1 1.5445e-09 134
## - QSCN6L1         1 1.5558e-09 134
## - TSPYL5          1 1.5624e-09 134
## - MCM6            1 1.5648e-09 134
## - RP5.860F19.3    1 1.5803e-09 134
## - C20orf46        1 1.5836e-09 134
## - WISP1           1 1.6019e-09 134
## - LGP2            1 1.6038e-09 134
## - MMP9            1 1.6092e-09 134
## - DIAPH3.1        1 1.6195e-09 134
## - Contig63649_RC  1 1.6273e-09 134
## - SLC2A3          1 1.6343e-09 134
## - OXCT1           1 1.6484e-09 134
## - PRC1            1 1.6645e-09 134
## - Diam            1 1.6791e-09 134
## - NM_004702       1 1.6883e-09 134
```

```
## - PITRM1          1 1.6952e-09 134
## - HRASLS          1 1.7089e-09 134
## - STK32B          1 1.7253e-09 134
## - LymphNodes      1 1.7308e-09 134
## - PECI.1          1 1.7913e-09 134
## - LOC643008       1 1.8505e-09 134
## - PALM2.AKAP2     1 1.8539e-09 134
## - FGF18           1 1.8931e-09 134
## - EGLN1           1 1.9236e-09 134
## - Contig32125_RC  1 2.0292e-09 134
## <none>              1.4174e-09 136
##
## Step:  AIC=134
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + ZNF533 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + MELK + COL4A2 +
##     DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 +
##     CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + IGFBP5.1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - ZNF533          1 1.4278e-09 132
## - MELK            1 1.4336e-09 132
## - IGFBP5.1        1 1.4348e-09 132
## - ESM1            1 1.4359e-09 132
## - COL4A2          1 1.4377e-09 132
## - RAB6B           1 1.4432e-09 132
## - ECT2            1 1.4452e-09 132
## - GSTM3           1 1.4458e-09 132
## - CDC42BPA        1 1.4471e-09 132
## - Contig20217_RC  1 1.4496e-09 132
## - RFC4            1 1.4511e-09 132
## - GNAZ            1 1.4518e-09 132
## - MS4A7           1 1.4544e-09 132
## - BBC3            1 1.4613e-09 132
## - RUNDC1          1 1.4631e-09 132
## - Age             1 1.4649e-09 132
## - UCHL5           1 1.4665e-09 132
## - ORC6L           1 1.4702e-09 132
## - GMPS            1 1.4702e-09 132
## - SERF1A          1 1.4723e-09 132
## - RTN4RL1         1 1.4794e-09 132
## - AP2B1           1 1.4810e-09 132
## - FLT1            1 1.4819e-09 132
## - IGFBP5          1 1.4837e-09 132
## - AYTL2           1 1.4882e-09 132
## - DIAPH3          1 1.4886e-09 132
## - KNTC2           1 1.4909e-09 132
## - SCUBE2          1 1.5076e-09 132
## - DIAPH3.2        1 1.5084e-09 132
```

```
## - CDCA7           1 1.5105e-09 132
## - ALDH4A1         1 1.5145e-09 132
## - EXT1            1 1.5148e-09 132
## - MTDH            1 1.5164e-09 132
## - Contig40831_RC  1 1.5192e-09 132
## - GPR126          1 1.5265e-09 132
## - CENPA           1 1.5347e-09 132
## - DTL             1 1.5364e-09 132
## - PECI            1 1.5375e-09 132
## - DCK             1 1.5464e-09 132
## - GPR180          1 1.5533e-09 132
## - TSPYL5          1 1.5660e-09 132
## - C16orf61        1 1.5704e-09 132
## - QSCN6L1         1 1.5707e-09 132
## - MCM6            1 1.5731e-09 132
## - RP5.860F19.3    1 1.5842e-09 132
## - C20orf46        1 1.5890e-09 132
## - MMP9            1 1.6113e-09 132
## - WISP1           1 1.6126e-09 132
## - LGP2            1 1.6194e-09 132
## - DIAPH3.1        1 1.6213e-09 132
## - SLC2A3          1 1.6369e-09 132
## - OXCT1           1 1.6594e-09 132
## - Contig63649_RC  1 1.6679e-09 132
## - NM_004702       1 1.6945e-09 132
## - Diam            1 1.6949e-09 132
## - PRC1            1 1.6966e-09 132
## - PITRM1          1 1.7028e-09 132
## - HRASLS          1 1.7218e-09 132
## - LymphNodes      1 1.7350e-09 132
## - STK32B          1 1.7379e-09 132
## - LOC643008       1 1.8587e-09 132
## - PALM2.AKAP2     1 1.8834e-09 132
## - PECI.1          1 1.9035e-09 132
## - FGF18           1 1.9168e-09 132
## - EGLN1           1 1.9411e-09 132
## - Contig32125_RC  1 2.0314e-09 132
## <none>              1.4240e-09 134
##
## Step:  AIC=132
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + MELK + COL4A2 + DTL +
##     STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 +
##     CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + IGFBP5.1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - IGFBP5.1        1 1.4367e-09 130
## - ESM1            1 1.4388e-09 130
```

```
## - COL4A2          1 1.4408e-09 130
## - ECT2            1 1.4478e-09 130
## - CDC42BPA        1 1.4488e-09 130
## - RAB6B           1 1.4489e-09 130
## - MELK            1 1.4499e-09 130
## - GSTM3           1 1.4537e-09 130
## - RFC4            1 1.4543e-09 130
## - Contig20217_RC  1 1.4555e-09 130
## - GNAZ            1 1.4587e-09 130
## - MS4A7           1 1.4627e-09 130
## - BBC3            1 1.4726e-09 130
## - RUNDC1          1 1.4729e-09 130
## - ORC6L           1 1.4752e-09 130
## - FLT1            1 1.4873e-09 130
## - IGFBP5          1 1.4882e-09 130
## - AP2B1           1 1.4887e-09 130
## - RTN4RL1         1 1.4919e-09 130
## - UCHL5           1 1.4923e-09 130
## - GMPS            1 1.4952e-09 130
## - KNTC2           1 1.4964e-09 130
## - DIAPH3          1 1.5069e-09 130
## - Age             1 1.5071e-09 130
## - CDCA7           1 1.5103e-09 130
## - SCUBE2          1 1.5105e-09 130
## - DIAPH3.2        1 1.5129e-09 130
## - ALDH4A1         1 1.5192e-09 130
## - EXT1            1 1.5207e-09 130
## - MTDH            1 1.5265e-09 130
## - GPR126          1 1.5273e-09 130
## - DTL             1 1.5353e-09 130
## - SERF1A          1 1.5390e-09 130
## - AYTL2           1 1.5446e-09 130
## - Contig40831_RC  1 1.5480e-09 130
## - DCK             1 1.5543e-09 130
## - GPR180          1 1.5565e-09 130
## - PECI            1 1.5584e-09 130
## - CENPA           1 1.5599e-09 130
## - TSPYL5          1 1.5797e-09 130
## - MCM6            1 1.5805e-09 130
## - C16orf61        1 1.5839e-09 130
## - QSCN6L1         1 1.5850e-09 130
## - C20orf46        1 1.5901e-09 130
## - RP5.860F19.3    1 1.5924e-09 130
## - MMP9            1 1.6233e-09 130
## - LGP2            1 1.6464e-09 130
## - WISP1           1 1.6502e-09 130
## - DIAPH3.1        1 1.6568e-09 130
## - OXCT1           1 1.6798e-09 130
## - Diam            1 1.6994e-09 130
## - PRC1            1 1.7002e-09 130
## - Contig63649_RC  1 1.7173e-09 130
## - NM_004702       1 1.7335e-09 130
## - PITRM1          1 1.7493e-09 130
## - LymphNodes      1 1.7504e-09 130
```

```
## - SLC2A3          1 1.7697e-09 130
## - HRASLS          1 1.7760e-09 130
## - STK32B          1 1.8445e-09 130
## - LOC643008       1 1.8893e-09 130
## - PECI.1          1 1.9074e-09 130
## - PALM2.AKAP2     1 1.9160e-09 130
## - FGF18           1 1.9301e-09 130
## - EGLN1           1 1.9443e-09 130
## - Contig32125_RC  1 2.0352e-09 130
## <none>              1.4278e-09 132
##
## Step:  AIC=130
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RAB6B + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + MELK + COL4A2 + DTL +
##     STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 +
##     CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA +
##     EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - RAB6B           1 1.4508e-09 128
## - ESM1            1 1.4509e-09 128
## - ECT2            1 1.4541e-09 128
## - RFC4            1 1.4605e-09 128
## - MELK            1 1.4626e-09 128
## - CDC42BPA        1 1.4627e-09 128
## - COL4A2          1 1.4650e-09 128
## - MS4A7           1 1.4668e-09 128
## - GSTM3           1 1.4697e-09 128
## - GNAZ            1 1.4794e-09 128
## - Contig20217_RC  1 1.4840e-09 128
## - ORC6L           1 1.4855e-09 128
## - BBC3            1 1.4862e-09 128
## - UCHL5           1 1.4933e-09 128
## - RUNDC1          1 1.4958e-09 128
## - AP2B1           1 1.4964e-09 128
## - KNTC2           1 1.4994e-09 128
## - FLT1            1 1.4995e-09 128
## - RTN4RL1         1 1.5003e-09 128
## - GMPS            1 1.5103e-09 128
## - SCUBE2          1 1.5119e-09 128
## - CDCA7           1 1.5140e-09 128
## - DIAPH3.2        1 1.5177e-09 128
## - EXT1            1 1.5213e-09 128
## - DIAPH3          1 1.5303e-09 128
## - Age             1 1.5332e-09 128
## - MTDH            1 1.5355e-09 128
## - DTL             1 1.5387e-09 128
## - AYTL2           1 1.5610e-09 128
## - SERF1A          1 1.5634e-09 128
```

```
## - CENPA           1 1.5662e-09 128
## - PECI            1 1.5701e-09 128
## - Contig40831_RC  1 1.5705e-09 128
## - GPR126          1 1.5786e-09 128
## - DCK             1 1.5821e-09 128
## - MCM6            1 1.5845e-09 128
## - C16orf61        1 1.5857e-09 128
## - C20orf46        1 1.5913e-09 128
## - GPR180          1 1.6022e-09 128
## - RP5.860F19.3    1 1.6053e-09 128
## - ALDH4A1         1 1.6075e-09 128
## - QSCN6L1         1 1.6123e-09 128
## - TSPYL5          1 1.6188e-09 128
## - MMP9            1 1.6253e-09 128
## - LGP2            1 1.6566e-09 128
## - WISP1           1 1.6791e-09 128
## - DIAPH3.1        1 1.6823e-09 128
## - Diam            1 1.7057e-09 128
## - IGFBP5          1 1.7130e-09 128
## - PRC1            1 1.7151e-09 128
## - OXCT1           1 1.7200e-09 128
## - Contig63649_RC  1 1.7271e-09 128
## - LymphNodes      1 1.7571e-09 128
## - PITRM1          1 1.7787e-09 128
## - HRASLS          1 1.7895e-09 128
## - SLC2A3          1 1.7959e-09 128
## - NM_004702       1 1.8147e-09 128
## - STK32B          1 1.8659e-09 128
## - LOC643008       1 1.8894e-09 128
## - PALM2.AKAP2     1 1.9184e-09 128
## - PECI.1          1 1.9250e-09 128
## - FGF18           1 1.9332e-09 128
## - EGLN1           1 2.0018e-09 128
## - Contig32125_RC  1 2.1720e-09 128
## <none>              1.4367e-09 130
##
## Step:  AIC=128
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + ECT2 + GMPS + KNTC2 + WISP1 +
##     CDC42BPA + SERF1A + AYTL2 + GSTM3 + GPR180 + RTN4RL1 + UCHL5 +
##     PECI + MTDH + Contig40831_RC + MELK + COL4A2 + DTL + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 +
##     MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - ECT2            1 1.4641e-09 126
## - ESM1            1 1.4655e-09 126
## - CDC42BPA        1 1.4763e-09 126
## - MS4A7           1 1.4795e-09 126
## - GSTM3           1 1.4798e-09 126
```

```
## - MELK            1 1.4812e-09 126
## - RFC4            1 1.4828e-09 126
## - COL4A2          1 1.4874e-09 126
## - BBC3            1 1.4889e-09 126
## - GNAZ            1 1.4917e-09 126
## - ORC6L           1 1.4943e-09 126
## - RTN4RL1         1 1.5060e-09 126
## - AP2B1           1 1.5062e-09 126
## - KNTC2           1 1.5072e-09 126
## - UCHL5           1 1.5089e-09 126
## - RUNDC1          1 1.5105e-09 126
## - GMPS            1 1.5138e-09 126
## - FLT1            1 1.5150e-09 126
## - Contig20217_RC  1 1.5159e-09 126
## - CDCA7           1 1.5252e-09 126
## - SCUBE2          1 1.5328e-09 126
## - DIAPH3.2        1 1.5342e-09 126
## - DIAPH3          1 1.5369e-09 126
## - EXT1            1 1.5460e-09 126
## - Age             1 1.5468e-09 126
## - MTDH            1 1.5476e-09 126
## - DTL             1 1.5481e-09 126
## - CENPA           1 1.5703e-09 126
## - SERF1A          1 1.5718e-09 126
## - AYTL2           1 1.5828e-09 126
## - C16orf61        1 1.5896e-09 126
## - DCK             1 1.5945e-09 126
## - PECI            1 1.5955e-09 126
## - Contig40831_RC  1 1.5993e-09 126
## - C20orf46        1 1.6055e-09 126
## - GPR180          1 1.6116e-09 126
## - ALDH4A1         1 1.6152e-09 126
## - TSPYL5          1 1.6219e-09 126
## - QSCN6L1         1 1.6305e-09 126
## - RP5.860F19.3    1 1.6361e-09 126
## - MMP9            1 1.6512e-09 126
## - GPR126          1 1.6624e-09 126
## - MCM6            1 1.6726e-09 126
## - DIAPH3.1        1 1.6838e-09 126
## - WISP1           1 1.6916e-09 126
## - LGP2            1 1.7084e-09 126
## - Contig63649_RC  1 1.7309e-09 126
## - PRC1            1 1.7383e-09 126
## - IGFBP5          1 1.7513e-09 126
## - OXCT1           1 1.7701e-09 126
## - Diam            1 1.7777e-09 126
## - LymphNodes      1 1.7805e-09 126
## - PITRM1          1 1.7848e-09 126
## - SLC2A3          1 1.7987e-09 126
## - NM_004702       1 1.8576e-09 126
## - STK32B          1 1.8681e-09 126
## - HRASLS          1 1.8755e-09 126
## - PALM2.AKAP2     1 1.9228e-09 126
## - LOC643008       1 1.9811e-09 126
```

```
## - PECI.1          1 2.0009e-09 126
## - EGLN1           1 2.0160e-09 126
## - FGF18           1 2.1023e-09 126
## - Contig32125_RC  1 2.2153e-09 126
## <none>              1.4508e-09 128
##
## Step:  AIC=126
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + GMPS + KNTC2 + WISP1 + CDC42BPA +
##     SERF1A + AYTL2 + GSTM3 + GPR180 + RTN4RL1 + UCHL5 + PECI +
##     MTDH + Contig40831_RC + MELK + COL4A2 + DTL + STK32B + DCK +
##     GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 +
##     MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - GSTM3           1 1.4805e-09 124
## - CDC42BPA        1 1.4813e-09 124
## - ESM1            1 1.4817e-09 124
## - MS4A7           1 1.4851e-09 124
## - MELK            1 1.4889e-09 124
## - RFC4            1 1.4930e-09 124
## - ORC6L           1 1.4969e-09 124
## - GNAZ            1 1.4973e-09 124
## - COL4A2          1 1.5017e-09 124
## - BBC3            1 1.5019e-09 124
## - KNTC2           1 1.5077e-09 124
## - RUNDC1          1 1.5087e-09 124
## - FLT1            1 1.5229e-09 124
## - GMPS            1 1.5265e-09 124
## - AP2B1           1 1.5305e-09 124
## - DIAPH3          1 1.5372e-09 124
## - UCHL5           1 1.5400e-09 124
## - Contig20217_RC  1 1.5417e-09 124
## - CDCA7           1 1.5428e-09 124
## - RTN4RL1         1 1.5435e-09 124
## - Age             1 1.5482e-09 124
## - SCUBE2          1 1.5514e-09 124
## - DTL             1 1.5544e-09 124
## - DIAPH3.2        1 1.5555e-09 124
## - CENPA           1 1.5717e-09 124
## - EXT1            1 1.5720e-09 124
## - SERF1A          1 1.5766e-09 124
## - MTDH            1 1.5888e-09 124
## - C16orf61        1 1.5940e-09 124
## - PECI            1 1.5950e-09 124
## - Contig40831_RC  1 1.5983e-09 124
## - C20orf46        1 1.6055e-09 124
## - DCK             1 1.6121e-09 124
## - ALDH4A1         1 1.6201e-09 124
## - TSPYL5          1 1.6223e-09 124
```

```
## - AYTL2           1 1.6266e-09 124
## - GPR180          1 1.6475e-09 124
## - QSCN6L1         1 1.6564e-09 124
## - RP5.860F19.3    1 1.6693e-09 124
## - MMP9            1 1.6710e-09 124
## - DIAPH3.1        1 1.6871e-09 124
## - MCM6            1 1.6907e-09 124
## - WISP1           1 1.7003e-09 124
## - GPR126          1 1.7052e-09 124
## - Contig63649_RC  1 1.7312e-09 124
## - PRC1            1 1.7460e-09 124
## - IGFBP5          1 1.7591e-09 124
## - OXCT1           1 1.7814e-09 124
## - Diam            1 1.7856e-09 124
## - SLC2A3          1 1.8022e-09 124
## - LGP2            1 1.8205e-09 124
## - PITRM1          1 1.8239e-09 124
## - LymphNodes      1 1.8241e-09 124
## - HRASLS          1 1.8868e-09 124
## - STK32B          1 1.8950e-09 124
## - PALM2.AKAP2     1 1.9381e-09 124
## - NM_004702       1 1.9645e-09 124
## - PECI.1          1 2.0197e-09 124
## - EGLN1           1 2.0230e-09 124
## - LOC643008       1 2.0598e-09 124
## - FGF18           1 2.1364e-09 124
## - Contig32125_RC  1 2.2309e-09 124
## <none>              1.4641e-09 126
##
## Step:  AIC=124
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + GMPS + KNTC2 + WISP1 + CDC42BPA +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + MELK + COL4A2 + DTL + STK32B + DCK + GPR126 +
##     SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 +
##     MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 +
##     PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 +
##     C20orf46
##
##                  Df   Deviance AIC
## - CDC42BPA        1 1.4915e-09 122
## - ESM1            1 1.4976e-09 122
## - MELK            1 1.5005e-09 122
## - MS4A7           1 1.5026e-09 122
## - RFC4            1 1.5058e-09 122
## - GNAZ            1 1.5072e-09 122
## - COL4A2          1 1.5083e-09 122
## - RUNDC1          1 1.5201e-09 122
## - KNTC2           1 1.5228e-09 122
## - BBC3            1 1.5228e-09 122
## - ORC6L           1 1.5247e-09 122
## - GMPS            1 1.5396e-09 122
```

```
## - FLT1            1 1.5398e-09 122
## - AP2B1           1 1.5450e-09 122
## - DIAPH3          1 1.5488e-09 122
## - UCHL5           1 1.5509e-09 122
## - Contig20217_RC  1 1.5526e-09 122
## - Age             1 1.5570e-09 122
## - RTN4RL1         1 1.5575e-09 122
## - CDCA7           1 1.5625e-09 122
## - SCUBE2          1 1.5635e-09 122
## - DTL             1 1.5689e-09 122
## - DIAPH3.2        1 1.5715e-09 122
## - CENPA           1 1.5804e-09 122
## - EXT1            1 1.5967e-09 122
## - SERF1A          1 1.6034e-09 122
## - C16orf61        1 1.6070e-09 122
## - MTDH            1 1.6097e-09 122
## - C20orf46        1 1.6187e-09 122
## - Contig40831_RC  1 1.6211e-09 122
## - DCK             1 1.6311e-09 122
## - PECI            1 1.6321e-09 122
## - ALDH4A1         1 1.6408e-09 122
## - TSPYL5          1 1.6471e-09 122
## - AYTL2           1 1.6478e-09 122
## - GPR180          1 1.6720e-09 122
## - QSCN6L1         1 1.7002e-09 122
## - DIAPH3.1        1 1.7057e-09 122
## - MCM6            1 1.7058e-09 122
## - MMP9            1 1.7159e-09 122
## - GPR126          1 1.7255e-09 122
## - WISP1           1 1.7256e-09 122
## - RP5.860F19.3    1 1.7393e-09 122
## - Contig63649_RC  1 1.7593e-09 122
## - PRC1            1 1.7765e-09 122
## - IGFBP5          1 1.7888e-09 122
## - OXCT1           1 1.7915e-09 122
## - Diam            1 1.8043e-09 122
## - SLC2A3          1 1.8282e-09 122
## - LGP2            1 1.8713e-09 122
## - LymphNodes      1 1.8713e-09 122
## - HRASLS          1 1.9016e-09 122
## - STK32B          1 1.9210e-09 122
## - PITRM1          1 1.9259e-09 122
## - PALM2.AKAP2     1 1.9485e-09 122
## - NM_004702       1 1.9894e-09 122
## - PECI.1          1 2.0368e-09 122
## - EGLN1           1 2.0905e-09 122
## - LOC643008       1 2.0930e-09 122
## - FGF18           1 2.1865e-09 122
## - Contig32125_RC  1 2.3981e-09 122
## <none>              1.4805e-09 124
##
## Step:  AIC=122
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
```

```
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + GMPS + KNTC2 + WISP1 + SERF1A +
##     AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     MELK + COL4A2 + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                   Df   Deviance AIC
## - MELK             1 1.5101e-09 120
## - ESM1             1 1.5121e-09 120
## - RFC4             1 1.5149e-09 120
## - GNAZ             1 1.5164e-09 120
## - COL4A2           1 1.5202e-09 120
## - RUNDC1           1 1.5230e-09 120
## - KNTC2            1 1.5255e-09 120
## - MS4A7            1 1.5282e-09 120
## - ORC6L            1 1.5363e-09 120
## - DIAPH3           1 1.5515e-09 120
## - BBC3             1 1.5599e-09 120
## - Age              1 1.5641e-09 120
## - RTN4RL1          1 1.5654e-09 120
## - AP2B1            1 1.5664e-09 120
## - CDCA7            1 1.5685e-09 120
## - FLT1             1 1.5685e-09 120
## - GMPS             1 1.5805e-09 120
## - SCUBE2           1 1.5845e-09 120
## - DIAPH3.2         1 1.5993e-09 120
## - EXT1             1 1.6003e-09 120
## - UCHL5            1 1.6022e-09 120
## - Contig20217_RC   1 1.6026e-09 120
## - SERF1A           1 1.6030e-09 120
## - MTDH             1 1.6120e-09 120
## - C16orf61         1 1.6157e-09 120
## - CENPA            1 1.6217e-09 120
## - PECI             1 1.6346e-09 120
## - C20orf46         1 1.6393e-09 120
## - DTL              1 1.6441e-09 120
## - ALDH4A1          1 1.6442e-09 120
## - AYTL2            1 1.6496e-09 120
## - TSPYL5           1 1.6499e-09 120
## - DCK              1 1.6509e-09 120
## - Contig40831_RC   1 1.6819e-09 120
## - QSCN6L1          1 1.7074e-09 120
## - DIAPH3.1         1 1.7084e-09 120
## - MCM6             1 1.7193e-09 120
## - MMP9             1 1.7244e-09 120
## - GPR126           1 1.7363e-09 120
## - RP5.860F19.3     1 1.7448e-09 120
## - WISP1            1 1.7594e-09 120
## - GPR180           1 1.7751e-09 120
## - PRC1             1 1.7920e-09 120
## - OXCT1            1 1.7995e-09 120
## - Contig63649_RC   1 1.8033e-09 120
```

```
## - IGFBP5          1 1.8047e-09 120
## - SLC2A3          1 1.8305e-09 120
## - Diam            1 1.8334e-09 120
## - LGP2            1 1.8728e-09 120
## - LymphNodes      1 1.9119e-09 120
## - HRASLS          1 1.9500e-09 120
## - PITRM1          1 1.9760e-09 120
## - PALM2.AKAP2     1 1.9951e-09 120
## - STK32B          1 2.0022e-09 120
## - PECI.1          1 2.0907e-09 120
## - EGLN1           1 2.0970e-09 120
## - NM_004702       1 2.1395e-09 120
## - LOC643008       1 2.1502e-09 120
## - FGF18           1 2.2702e-09 120
## - Contig32125_RC  1 2.4336e-09 120
## <none>              1.4915e-09 122
##
## Step:  AIC=120
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     GNAZ + OXCT1 + MMP9 + RUNDC1 + GMPS + KNTC2 + WISP1 + SERF1A +
##     AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     COL4A2 + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - GNAZ            1 1.5212e-09 118
## - RUNDC1          1 1.5270e-09 118
## - COL4A2          1 1.5271e-09 118
## - MS4A7           1 1.5358e-09 118
## - ESM1            1 1.5432e-09 118
## - ORC6L           1 1.5434e-09 118
## - RFC4            1 1.5477e-09 118
## - KNTC2           1 1.5502e-09 118
## - DIAPH3          1 1.5596e-09 118
## - Age             1 1.5699e-09 118
## - CDCA7           1 1.5701e-09 118
## - RTN4RL1         1 1.5712e-09 118
## - FLT1            1 1.5755e-09 118
## - BBC3            1 1.5764e-09 118
## - AP2B1           1 1.5824e-09 118
## - GMPS            1 1.5881e-09 118
## - UCHL5           1 1.6098e-09 118
## - EXT1            1 1.6104e-09 118
## - SERF1A          1 1.6157e-09 118
## - Contig20217_RC  1 1.6170e-09 118
## - DIAPH3.2        1 1.6215e-09 118
## - MTDH            1 1.6226e-09 118
## - C16orf61        1 1.6259e-09 118
## - CENPA           1 1.6303e-09 118
## - SCUBE2          1 1.6373e-09 118
```

```
## - C20orf46        1 1.6445e-09 118
## - PECI            1 1.6557e-09 118
## - DTL             1 1.6567e-09 118
## - DCK             1 1.6569e-09 118
## - TSPYL5          1 1.6757e-09 118
## - AYTL2           1 1.6758e-09 118
## - ALDH4A1         1 1.6881e-09 118
## - Contig40831_RC  1 1.7006e-09 118
## - QSCN6L1         1 1.7220e-09 118
## - DIAPH3.1        1 1.7235e-09 118
## - MCM6            1 1.7305e-09 118
## - RP5.860F19.3    1 1.7477e-09 118
## - GPR126          1 1.7602e-09 118
## - WISP1           1 1.7774e-09 118
## - GPR180          1 1.7907e-09 118
## - PRC1            1 1.8071e-09 118
## - MMP9            1 1.8117e-09 118
## - IGFBP5          1 1.8173e-09 118
## - Contig63649_RC  1 1.8180e-09 118
## - SLC2A3          1 1.8337e-09 118
## - Diam            1 1.8425e-09 118
## - OXCT1           1 1.8748e-09 118
## - LGP2            1 1.8778e-09 118
## - LymphNodes      1 1.9145e-09 118
## - STK32B          1 2.0045e-09 118
## - HRASLS          1 2.0049e-09 118
## - PITRM1          1 2.0236e-09 118
## - PALM2.AKAP2     1 2.0414e-09 118
## - PECI.1          1 2.0915e-09 118
## - EGLN1           1 2.1193e-09 118
## - NM_004702       1 2.1513e-09 118
## - LOC643008       1 2.1644e-09 118
## - FGF18           1 2.2911e-09 118
## - Contig32125_RC  1 2.4468e-09 118
## <none>              1.5101e-09 120
##
## Step:  AIC=118
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + RUNDC1 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 +
##     GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     COL4A2 + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     ORC6L + RFC4 + CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - RUNDC1          1 1.5339e-09 116
## - COL4A2          1 1.5407e-09 116
## - KNTC2           1 1.5524e-09 116
## - MS4A7           1 1.5570e-09 116
## - ESM1            1 1.5575e-09 116
## - RFC4            1 1.5660e-09 116
```

```
## - ORC6L           1 1.5664e-09 116
## - Age             1 1.5708e-09 116
## - DIAPH3          1 1.5725e-09 116
## - CDCA7           1 1.5756e-09 116
## - FLT1            1 1.5906e-09 116
## - GMPS            1 1.5947e-09 116
## - EXT1            1 1.6084e-09 116
## - BBC3            1 1.6150e-09 116
## - UCHL5           1 1.6195e-09 116
## - AP2B1           1 1.6195e-09 116
## - DIAPH3.2        1 1.6230e-09 116
## - RTN4RL1         1 1.6231e-09 116
## - CENPA           1 1.6338e-09 116
## - MTDH            1 1.6496e-09 116
## - SERF1A          1 1.6536e-09 116
## - C16orf61        1 1.6569e-09 116
## - PECI            1 1.6593e-09 116
## - SCUBE2          1 1.6608e-09 116
## - DTL             1 1.6679e-09 116
## - DCK             1 1.6739e-09 116
## - TSPYL5          1 1.6775e-09 116
## - AYTL2           1 1.6807e-09 116
## - C20orf46        1 1.6832e-09 116
## - Contig20217_RC  1 1.6861e-09 116
## - Contig40831_RC  1 1.7080e-09 116
## - ALDH4A1         1 1.7126e-09 116
## - DIAPH3.1        1 1.7316e-09 116
## - MCM6            1 1.7383e-09 116
## - RP5.860F19.3    1 1.7468e-09 116
## - GPR126          1 1.7616e-09 116
## - QSCN6L1         1 1.7872e-09 116
## - WISP1           1 1.7891e-09 116
## - MMP9            1 1.8120e-09 116
## - Contig63649_RC  1 1.8238e-09 116
## - GPR180          1 1.8269e-09 116
## - Diam            1 1.8465e-09 116
## - PRC1            1 1.8626e-09 116
## - LGP2            1 1.8761e-09 116
## - OXCT1           1 1.8802e-09 116
## - SLC2A3          1 1.8941e-09 116
## - LymphNodes      1 1.9245e-09 116
## - IGFBP5          1 1.9555e-09 116
## - STK32B          1 2.0052e-09 116
## - HRASLS          1 2.0073e-09 116
## - PECI.1          1 2.1239e-09 116
## - EGLN1           1 2.2073e-09 116
## - NM_004702       1 2.2110e-09 116
## - PALM2.AKAP2     1 2.2377e-09 116
## - PITRM1          1 2.2665e-09 116
## - FGF18           1 2.2859e-09 116
## - LOC643008       1 2.2884e-09 116
## - Contig32125_RC  1 2.5034e-09 116
## <none>              1.5212e-09 118
##
```

```
## Step:  AIC=116
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + COL4A2 +
##     DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 +
##     CDCA7 + LOC643008 + MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA +
##     EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                   Df   Deviance AIC
## - COL4A2           1 1.5492e-09 114
## - MS4A7            1 1.5658e-09 114
## - Age              1 1.5798e-09 114
## - KNTC2            1 1.5826e-09 114
## - RFC4             1 1.5843e-09 114
## - DIAPH3           1 1.5873e-09 114
## - CDCA7            1 1.5883e-09 114
## - FLT1             1 1.5999e-09 114
## - ESM1             1 1.6044e-09 114
## - GMPS             1 1.6087e-09 114
## - ORC6L            1 1.6099e-09 114
## - RTN4RL1          1 1.6364e-09 114
## - DIAPH3.2         1 1.6379e-09 114
## - EXT1             1 1.6536e-09 114
## - SCUBE2           1 1.6646e-09 114
## - UCHL5            1 1.6671e-09 114
## - PECI             1 1.6734e-09 114
## - BBC3             1 1.6740e-09 114
## - DCK              1 1.6833e-09 114
## - TSPYL5           1 1.6880e-09 114
## - AP2B1            1 1.6880e-09 114
## - CENPA            1 1.6943e-09 114
## - DTL              1 1.6993e-09 114
## - C20orf46         1 1.7024e-09 114
## - AYTL2            1 1.7024e-09 114
## - Contig20217_RC   1 1.7094e-09 114
## - ALDH4A1          1 1.7218e-09 114
## - Contig40831_RC   1 1.7278e-09 114
## - SERF1A           1 1.7332e-09 114
## - C16orf61         1 1.7342e-09 114
## - MTDH             1 1.7403e-09 114
## - RP5.860F19.3     1 1.7557e-09 114
## - GPR126           1 1.7744e-09 114
## - MCM6             1 1.7994e-09 114
## - DIAPH3.1         1 1.8021e-09 114
## - WISP1            1 1.8103e-09 114
## - MMP9             1 1.8194e-09 114
## - QSCN6L1          1 1.8199e-09 114
## - Contig63649_RC   1 1.8563e-09 114
## - PRC1             1 1.8669e-09 114
## - OXCT1            1 1.8967e-09 114
## - SLC2A3           1 1.9042e-09 114
```

```
## - LGP2            1 1.9120e-09 114
## - IGFBP5          1 1.9696e-09 114
## - GPR180          1 1.9868e-09 114
## - Diam            1 2.0085e-09 114
## - STK32B          1 2.0652e-09 114
## - HRASLS          1 2.0834e-09 114
## - LymphNodes      1 2.1080e-09 114
## - PECI.1          1 2.1389e-09 114
## - EGLN1           1 2.2074e-09 114
## - NM_004702       1 2.2403e-09 114
## - PALM2.AKAP2     1 2.2450e-09 114
## - FGF18           1 2.2992e-09 114
## - LOC643008       1 2.2998e-09 114
## - PITRM1          1 2.3353e-09 114
## - Contig32125_RC  1 2.5385e-09 114
## <none>              1.5339e-09 116
##
## Step:  AIC=114
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 +
##     MS4A7 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - MS4A7           1 1.5809e-09 112
## - RFC4            1 1.5889e-09 112
## - DIAPH3          1 1.5936e-09 112
## - Age             1 1.6020e-09 112
## - CDCA7           1 1.6030e-09 112
## - GMPS            1 1.6109e-09 112
## - ESM1            1 1.6243e-09 112
## - ORC6L           1 1.6263e-09 112
## - FLT1            1 1.6307e-09 112
## - KNTC2           1 1.6328e-09 112
## - RTN4RL1         1 1.6474e-09 112
## - DIAPH3.2        1 1.6482e-09 112
## - EXT1            1 1.6558e-09 112
## - UCHL5           1 1.6686e-09 112
## - SCUBE2          1 1.6753e-09 112
## - DCK             1 1.6836e-09 112
## - PECI            1 1.6869e-09 112
## - AP2B1           1 1.6957e-09 112
## - DTL             1 1.7019e-09 112
## - AYTL2           1 1.7098e-09 112
## - BBC3            1 1.7115e-09 112
## - Contig20217_RC  1 1.7171e-09 112
## - ALDH4A1         1 1.7230e-09 112
## - C20orf46        1 1.7304e-09 112
## - Contig40831_RC  1 1.7323e-09 112
```

```
## - MTDH            1 1.7506e-09 112
## - TSPYL5          1 1.7515e-09 112
## - SERF1A          1 1.7549e-09 112
## - CENPA           1 1.7578e-09 112
## - RP5.860F19.3    1 1.7654e-09 112
## - C16orf61        1 1.7667e-09 112
## - GPR126          1 1.7777e-09 112
## - WISP1           1 1.8206e-09 112
## - MMP9            1 1.8213e-09 112
## - DIAPH3.1        1 1.8213e-09 112
## - QSCN6L1         1 1.8335e-09 112
## - MCM6            1 1.8437e-09 112
## - Contig63649_RC  1 1.8680e-09 112
## - PRC1            1 1.8756e-09 112
## - OXCT1           1 1.9084e-09 112
## - LGP2            1 1.9110e-09 112
## - SLC2A3          1 1.9236e-09 112
## - IGFBP5          1 1.9818e-09 112
## - GPR180          1 1.9923e-09 112
## - Diam            1 2.0098e-09 112
## - HRASLS          1 2.0981e-09 112
## - LymphNodes      1 2.1093e-09 112
## - STK32B          1 2.1942e-09 112
## - PALM2.AKAP2     1 2.2435e-09 112
## - NM_004702       1 2.2507e-09 112
## - PECI.1          1 2.2527e-09 112
## - EGLN1           1 2.2663e-09 112
## - FGF18           1 2.3142e-09 112
## - PITRM1          1 2.3385e-09 112
## - LOC643008       1 2.3474e-09 112
## - Contig32125_RC  1 2.5549e-09 112
## <none>              1.5492e-09 114
##
## Step:  AIC=112
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + RFC4 + CDCA7 + LOC643008 +
##     MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 +
##     PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 +
##     C20orf46
##
##                 Df   Deviance AIC
## - RFC4           1 1.6141e-09 110
## - CDCA7          1 1.6343e-09 110
## - Age            1 1.6405e-09 110
## - DIAPH3         1 1.6460e-09 110
## - ESM1           1 1.6475e-09 110
## - GMPS           1 1.6477e-09 110
## - FLT1           1 1.6495e-09 110
## - KNTC2          1 1.6611e-09 110
## - ORC6L          1 1.6786e-09 110
```

```
## - EXT1            1 1.6813e-09 110
## - DIAPH3.2        1 1.6819e-09 110
## - RTN4RL1         1 1.6896e-09 110
## - SCUBE2          1 1.6977e-09 110
## - PECI            1 1.7017e-09 110
## - UCHL5           1 1.7240e-09 110
## - DTL             1 1.7337e-09 110
## - DCK             1 1.7492e-09 110
## - C20orf46        1 1.7551e-09 110
## - Contig40831_RC  1 1.7646e-09 110
## - AP2B1           1 1.7759e-09 110
## - MTDH            1 1.7766e-09 110
## - C16orf61        1 1.7875e-09 110
## - ALDH4A1         1 1.7901e-09 110
## - SERF1A          1 1.7931e-09 110
## - RP5.860F19.3    1 1.7939e-09 110
## - Contig20217_RC  1 1.7960e-09 110
## - BBC3            1 1.8007e-09 110
## - AYTL2           1 1.8105e-09 110
## - TSPYL5          1 1.8260e-09 110
## - WISP1           1 1.8403e-09 110
## - CENPA           1 1.8446e-09 110
## - GPR126          1 1.8453e-09 110
## - MCM6            1 1.8667e-09 110
## - MMP9            1 1.8805e-09 110
## - QSCN6L1         1 1.8978e-09 110
## - Contig63649_RC  1 1.9250e-09 110
## - PRC1            1 1.9433e-09 110
## - LGP2            1 1.9556e-09 110
## - DIAPH3.1        1 1.9781e-09 110
## - OXCT1           1 1.9959e-09 110
## - IGFBP5          1 2.0231e-09 110
## - GPR180          1 2.0376e-09 110
## - SLC2A3          1 2.0631e-09 110
## - Diam            1 2.1019e-09 110
## - HRASLS          1 2.1456e-09 110
## - LymphNodes      1 2.1525e-09 110
## - PALM2.AKAP2     1 2.2795e-09 110
## - PECI.1          1 2.3178e-09 110
## - EGLN1           1 2.3190e-09 110
## - PITRM1          1 2.3695e-09 110
## - STK32B          1 2.3870e-09 110
## - NM_004702       1 2.4056e-09 110
## - FGF18           1 2.4115e-09 110
## - LOC643008       1 2.4196e-09 110
## - Contig32125_RC  1 2.6483e-09 110
## <none>              1.5809e-09 112
##
## Step:  AIC=110
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B +
```

```
##     DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + CDCA7 + LOC643008 +
##     MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 +
##     PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 +
##     C20orf46
##
##                   Df   Deviance AIC
## - CDCA7            1 1.6538e-09 108
## - DIAPH3           1 1.6666e-09 108
## - GMPS             1 1.6692e-09 108
## - DIAPH3.2         1 1.7000e-09 108
## - ORC6L            1 1.7104e-09 108
## - ESM1             1 1.7147e-09 108
## - KNTC2            1 1.7147e-09 108
## - Age              1 1.7154e-09 108
## - PECI             1 1.7198e-09 108
## - FLT1             1 1.7276e-09 108
## - EXT1             1 1.7343e-09 108
## - RTN4RL1          1 1.7456e-09 108
## - DTL              1 1.7502e-09 108
## - SCUBE2           1 1.7548e-09 108
## - C20orf46         1 1.7681e-09 108
## - UCHL5            1 1.7808e-09 108
## - DCK              1 1.7950e-09 108
## - Contig40831_RC   1 1.7981e-09 108
## - RP5.860F19.3     1 1.8112e-09 108
## - SERF1A           1 1.8224e-09 108
## - C16orf61         1 1.8227e-09 108
## - ALDH4A1          1 1.8239e-09 108
## - Contig20217_RC   1 1.8298e-09 108
## - AP2B1            1 1.8313e-09 108
## - AYTL2            1 1.8338e-09 108
## - WISP1            1 1.8637e-09 108
## - GPR126           1 1.8651e-09 108
## - TSPYL5           1 1.8668e-09 108
## - MTDH             1 1.8714e-09 108
## - CENPA            1 1.8718e-09 108
## - BBC3             1 1.8744e-09 108
## - MCM6             1 1.8813e-09 108
## - QSCN6L1          1 1.9200e-09 108
## - MMP9             1 1.9212e-09 108
## - Contig63649_RC   1 1.9442e-09 108
## - LGP2             1 1.9766e-09 108
## - PRC1             1 1.9899e-09 108
## - DIAPH3.1         1 2.0070e-09 108
## - IGFBP5           1 2.0425e-09 108
## - GPR180           1 2.0659e-09 108
## - OXCT1            1 2.0910e-09 108
## - Diam             1 2.1290e-09 108
## - HRASLS           1 2.1581e-09 108
## - LymphNodes       1 2.1736e-09 108
## - SLC2A3           1 2.1809e-09 108
## - PALM2.AKAP2      1 2.3417e-09 108
## - EGLN1            1 2.3438e-09 108
## - PECI.1           1 2.3653e-09 108
```

```
## - PITRM1          1 2.3989e-09 108
## - FGF18           1 2.4275e-09 108
## - NM_004702       1 2.4449e-09 108
## - STK32B          1 2.4650e-09 108
## - LOC643008       1 2.5559e-09 108
## - Contig32125_RC  1 2.7265e-09 108
## <none>              1.6141e-09 110
##
## Step:  AIC=108
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + DIAPH3 +
##     ALDH4A1 + QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 +
##     DIAPH3.2 + RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 +
##     OXCT1 + MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + ORC6L + LOC643008 + MCM6 +
##     AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 +
##     Contig20217_RC + CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - DIAPH3          1 1.6793e-09 106
## - GMPS            1 1.7026e-09 106
## - DIAPH3.2        1 1.7214e-09 106
## - ORC6L           1 1.7301e-09 106
## - PECI            1 1.7429e-09 106
## - Age             1 1.7489e-09 106
## - EXT1            1 1.7499e-09 106
## - SCUBE2          1 1.7620e-09 106
## - DTL             1 1.7728e-09 106
## - RTN4RL1         1 1.7835e-09 106
## - KNTC2           1 1.7859e-09 106
## - UCHL5           1 1.7934e-09 106
## - ESM1            1 1.7935e-09 106
## - FLT1            1 1.8022e-09 106
## - C20orf46        1 1.8051e-09 106
## - Contig40831_RC  1 1.8084e-09 106
## - SERF1A          1 1.8210e-09 106
## - RP5.860F19.3    1 1.8222e-09 106
## - DCK             1 1.8327e-09 106
## - AYTL2           1 1.8391e-09 106
## - C16orf61        1 1.8402e-09 106
## - ALDH4A1         1 1.8449e-09 106
## - Contig20217_RC  1 1.8469e-09 106
## - TSPYL5          1 1.8717e-09 106
## - MTDH            1 1.8756e-09 106
## - GPR126          1 1.8867e-09 106
## - MCM6            1 1.8919e-09 106
## - CENPA           1 1.8962e-09 106
## - AP2B1           1 1.9107e-09 106
## - BBC3            1 1.9195e-09 106
## - WISP1           1 1.9235e-09 106
## - MMP9            1 1.9445e-09 106
## - QSCN6L1         1 1.9477e-09 106
## - Contig63649_RC  1 1.9807e-09 106
## - DIAPH3.1        1 2.0172e-09 106
```

```
## - LGP2            1 2.0662e-09 106
## - PRC1            1 2.0866e-09 106
## - GPR180          1 2.1080e-09 106
## - OXCT1           1 2.1109e-09 106
## - Diam            1 2.1691e-09 106
## - IGFBP5          1 2.1917e-09 106
## - SLC2A3          1 2.1984e-09 106
## - LymphNodes      1 2.1992e-09 106
## - HRASLS          1 2.2128e-09 106
## - PALM2.AKAP2     1 2.3527e-09 106
## - PECI.1          1 2.4013e-09 106
## - EGLN1           1 2.4157e-09 106
## - NM_004702       1 2.4477e-09 106
## - FGF18           1 2.5116e-09 106
## - STK32B          1 2.5354e-09 106
## - PITRM1          1 2.6044e-09 106
## - Contig32125_RC  1 2.7306e-09 106
## - LOC643008       1 2.7767e-09 106
## <none>              1.6538e-09 108
##
## Step:  AIC=106
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + OXCT1 +
##     MMP9 + GMPS + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B + DCK +
##     GPR126 + SLC2A3 + PECI.1 + ORC6L + LOC643008 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - GMPS            1 1.7200e-09 104
## - ORC6L           1 1.7335e-09 104
## - EXT1            1 1.7517e-09 104
## - DIAPH3.2        1 1.7640e-09 104
## - PECI            1 1.7727e-09 104
## - DTL             1 1.8092e-09 104
## - ESM1            1 1.8108e-09 104
## - RTN4RL1         1 1.8124e-09 104
## - UCHL5           1 1.8184e-09 104
## - Age             1 1.8193e-09 104
## - KNTC2           1 1.8317e-09 104
## - Contig40831_RC  1 1.8373e-09 104
## - SERF1A          1 1.8471e-09 104
## - SCUBE2          1 1.8472e-09 104
## - RP5.860F19.3    1 1.8497e-09 104
## - AYTL2           1 1.8559e-09 104
## - Contig20217_RC  1 1.8645e-09 104
## - TSPYL5          1 1.8755e-09 104
## - ALDH4A1         1 1.8781e-09 104
## - FLT1            1 1.8846e-09 104
## - DCK             1 1.8865e-09 104
## - MTDH            1 1.8905e-09 104
## - C20orf46        1 1.8957e-09 104
```

```
## - C16orf61        1 1.8960e-09 104
## - GPR126          1 1.8977e-09 104
## - MCM6            1 1.9008e-09 104
## - AP2B1           1 1.9179e-09 104
## - WISP1           1 1.9248e-09 104
## - CENPA           1 1.9355e-09 104
## - QSCN6L1         1 1.9526e-09 104
## - BBC3            1 1.9837e-09 104
## - MMP9            1 1.9921e-09 104
## - Contig63649_RC  1 2.0280e-09 104
## - DIAPH3.1        1 2.0313e-09 104
## - LGP2            1 2.0807e-09 104
## - PRC1            1 2.0949e-09 104
## - GPR180          1 2.1282e-09 104
## - OXCT1           1 2.1302e-09 104
## - IGFBP5          1 2.1944e-09 104
## - SLC2A3          1 2.2126e-09 104
## - HRASLS          1 2.2379e-09 104
## - LymphNodes      1 2.2496e-09 104
## - Diam            1 2.2555e-09 104
## - PALM2.AKAP2     1 2.4035e-09 104
## - PECI.1          1 2.4201e-09 104
## - NM_004702       1 2.4619e-09 104
## - FGF18           1 2.5168e-09 104
## - STK32B          1 2.5451e-09 104
## - PITRM1          1 2.6431e-09 104
## - EGLN1           1 2.6647e-09 104
## - Contig32125_RC  1 2.7445e-09 104
## - LOC643008       1 2.7996e-09 104
## <none>              1.6793e-09 106
##
## Step:  AIC=104
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B + DCK +
##     GPR126 + SLC2A3 + PECI.1 + ORC6L + LOC643008 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - ORC6L           1 1.7553e-09 102
## - EXT1            1 1.7588e-09 102
## - DIAPH3.2        1 1.7739e-09 102
## - DTL             1 1.8161e-09 102
## - RTN4RL1         1 1.8252e-09 102
## - UCHL5           1 1.8313e-09 102
## - ESM1            1 1.8345e-09 102
## - PECI            1 1.8424e-09 102
## - Age             1 1.8471e-09 102
## - RP5.860F19.3    1 1.8690e-09 102
## - AYTL2           1 1.8726e-09 102
## - Contig40831_RC  1 1.8769e-09 102
```

```
## - SERF1A          1 1.8790e-09 102
## - KNTC2           1 1.9012e-09 102
## - C20orf46        1 1.9043e-09 102
## - ALDH4A1         1 1.9058e-09 102
## - GPR126          1 1.9120e-09 102
## - Contig20217_RC  1 1.9227e-09 102
## - SCUBE2          1 1.9334e-09 102
## - AP2B1           1 1.9381e-09 102
## - MTDH            1 1.9394e-09 102
## - CENPA           1 1.9491e-09 102
## - MCM6            1 1.9515e-09 102
## - WISP1           1 1.9780e-09 102
## - BBC3            1 2.0084e-09 102
## - MMP9            1 2.0105e-09 102
## - FLT1            1 2.0148e-09 102
## - TSPYL5          1 2.0175e-09 102
## - DCK             1 2.0193e-09 102
## - QSCN6L1         1 2.0240e-09 102
## - DIAPH3.1        1 2.0446e-09 102
## - C16orf61        1 2.0523e-09 102
## - Contig63649_RC  1 2.0571e-09 102
## - LGP2            1 2.1307e-09 102
## - GPR180          1 2.1783e-09 102
## - PRC1            1 2.1801e-09 102
## - SLC2A3          1 2.2179e-09 102
## - OXCT1           1 2.2264e-09 102
## - HRASLS          1 2.2486e-09 102
## - IGFBP5          1 2.2590e-09 102
## - Diam            1 2.2649e-09 102
## - LymphNodes      1 2.3661e-09 102
## - PALM2.AKAP2     1 2.4210e-09 102
## - NM_004702       1 2.4880e-09 102
## - PECI.1          1 2.5142e-09 102
## - FGF18           1 2.6081e-09 102
## - STK32B          1 2.6775e-09 102
## - PITRM1          1 2.7070e-09 102
## - Contig32125_RC  1 2.8474e-09 102
## - LOC643008       1 2.9232e-09 102
## - EGLN1           1 3.1027e-09 102
## <none>              1.7200e-09 104
##
## Step:  AIC=102
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + EXT1 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 + RTN4RL1 +
##     UCHL5 + PECI + MTDH + Contig40831_RC + DTL + STK32B + DCK +
##     GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 +
##     HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     CENPA + EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                  Df   Deviance AIC
## - EXT1            1 1.7796e-09 100
## - DIAPH3.2        1 1.8026e-09 100
```

```
## - UCHL5           1 1.8423e-09 100
## - RTN4RL1         1 1.8624e-09 100
## - ESM1            1 1.8665e-09 100
## - DTL             1 1.8796e-09 100
## - RP5.860F19.3    1 1.8841e-09 100
## - Age             1 1.8920e-09 100
## - PECI            1 1.8933e-09 100
## - Contig40831_RC  1 1.8948e-09 100
## - C20orf46        1 1.9091e-09 100
## - AYTL2           1 1.9279e-09 100
## - GPR126          1 1.9513e-09 100
## - AP2B1           1 1.9517e-09 100
## - MTDH            1 1.9519e-09 100
## - KNTC2           1 1.9540e-09 100
## - MCM6            1 1.9572e-09 100
## - CENPA           1 1.9610e-09 100
## - SERF1A          1 1.9649e-09 100
## - SCUBE2          1 1.9667e-09 100
## - WISP1           1 1.9901e-09 100
## - ALDH4A1         1 2.0068e-09 100
## - MMP9            1 2.0226e-09 100
## - TSPYL5          1 2.0268e-09 100
## - QSCN6L1         1 2.0493e-09 100
## - FLT1            1 2.0494e-09 100
## - BBC3            1 2.0527e-09 100
## - DIAPH3.1        1 2.0584e-09 100
## - C16orf61        1 2.0635e-09 100
## - Contig63649_RC  1 2.0762e-09 100
## - Contig20217_RC  1 2.0854e-09 100
## - DCK             1 2.1477e-09 100
## - LGP2            1 2.1904e-09 100
## - PRC1            1 2.1937e-09 100
## - GPR180          1 2.2095e-09 100
## - SLC2A3          1 2.2305e-09 100
## - OXCT1           1 2.2410e-09 100
## - HRASLS          1 2.2692e-09 100
## - Diam            1 2.2850e-09 100
## - LymphNodes      1 2.3812e-09 100
## - PALM2.AKAP2     1 2.4233e-09 100
## - IGFBP5          1 2.4243e-09 100
## - NM_004702       1 2.5097e-09 100
## - PECI.1          1 2.5468e-09 100
## - FGF18           1 2.6109e-09 100
## - STK32B          1 2.6987e-09 100
## - PITRM1          1 2.7112e-09 100
## - Contig32125_RC  1 2.9057e-09 100
## - LOC643008       1 3.1246e-09 100
## - EGLN1           1 3.1305e-09 100
## <none>              1.7553e-09 102
##
## Step:  AIC=100
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 +
```

```
##     KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 +
##     PECI + MTDH + Contig40831_RC + DTL + STK32B + DCK + GPR126 +
##     SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA +
##     EGLN1 + NM_004702 + ESM1 + C20orf46
##
##                   Df   Deviance AIC
## - ESM1             1 1.8748e-09  98
## - DIAPH3.2         1 1.8911e-09  98
## - RP5.860F19.3     1 1.8913e-09  98
## - Age              1 1.9049e-09  98
## - PECI             1 1.9082e-09  98
## - C20orf46         1 1.9105e-09  98
## - Contig40831_RC   1 1.9107e-09  98
## - UCHL5            1 1.9222e-09  98
## - RTN4RL1          1 1.9317e-09  98
## - AYTL2            1 1.9598e-09  98
## - MCM6             1 1.9730e-09  98
## - KNTC2            1 1.9733e-09  98
## - SERF1A           1 1.9736e-09  98
## - DTL              1 1.9810e-09  98
## - CENPA            1 1.9817e-09  98
## - AP2B1            1 1.9892e-09  98
## - WISP1            1 2.0089e-09  98
## - ALDH4A1          1 2.0347e-09  98
## - GPR126           1 2.0358e-09  98
## - MTDH             1 2.0496e-09  98
## - TSPYL5           1 2.0555e-09  98
## - SCUBE2           1 2.0695e-09  98
## - MMP9             1 2.0715e-09  98
## - BBC3             1 2.0729e-09  98
## - QSCN6L1          1 2.0850e-09  98
## - FLT1             1 2.1029e-09  98
## - Contig63649_RC   1 2.1037e-09  98
## - DIAPH3.1         1 2.1052e-09  98
## - C16orf61         1 2.1165e-09  98
## - Contig20217_RC   1 2.1573e-09  98
## - DCK              1 2.1800e-09  98
## - LGP2             1 2.1970e-09  98
## - PRC1             1 2.2517e-09  98
## - OXCT1            1 2.2551e-09  98
## - GPR180           1 2.2738e-09  98
## - HRASLS           1 2.2813e-09  98
## - SLC2A3           1 2.3990e-09  98
## - PALM2.AKAP2      1 2.4328e-09  98
## - IGFBP5           1 2.4476e-09  98
## - LymphNodes       1 2.4545e-09  98
## - Diam             1 2.4616e-09  98
## - NM_004702        1 2.5319e-09  98
## - PECI.1           1 2.5588e-09  98
## - PITRM1           1 2.7184e-09  98
## - FGF18            1 2.7970e-09  98
## - STK32B           1 2.9273e-09  98
## - Contig32125_RC   1 3.0398e-09  98
```

```
## - EGLN1           1 3.1993e-09  98
## - LOC643008       1 3.4471e-09  98
## <none>              1.7796e-09 100
##
## Step:  AIC=98
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     RP5.860F19.3 + C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 +
##     KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 +
##     PECI + MTDH + Contig40831_RC + DTL + STK32B + DCK + GPR126 +
##     SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + CENPA +
##     EGLN1 + NM_004702 + C20orf46
##
##                  Df   Deviance AIC
## - RP5.860F19.3    1 1.9266e-09  96
## - C20orf46        1 1.9481e-09  96
## - RTN4RL1         1 1.9811e-09  96
## - SERF1A          1 1.9948e-09  96
## - Age             1 2.0062e-09  96
## - AP2B1           1 2.0136e-09  96
## - PECI            1 2.0191e-09  96
## - DTL             1 2.0253e-09  96
## - DIAPH3.2        1 2.0448e-09  96
## - CENPA           1 2.0574e-09  96
## - Contig40831_RC  1 2.0687e-09  96
## - KNTC2           1 2.0814e-09  96
## - AYTL2           1 2.0873e-09  96
## - UCHL5           1 2.0935e-09  96
## - ALDH4A1         1 2.1119e-09  96
## - GPR126          1 2.1124e-09  96
## - FLT1            1 2.1171e-09  96
## - SCUBE2          1 2.1347e-09  96
## - BBC3            1 2.1433e-09  96
## - C16orf61        1 2.1607e-09  96
## - MTDH            1 2.1748e-09  96
## - Contig20217_RC  1 2.2179e-09  96
## - QSCN6L1         1 2.2200e-09  96
## - MCM6            1 2.2539e-09  96
## - PRC1            1 2.2601e-09  96
## - HRASLS          1 2.2902e-09  96
## - GPR180          1 2.2904e-09  96
## - DCK             1 2.2921e-09  96
## - WISP1           1 2.3362e-09  96
## - DIAPH3.1        1 2.3409e-09  96
## - Contig63649_RC  1 2.3488e-09  96
## - TSPYL5          1 2.3533e-09  96
## - MMP9            1 2.3655e-09  96
## - PALM2.AKAP2     1 2.4391e-09  96
## - IGFBP5          1 2.4708e-09  96
## - LGP2            1 2.5043e-09  96
## - NM_004702       1 2.5378e-09  96
## - Diam            1 2.5518e-09  96
## - PECI.1          1 2.5935e-09  96
```

```
## - LymphNodes      1 2.6631e-09  96
## - PITRM1          1 2.7204e-09  96
## - SLC2A3          1 2.7414e-09  96
## - OXCT1           1 2.7653e-09  96
## - FGF18           1 2.8644e-09  96
## - Contig32125_RC  1 3.0539e-09  96
## - EGLN1           1 3.1868e-09  96
## - STK32B          1 3.3148e-09  96
## - LOC643008       1 4.0303e-09  96
## <none>              1.8748e-09  98
##
## Step:  AIC=96
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702 +
##     C20orf46
##
##                  Df   Deviance AIC
## - C20orf46        1 1.9777e-09  94
## - AP2B1           1 2.0574e-09  94
## - Age             1 2.0638e-09  94
## - CENPA           1 2.0720e-09  94
## - RTN4RL1         1 2.0863e-09  94
## - Contig40831_RC  1 2.0962e-09  94
## - DTL             1 2.1008e-09  94
## - DIAPH3.2        1 2.1068e-09  94
## - SERF1A          1 2.1163e-09  94
## - ALDH4A1         1 2.1171e-09  94
## - GPR126          1 2.1184e-09  94
## - AYTL2           1 2.1278e-09  94
## - FLT1            1 2.1359e-09  94
## - PECI            1 2.1508e-09  94
## - UCHL5           1 2.1779e-09  94
## - MTDH            1 2.1846e-09  94
## - BBC3            1 2.2097e-09  94
## - C16orf61        1 2.2219e-09  94
## - QSCN6L1         1 2.2257e-09  94
## - KNTC2           1 2.2422e-09  94
## - PRC1            1 2.2617e-09  94
## - GPR180          1 2.2965e-09  94
## - DCK             1 2.3162e-09  94
## - HRASLS          1 2.3324e-09  94
## - Contig20217_RC  1 2.3344e-09  94
## - MCM6            1 2.3360e-09  94
## - SCUBE2          1 2.3416e-09  94
## - WISP1           1 2.3504e-09  94
## - TSPYL5          1 2.3871e-09  94
## - MMP9            1 2.3938e-09  94
## - PALM2.AKAP2     1 2.4368e-09  94
## - DIAPH3.1        1 2.4381e-09  94
```

```
## - LGP2            1 2.5296e-09  94
## - Contig63649_RC  1 2.5431e-09  94
## - NM_004702       1 2.6061e-09  94
## - IGFBP5          1 2.6098e-09  94
## - Diam            1 2.6465e-09  94
## - PITRM1          1 2.7390e-09  94
## - SLC2A3          1 2.7512e-09  94
## - LymphNodes      1 2.8172e-09  94
## - FGF18           1 2.9104e-09  94
## - OXCT1           1 2.9452e-09  94
## - PECI.1          1 2.9469e-09  94
## - Contig32125_RC  1 3.0986e-09  94
## - EGLN1           1 3.2086e-09  94
## - STK32B          1 3.3374e-09  94
## - LOC643008       1 4.1745e-09  94
## <none>              1.9266e-09  96
##
## Step:  AIC=94
## Event ~ Diam + LymphNodes + Age + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - Age             1 2.0755e-09  92
## - CENPA           1 2.1066e-09  92
## - DTL             1 2.1111e-09  92
## - SERF1A          1 2.1281e-09  92
## - AP2B1           1 2.1380e-09  92
## - FLT1            1 2.1435e-09  92
## - ALDH4A1         1 2.1441e-09  92
## - GPR126          1 2.1534e-09  92
## - RTN4RL1         1 2.1734e-09  92
## - Contig40831_RC  1 2.1859e-09  92
## - UCHL5           1 2.1884e-09  92
## - DIAPH3.2        1 2.1940e-09  92
## - MTDH            1 2.2083e-09  92
## - QSCN6L1         1 2.2275e-09  92
## - AYTL2           1 2.2411e-09  92
## - KNTC2           1 2.2519e-09  92
## - BBC3            1 2.2589e-09  92
## - C16orf61        1 2.2994e-09  92
## - PECI            1 2.3060e-09  92
## - MCM6            1 2.3408e-09  92
## - GPR180          1 2.3621e-09  92
## - PRC1            1 2.3806e-09  92
## - DCK             1 2.4119e-09  92
## - SCUBE2          1 2.4177e-09  92
## - MMP9            1 2.4191e-09  92
## - WISP1           1 2.4212e-09  92
## - PALM2.AKAP2     1 2.4725e-09  92
```

```
## - TSPYL5          1 2.5059e-09  92
## - HRASLS          1 2.5091e-09  92
## - DIAPH3.1        1 2.5517e-09  92
## - Contig63649_RC  1 2.5712e-09  92
## - Contig20217_RC  1 2.5800e-09  92
## - NM_004702       1 2.6318e-09  92
## - IGFBP5          1 2.6380e-09  92
## - Diam            1 2.6587e-09  92
## - LGP2            1 2.8175e-09  92
## - SLC2A3          1 2.8998e-09  92
## - FGF18           1 2.9626e-09  92
## - LymphNodes      1 2.9655e-09  92
## - PITRM1          1 3.0054e-09  92
## - OXCT1           1 3.1174e-09  92
## - Contig32125_RC  1 3.1269e-09  92
## - EGLN1           1 3.2427e-09  92
## - PECI.1          1 3.2663e-09  92
## - STK32B          1 3.3527e-09  92
## - LOC643008       1 4.3924e-09  92
## <none>              1.9777e-09  94
##
## Step:  AIC=92
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + DTL + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - DTL             1 2.1505e-09  90
## - AP2B1           1 2.1561e-09  90
## - FLT1            1 2.1947e-09  90
## - SERF1A          1 2.1981e-09  90
## - CENPA           1 2.2212e-09  90
## - Contig40831_RC  1 2.2399e-09  90
## - ALDH4A1         1 2.2405e-09  90
## - DIAPH3.2        1 2.2479e-09  90
## - MTDH            1 2.2893e-09  90
## - RTN4RL1         1 2.2932e-09  90
## - AYTL2           1 2.2945e-09  90
## - QSCN6L1         1 2.2982e-09  90
## - BBC3            1 2.3034e-09  90
## - GPR126          1 2.3046e-09  90
## - PECI            1 2.3276e-09  90
## - UCHL5           1 2.3311e-09  90
## - KNTC2           1 2.3469e-09  90
## - C16orf61        1 2.3883e-09  90
## - MCM6            1 2.4183e-09  90
## - PRC1            1 2.4431e-09  90
## - GPR180          1 2.4641e-09  90
## - DCK             1 2.4709e-09  90
## - PALM2.AKAP2     1 2.4802e-09  90
```

```
## - TSPYL5          1 2.5215e-09  90
## - SCUBE2          1 2.5519e-09  90
## - WISP1           1 2.5820e-09  90
## - HRASLS          1 2.5935e-09  90
## - MMP9            1 2.6376e-09  90
## - Contig20217_RC  1 2.6416e-09  90
## - DIAPH3.1        1 2.6575e-09  90
## - Contig63649_RC  1 2.6738e-09  90
## - IGFBP5          1 2.7817e-09  90
## - Diam            1 2.9588e-09  90
## - LGP2            1 2.9765e-09  90
## - SLC2A3          1 2.9846e-09  90
## - NM_004702       1 3.0195e-09  90
## - PITRM1          1 3.0309e-09  90
## - LymphNodes      1 3.0988e-09  90
## - Contig32125_RC  1 3.1341e-09  90
## - FGF18           1 3.2205e-09  90
## - EGLN1           1 3.2503e-09  90
## - PECI.1          1 3.2687e-09  90
## - OXCT1           1 3.3716e-09  90
## - STK32B          1 3.5924e-09  90
## - LOC643008       1 4.8263e-09  90
## <none>              2.0755e-09  92
##
## Step:  AIC=90
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + CENPA + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - CENPA           1 2.2566e-09  88
## - DIAPH3.2        1 2.2846e-09  88
## - ALDH4A1         1 2.2957e-09  88
## - Contig40831_RC  1 2.3123e-09  88
## - SERF1A          1 2.3223e-09  88
## - PECI            1 2.3337e-09  88
## - AYTL2           1 2.3411e-09  88
## - RTN4RL1         1 2.3459e-09  88
## - MTDH            1 2.3467e-09  88
## - FLT1            1 2.3774e-09  88
## - QSCN6L1         1 2.3980e-09  88
## - BBC3            1 2.4107e-09  88
## - AP2B1           1 2.4300e-09  88
## - KNTC2           1 2.4303e-09  88
## - UCHL5           1 2.4637e-09  88
## - PALM2.AKAP2     1 2.5374e-09  88
## - MCM6            1 2.5536e-09  88
## - WISP1           1 2.5927e-09  88
## - GPR126          1 2.6338e-09  88
## - GPR180          1 2.6440e-09  88
```

```
## - DCK             1 2.6514e-09  88
## - HRASLS          1 2.6597e-09  88
## - Contig20217_RC  1 2.6621e-09  88
## - TSPYL5          1 2.6679e-09  88
## - PRC1            1 2.6788e-09  88
## - MMP9            1 2.7049e-09  88
## - Contig63649_RC  1 2.7093e-09  88
## - SCUBE2          1 2.7130e-09  88
## - C16orf61        1 2.7867e-09  88
## - IGFBP5          1 2.8082e-09  88
## - Diam            1 2.9642e-09  88
## - LGP2            1 2.9818e-09  88
## - NM_004702       1 3.0473e-09  88
## - SLC2A3          1 3.0975e-09  88
## - DIAPH3.1        1 3.1001e-09  88
## - PITRM1          1 3.1545e-09  88
## - FGF18           1 3.2261e-09  88
## - PECI.1          1 3.2903e-09  88
## - EGLN1           1 3.3574e-09  88
## - LymphNodes      1 3.3957e-09  88
## - Contig32125_RC  1 3.4222e-09  88
## - STK32B          1 3.6660e-09  88
## - OXCT1           1 3.7079e-09  88
## - LOC643008       1 4.9000e-09  88
## <none>              2.1505e-09  90
##
## Step:  AIC=88
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + DIAPH3.2 +
##     C16orf61 + SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 +
##     SERF1A + AYTL2 + GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH +
##     Contig40831_RC + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - DIAPH3.2        1 2.3666e-09  86
## - Contig40831_RC  1 2.3733e-09  86
## - ALDH4A1         1 2.3983e-09  86
## - RTN4RL1         1 2.4143e-09  86
## - SERF1A          1 2.4205e-09  86
## - MTDH            1 2.4584e-09  86
## - KNTC2           1 2.4612e-09  86
## - FLT1            1 2.4825e-09  86
## - BBC3            1 2.4883e-09  86
## - QSCN6L1         1 2.5045e-09  86
## - AYTL2           1 2.5084e-09  86
## - UCHL5           1 2.5313e-09  86
## - AP2B1           1 2.5461e-09  86
## - PALM2.AKAP2     1 2.5711e-09  86
## - MCM6            1 2.5755e-09  86
## - PECI            1 2.5986e-09  86
## - GPR126          1 2.6449e-09  86
## - HRASLS          1 2.6575e-09  86
```

```
## - DCK             1 2.6953e-09  86
## - WISP1           1 2.6986e-09  86
## - Contig63649_RC  1 2.7116e-09  86
## - PRC1            1 2.7173e-09  86
## - GPR180          1 2.7614e-09  86
## - C16orf61        1 2.8076e-09  86
## - SCUBE2          1 2.8198e-09  86
## - MMP9            1 2.8498e-09  86
## - Contig20217_RC  1 2.9327e-09  86
## - TSPYL5          1 2.9888e-09  86
## - LGP2            1 3.0634e-09  86
## - IGFBP5          1 3.0844e-09  86
## - DIAPH3.1        1 3.1081e-09  86
## - SLC2A3          1 3.1216e-09  86
## - Diam            1 3.1505e-09  86
## - FGF18           1 3.2661e-09  86
## - PITRM1          1 3.2675e-09  86
## - NM_004702       1 3.3446e-09  86
## - LymphNodes      1 3.4134e-09  86
## - Contig32125_RC  1 3.4260e-09  86
## - PECI.1          1 3.5287e-09  86
## - EGLN1           1 3.9727e-09  86
## - STK32B          1 4.1238e-09  86
## - OXCT1           1 4.4253e-09  86
## - LOC643008       1 5.5658e-09  86
## <none>              2.2566e-09  88
##
## Step:  AIC=86
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + ALDH4A1 +
##     QSCN6L1 + FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 +
##     SCUBE2 + FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 +
##     GPR180 + RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC +
##     STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 +
##     AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 +
##     Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - ALDH4A1         1 2.4586e-09  84
## - Contig40831_RC  1 2.4615e-09  84
## - QSCN6L1         1 2.5338e-09  84
## - FLT1            1 2.5401e-09  84
## - MTDH            1 2.5427e-09  84
## - RTN4RL1         1 2.5495e-09  84
## - AYTL2           1 2.5535e-09  84
## - KNTC2           1 2.5757e-09  84
## - PALM2.AKAP2     1 2.5937e-09  84
## - SERF1A          1 2.6025e-09  84
## - UCHL5           1 2.6313e-09  84
## - MCM6            1 2.6347e-09  84
## - PECI            1 2.6407e-09  84
## - BBC3            1 2.6433e-09  84
## - HRASLS          1 2.6805e-09  84
## - AP2B1           1 2.6995e-09  84
## - Contig63649_RC  1 2.7280e-09  84
```

```
## - DCK             1 2.7281e-09  84
## - GPR126          1 2.7482e-09  84
## - PRC1            1 2.7780e-09  84
## - WISP1           1 2.8229e-09  84
## - GPR180          1 2.8347e-09  84
## - SCUBE2          1 2.8647e-09  84
## - MMP9            1 2.9575e-09  84
## - Contig20217_RC  1 2.9743e-09  84
## - C16orf61        1 3.0730e-09  84
## - TSPYL5          1 3.0882e-09  84
## - IGFBP5          1 3.1010e-09  84
## - DIAPH3.1        1 3.1200e-09  84
## - SLC2A3          1 3.1297e-09  84
## - LGP2            1 3.1536e-09  84
## - Diam            1 3.1899e-09  84
## - FGF18           1 3.2782e-09  84
## - NM_004702       1 3.3886e-09  84
## - PITRM1          1 3.4796e-09  84
## - Contig32125_RC  1 3.5408e-09  84
## - LymphNodes      1 3.6785e-09  84
## - PECI.1          1 3.7010e-09  84
## - EGLN1           1 3.9960e-09  84
## - STK32B          1 4.2510e-09  84
## - OXCT1           1 4.4386e-09  84
## - LOC643008       1 6.1560e-09  84
## <none>              2.3666e-09  86
##
## Step:  AIC=84
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + Contig40831_RC + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - Contig40831_RC  1 2.5280e-09  82
## - RTN4RL1         1 2.5826e-09  82
## - FLT1            1 2.6304e-09  82
## - AYTL2           1 2.6717e-09  82
## - PECI            1 2.6720e-09  82
## - QSCN6L1         1 2.7093e-09  82
## - SERF1A          1 2.7410e-09  82
## - BBC3            1 2.7537e-09  82
## - MTDH            1 2.7825e-09  82
## - HRASLS          1 2.8000e-09  82
## - MCM6            1 2.8199e-09  82
## - WISP1           1 2.8487e-09  82
## - KNTC2           1 2.8693e-09  82
## - GPR126          1 2.8699e-09  82
## - AP2B1           1 2.8788e-09  82
## - DCK             1 2.8827e-09  82
## - SCUBE2          1 2.9645e-09  82
```

```
## - Contig20217_RC  1 2.9727e-09  82
## - PALM2.AKAP2     1 2.9808e-09  82
## - MMP9            1 2.9946e-09  82
## - PRC1            1 3.0158e-09  82
## - GPR180          1 3.0547e-09  82
## - C16orf61        1 3.1229e-09  82
## - UCHL5           1 3.2147e-09  82
## - Contig63649_RC  1 3.2303e-09  82
## - TSPYL5          1 3.2808e-09  82
## - FGF18           1 3.2810e-09  82
## - LGP2            1 3.3076e-09  82
## - IGFBP5          1 3.3277e-09  82
## - PITRM1          1 3.4702e-09  82
## - NM_004702       1 3.5849e-09  82
## - Contig32125_RC  1 3.6472e-09  82
## - PECI.1          1 3.7711e-09  82
## - SLC2A3          1 3.8064e-09  82
## - DIAPH3.1        1 3.8502e-09  82
## - Diam            1 3.8550e-09  82
## - LymphNodes      1 4.0787e-09  82
## - EGLN1           1 4.1172e-09  82
## - STK32B          1 4.3407e-09  82
## - OXCT1           1 4.9532e-09  82
## - LOC643008       1 6.3213e-09  82
## <none>              2.4586e-09  84
##
## Step:  AIC=82
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     RTN4RL1 + UCHL5 + PECI + MTDH + STK32B + DCK + GPR126 + SLC2A3 +
##     PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 +
##     PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - RTN4RL1         1 2.6833e-09  80
## - QSCN6L1         1 2.7569e-09  80
## - SERF1A          1 2.7715e-09  80
## - PECI            1 2.7898e-09  80
## - AYTL2           1 2.7919e-09  80
## - FLT1            1 2.8507e-09  80
## - BBC3            1 2.8750e-09  80
## - AP2B1           1 2.8921e-09  80
## - DCK             1 2.8974e-09  80
## - MCM6            1 2.9087e-09  80
## - GPR126          1 2.9237e-09  80
## - HRASLS          1 2.9456e-09  80
## - MTDH            1 2.9813e-09  80
## - Contig20217_RC  1 2.9841e-09  80
## - WISP1           1 3.0325e-09  80
## - PRC1            1 3.0464e-09  80
## - PALM2.AKAP2     1 3.0486e-09  80
## - SCUBE2          1 3.0536e-09  80
## - C16orf61        1 3.1575e-09  80
```

```
## - MMP9            1 3.2762e-09  80
## - TSPYL5          1 3.3089e-09  80
## - IGFBP5          1 3.3519e-09  80
## - GPR180          1 3.3766e-09  80
## - KNTC2           1 3.3802e-09  80
## - FGF18           1 3.4221e-09  80
## - PITRM1          1 3.4795e-09  80
## - LGP2            1 3.5467e-09  80
## - UCHL5           1 3.6267e-09  80
## - NM_004702       1 3.6330e-09  80
## - Contig63649_RC  1 3.6757e-09  80
## - Contig32125_RC  1 3.7081e-09  80
## - PECI.1          1 3.7789e-09  80
## - SLC2A3          1 3.8648e-09  80
## - DIAPH3.1        1 4.0215e-09  80
## - Diam            1 4.0328e-09  80
## - LymphNodes      1 4.1848e-09  80
## - EGLN1           1 4.4429e-09  80
## - OXCT1           1 5.5192e-09  80
## - STK32B          1 6.1329e-09  80
## - LOC643008       1 6.4377e-09  80
## <none>              2.5280e-09  82
##
## Step:  AIC=80
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     UCHL5 + PECI + MTDH + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - PECI            1 2.8270e-09  78
## - AYTL2           1 2.8761e-09  78
## - SERF1A          1 2.8899e-09  78
## - QSCN6L1         1 2.9490e-09  78
## - MCM6            1 2.9873e-09  78
## - BBC3            1 3.0559e-09  78
## - MTDH            1 3.0805e-09  78
## - PRC1            1 3.1599e-09  78
## - AP2B1           1 3.1668e-09  78
## - FLT1            1 3.1709e-09  78
## - SCUBE2          1 3.1718e-09  78
## - WISP1           1 3.1771e-09  78
## - HRASLS          1 3.2006e-09  78
## - DCK             1 3.2062e-09  78
## - PALM2.AKAP2     1 3.2641e-09  78
## - Contig20217_RC  1 3.3050e-09  78
## - C16orf61        1 3.3148e-09  78
## - GPR126          1 3.3178e-09  78
## - GPR180          1 3.3871e-09  78
## - KNTC2           1 3.4321e-09  78
## - LGP2            1 3.5676e-09  78
## - TSPYL5          1 3.5716e-09  78
```

```
## - FGF18           1 3.6615e-09  78
## - PITRM1          1 3.6874e-09  78
## - NM_004702       1 3.7471e-09  78
## - PECI.1          1 3.7930e-09  78
## - MMP9            1 3.8372e-09  78
## - UCHL5           1 3.8553e-09  78
## - SLC2A3          1 3.8943e-09  78
## - Contig32125_RC  1 3.9509e-09  78
## - Diam            1 4.1196e-09  78
## - Contig63649_RC  1 4.2184e-09  78
## - IGFBP5          1 4.2251e-09  78
## - LymphNodes      1 4.4789e-09  78
## - EGLN1           1 4.6364e-09  78
## - DIAPH3.1        1 4.7156e-09  78
## - LOC643008       1 6.5528e-09  78
## - STK32B          1 6.7186e-09  78
## - OXCT1           1 1.0215e-08  78
## <none>              2.6833e-09  80
##
## Step:  AIC=78
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + AYTL2 + GPR180 +
##     UCHL5 + MTDH + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + PRC1 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - AYTL2           1 2.9340e-09  76
## - SERF1A          1 3.0366e-09  76
## - QSCN6L1         1 3.1293e-09  76
## - MCM6            1 3.1880e-09  76
## - FLT1            1 3.2378e-09  76
## - SCUBE2          1 3.2460e-09  76
## - DCK             1 3.2685e-09  76
## - PALM2.AKAP2     1 3.3282e-09  76
## - HRASLS          1 3.3486e-09  76
## - PRC1            1 3.3806e-09  76
## - MTDH            1 3.4394e-09  76
## - BBC3            1 3.4472e-09  76
## - GPR126          1 3.4490e-09  76
## - WISP1           1 3.4736e-09  76
## - LGP2            1 3.5955e-09  76
## - AP2B1           1 3.5982e-09  76
## - C16orf61        1 3.6610e-09  76
## - KNTC2           1 3.6707e-09  76
## - TSPYL5          1 3.7143e-09  76
## - FGF18           1 3.7219e-09  76
## - NM_004702       1 3.7688e-09  76
## - GPR180          1 3.7919e-09  76
## - MMP9            1 3.8792e-09  76
## - UCHL5           1 3.9991e-09  76
## - Contig32125_RC  1 4.0982e-09  76
## - Contig20217_RC  1 4.1266e-09  76
```

```
## - PITRM1          1 4.2128e-09  76
## - Contig63649_RC  1 4.4728e-09  76
## - Diam            1 4.5177e-09  76
## - SLC2A3          1 4.5763e-09  76
## - LymphNodes      1 4.6112e-09  76
## - IGFBP5          1 4.6975e-09  76
## - PECI.1          1 4.8332e-09  76
## - DIAPH3.1        1 4.8640e-09  76
## - EGLN1           1 5.2436e-09  76
## - LOC643008       1 6.7508e-09  76
## - STK32B          1 8.4369e-09  76
## - OXCT1           1 1.0332e-08  76
## <none>              2.8270e-09  78
##
## Step:  AIC=76
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + SERF1A + GPR180 + UCHL5 +
##     MTDH + STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + LOC643008 +
##     MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 +
##     PRC1 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - SERF1A          1 3.0472e-09  74
## - QSCN6L1         1 3.2011e-09  74
## - FLT1            1 3.3099e-09  74
## - PALM2.AKAP2     1 3.3609e-09  74
## - SCUBE2          1 3.4204e-09  74
## - DCK             1 3.4294e-09  74
## - MCM6            1 3.5001e-09  74
## - MTDH            1 3.5549e-09  74
## - WISP1           1 3.5993e-09  74
## - LGP2            1 3.6543e-09  74
## - C16orf61        1 3.6863e-09  74
## - TSPYL5          1 3.7178e-09  74
## - PRC1            1 3.7181e-09  74
## - FGF18           1 3.7417e-09  74
## - GPR126          1 3.7809e-09  74
## - GPR180          1 3.8360e-09  74
## - NM_004702       1 3.8626e-09  74
## - HRASLS          1 3.9823e-09  74
## - UCHL5           1 3.9876e-09  74
## - MMP9            1 4.0153e-09  74
## - AP2B1           1 4.1202e-09  74
## - Contig32125_RC  1 4.1707e-09  74
## - Contig20217_RC  1 4.1897e-09  74
## - BBC3            1 4.1975e-09  74
## - PITRM1          1 4.2180e-09  74
## - KNTC2           1 4.2399e-09  74
## - Contig63649_RC  1 4.4660e-09  74
## - IGFBP5          1 4.8061e-09  74
## - PECI.1          1 4.8685e-09  74
## - SLC2A3          1 4.9246e-09  74
## - DIAPH3.1        1 4.9826e-09  74
```

```
## - EGLN1           1 5.3846e-09  74
## - Diam            1 5.4700e-09  74
## - LymphNodes      1 5.4896e-09  74
## - LOC643008       1 7.3785e-09  74
## - STK32B          1 8.8720e-09  74
## - OXCT1           1 1.1205e-08  74
## <none>              2.9340e-09  76
##
## Step:  AIC=74
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + QSCN6L1 +
##     FGF18 + DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 +
##     FLT1 + OXCT1 + MMP9 + KNTC2 + WISP1 + GPR180 + UCHL5 + MTDH +
##     STK32B + DCK + GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 +
##     AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 +
##     Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - QSCN6L1         1 3.3812e-09  72
## - FLT1            1 3.4064e-09  72
## - SCUBE2          1 3.4950e-09  72
## - PALM2.AKAP2     1 3.5282e-09  72
## - MTDH            1 3.6115e-09  72
## - WISP1           1 3.6264e-09  72
## - DCK             1 3.7166e-09  72
## - C16orf61        1 3.8067e-09  72
## - LGP2            1 3.8314e-09  72
## - PRC1            1 3.8321e-09  72
## - GPR126          1 3.8519e-09  72
## - TSPYL5          1 3.9022e-09  72
## - NM_004702       1 3.9606e-09  72
## - UCHL5           1 3.9820e-09  72
## - GPR180          1 4.0313e-09  72
## - MCM6            1 4.1395e-09  72
## - KNTC2           1 4.2452e-09  72
## - AP2B1           1 4.2942e-09  72
## - HRASLS          1 4.4083e-09  72
## - FGF18           1 4.4122e-09  72
## - BBC3            1 4.4632e-09  72
## - PITRM1          1 4.5645e-09  72
## - Contig63649_RC  1 4.6148e-09  72
## - Contig20217_RC  1 4.9676e-09  72
## - DIAPH3.1        1 4.9832e-09  72
## - IGFBP5          1 5.2955e-09  72
## - PECI.1          1 5.3047e-09  72
## - Contig32125_RC  1 5.3289e-09  72
## - EGLN1           1 5.3884e-09  72
## - MMP9            1 5.5168e-09  72
## - Diam            1 5.8577e-09  72
## - LymphNodes      1 7.1548e-09  72
## - SLC2A3          1 7.6399e-09  72
## - LOC643008       1 8.4629e-09  72
## - STK32B          1 9.1457e-09  72
## - OXCT1           1 1.1336e-08  72
## <none>              3.0472e-09  74
```

```
##
## Step:  AIC=72
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + SCUBE2 + FLT1 +
##     OXCT1 + MMP9 + KNTC2 + WISP1 + GPR180 + UCHL5 + MTDH + STK32B +
##     DCK + GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 +
##     IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - SCUBE2          1 3.5156e-09  70
## - PALM2.AKAP2     1 3.5362e-09  70
## - WISP1           1 3.6843e-09  70
## - FLT1            1 3.8334e-09  70
## - PRC1            1 3.8496e-09  70
## - MTDH            1 3.8531e-09  70
## - GPR126          1 3.8919e-09  70
## - NM_004702       1 3.9732e-09  70
## - LGP2            1 4.0153e-09  70
## - TSPYL5          1 4.0457e-09  70
## - GPR180          1 4.0781e-09  70
## - C16orf61        1 4.1920e-09  70
## - MCM6            1 4.2059e-09  70
## - KNTC2           1 4.2773e-09  70
## - AP2B1           1 4.4143e-09  70
## - BBC3            1 4.5124e-09  70
## - FGF18           1 4.6080e-09  70
## - PITRM1          1 4.7170e-09  70
## - DCK             1 4.8658e-09  70
## - HRASLS          1 5.0207e-09  70
## - PECI.1          1 5.4284e-09  70
## - EGLN1           1 5.5289e-09  70
## - Contig20217_RC  1 5.5495e-09  70
## - IGFBP5          1 5.5620e-09  70
## - MMP9            1 5.7227e-09  70
## - Contig32125_RC  1 5.7548e-09  70
## - Diam            1 5.9830e-09  70
## - UCHL5           1 6.1649e-09  70
## - DIAPH3.1        1 6.3898e-09  70
## - LymphNodes      1 7.3905e-09  70
## - Contig63649_RC  1 7.7807e-09  70
## - SLC2A3          1 9.3749e-09  70
## - LOC643008       1 1.0414e-08  70
## - OXCT1           1 1.1509e-08  70
## - STK32B          1 1.3098e-08  70
## <none>              3.3812e-09  72
##
## Step:  AIC=70
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + WISP1 + GPR180 + UCHL5 + MTDH + STK32B + DCK +
##     GPR126 + SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 +
##     HRASLS + PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC +
##     EGLN1 + NM_004702
```

```
##
##                  Df   Deviance AIC
## - WISP1           1 3.7064e-09  68
## - PRC1            1 3.8553e-09  68
## - GPR126          1 3.9100e-09  68
## - NM_004702       1 3.9628e-09  68
## - LGP2            1 4.0265e-09  68
## - PALM2.AKAP2     1 4.3272e-09  68
## - TSPYL5          1 4.3346e-09  68
## - C16orf61        1 4.4031e-09  68
## - FLT1            1 4.4092e-09  68
## - MTDH            1 4.4414e-09  68
## - BBC3            1 4.5964e-09  68
## - AP2B1           1 4.6072e-09  68
## - GPR180          1 4.6537e-09  68
## - PITRM1          1 4.7611e-09  68
## - KNTC2           1 4.8332e-09  68
## - DCK             1 4.9457e-09  68
## - FGF18           1 5.0442e-09  68
## - PECI.1          1 5.4755e-09  68
## - EGLN1           1 5.5684e-09  68
## - HRASLS          1 5.6350e-09  68
## - MCM6            1 5.8241e-09  68
## - Contig20217_RC  1 5.9663e-09  68
## - Diam            1 6.2371e-09  68
## - IGFBP5          1 6.2508e-09  68
## - MMP9            1 6.4965e-09  68
## - DIAPH3.1        1 6.5290e-09  68
## - UCHL5           1 6.6128e-09  68
## - Contig32125_RC  1 7.0472e-09  68
## - Contig63649_RC  1 8.9456e-09  68
## - LymphNodes      1 9.4575e-09  68
## - OXCT1           1 1.2514e-08  68
## - SLC2A3          1 1.2607e-08  68
## - LOC643008       1 1.3376e-08  68
## - STK32B          1 1.6227e-08  68
## <none>              3.5156e-09  70
##
## Step:  AIC=68
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + GPR126 +
##     SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + PRC1 + Contig20217_RC + EGLN1 +
##     NM_004702
##
##                  Df   Deviance AIC
## - PRC1            1 3.9832e-09  66
## - GPR126          1 4.0443e-09  66
## - NM_004702       1 4.2027e-09  66
## - TSPYL5          1 4.3641e-09  66
## - C16orf61        1 4.4549e-09  66
## - LGP2            1 4.5627e-09  66
## - MTDH            1 4.6041e-09  66
```

```
## - BBC3            1 4.6041e-09  66
## - AP2B1           1 4.6218e-09  66
## - GPR180          1 4.6718e-09  66
## - PALM2.AKAP2     1 4.7806e-09  66
## - FLT1            1 4.8279e-09  66
## - PITRM1          1 5.0597e-09  66
## - FGF18           1 5.0787e-09  66
## - KNTC2           1 5.3840e-09  66
## - DCK             1 5.3892e-09  66
## - EGLN1           1 5.6071e-09  66
## - HRASLS          1 5.7025e-09  66
## - Contig20217_RC  1 6.2513e-09  66
## - MCM6            1 6.4845e-09  66
## - DIAPH3.1        1 6.5742e-09  66
## - IGFBP5          1 6.6150e-09  66
## - UCHL5           1 6.6274e-09  66
## - Diam            1 6.7917e-09  66
## - MMP9            1 6.8680e-09  66
## - PECI.1          1 7.1159e-09  66
## - Contig63649_RC  1 9.0522e-09  66
## - Contig32125_RC  1 9.5527e-09  66
## - LymphNodes      1 9.5765e-09  66
## - OXCT1           1 1.2593e-08  66
## - SLC2A3          1 1.2619e-08  66
## - LOC643008       1 1.3373e-08  66
## - STK32B          1 1.6570e-08  66
## <none>              3.7064e-09  68
##
## Step:  AIC=66
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + GPR126 +
##     SLC2A3 + PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS +
##     PITRM1 + PALM2.AKAP2 + LGP2 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - GPR126          1 4.3476e-09  64
## - NM_004702       1 4.3902e-09  64
## - TSPYL5          1 4.4546e-09  64
## - C16orf61        1 4.7274e-09  64
## - AP2B1           1 4.7534e-09  64
## - MTDH            1 4.7761e-09  64
## - BBC3            1 5.1123e-09  64
## - FLT1            1 5.1802e-09  64
## - PALM2.AKAP2     1 5.2416e-09  64
## - FGF18           1 5.5756e-09  64
## - GPR180          1 5.6294e-09  64
## - EGLN1           1 5.8223e-09  64
## - PITRM1          1 5.8849e-09  64
## - KNTC2           1 5.8869e-09  64
## - LGP2            1 5.9963e-09  64
## - Contig20217_RC  1 6.4405e-09  64
## - DCK             1 6.5632e-09  64
## - HRASLS          1 7.1050e-09  64
```

```
## - IGFBP5          1 7.2314e-09  64
## - Diam            1 7.3098e-09  64
## - DIAPH3.1        1 7.3629e-09  64
## - PECI.1          1 7.5999e-09  64
## - MMP9            1 7.9313e-09  64
## - MCM6            1 9.6176e-09  64
## - Contig32125_RC  1 1.0913e-08  64
## - Contig63649_RC  1 1.2376e-08  64
## - UCHL5           1 1.2854e-08  64
## - SLC2A3          1 1.3049e-08  64
## - OXCT1           1 1.3543e-08  64
## - LymphNodes      1 1.3910e-08  64
## - LOC643008       1 1.5130e-08  64
## - STK32B          1 2.4593e-08  64
## <none>              3.9832e-09  66
##
## Step:  AIC=64
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 +
##     PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 +
##     PALM2.AKAP2 + LGP2 + Contig20217_RC + EGLN1 + NM_004702
##
##                  Df   Deviance AIC
## - NM_004702       1 4.4810e-09  62
## - FLT1            1 5.2620e-09  62
## - FGF18           1 5.6380e-09  62
## - TSPYL5          1 5.7300e-09  62
## - MTDH            1 5.8640e-09  62
## - AP2B1           1 5.8920e-09  62
## - LGP2            1 6.0470e-09  62
## - BBC3            1 6.0840e-09  62
## - C16orf61        1 6.1380e-09  62
## - PITRM1          1 6.2160e-09  62
## - KNTC2           1 6.2430e-09  62
## - DCK             1 6.5560e-09  62
## - EGLN1           1 6.6220e-09  62
## - PALM2.AKAP2     1 6.6680e-09  62
## - GPR180          1 6.8320e-09  62
## - Contig20217_RC  1 7.2010e-09  62
## - IGFBP5          1 7.3070e-09  62
## - Diam            1 7.7340e-09  62
## - DIAPH3.1        1 8.0620e-09  62
## - HRASLS          1 8.6730e-09  62
## - MMP9            1 8.7160e-09  62
## - MCM6            1 1.0267e-08  62
## - PECI.1          1 1.0730e-08  62
## - Contig32125_RC  1 1.1140e-08  62
## - SLC2A3          1 1.3484e-08  62
## - OXCT1           1 1.3942e-08  62
## - UCHL5           1 1.4145e-08  62
## - Contig63649_RC  1 1.6136e-08  62
## - LOC643008       1 1.8823e-08  62
## - LymphNodes      1 2.3073e-08  62
```

```
## - STK32B          1 6.6538e-08  62
## <none>              4.3480e-09  64
##
## Step:  AIC=62
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + FLT1 + OXCT1 +
##     MMP9 + KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 +
##     PECI.1 + LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 +
##     PALM2.AKAP2 + LGP2 + Contig20217_RC + EGLN1
##
##                   Df Deviance    AIC
## - FLT1             1     0.00  60.00
## - FGF18            1     0.00  60.00
## - MTDH             1     0.00  60.00
## - TSPYL5           1     0.00  60.00
## - LGP2             1     0.00  60.00
## - BBC3             1     0.00  60.00
## - PITRM1           1     0.00  60.00
## - AP2B1            1     0.00  60.00
## - EGLN1            1     0.00  60.00
## - DCK              1     0.00  60.00
## - KNTC2            1     0.00  60.00
## - PALM2.AKAP2      1     0.00  60.00
## - Contig20217_RC   1     0.00  60.00
## - IGFBP5           1     0.00  60.00
## - GPR180           1     0.00  60.00
## - DIAPH3.1         1     0.00  60.00
## - C16orf61         1     0.00  60.00
## - Diam             1     0.00  60.00
## - HRASLS           1     0.00  60.00
## - MMP9             1     0.00  60.00
## - MCM6             1     0.00  60.00
## - PECI.1           1     0.00  60.00
## - Contig32125_RC   1     0.00  60.00
## - SLC2A3           1     0.00  60.00
## - OXCT1            1     0.00  60.00
## - UCHL5            1     0.00  60.00
## - Contig63649_RC   1     0.00  60.00
## - LOC643008        1     0.00  60.00
## - LymphNodes       1     0.00  60.00
## <none>                   0.00  62.00
## - STK32B           1   865.05 925.05
##
## Step:  AIC=60
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + OXCT1 + MMP9 +
##     KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PITRM1 + PALM2.AKAP2 +
##     LGP2 + Contig20217_RC + EGLN1
##
##                   Df Deviance    AIC
## - PITRM1           1     0.00  58.00
## - AP2B1            1     0.00  58.00
## - EGLN1            1     0.00  58.00
```

```
## - BBC3            1     0.00  58.00
## - MTDH            1     0.00  58.00
## - FGF18           1     0.00  58.00
## - Contig20217_RC  1     0.00  58.00
## - DCK             1     0.00  58.00
## - TSPYL5          1     0.00  58.00
## - KNTC2           1     0.00  58.00
## - LGP2            1     0.00  58.00
## - PALM2.AKAP2     1     0.00  58.00
## - IGFBP5          1     0.00  58.00
## - DIAPH3.1        1     0.00  58.00
## - MMP9            1     0.00  58.00
## - C16orf61        1     0.00  58.00
## - HRASLS          1     0.00  58.00
## - GPR180          1     0.00  58.00
## - Diam            1     0.00  58.00
## - MCM6            1     0.00  58.00
## - UCHL5           1     0.00  58.00
## - OXCT1           1     0.00  58.00
## - Contig63649_RC  1     0.00  58.00
## - Contig32125_RC  1     0.00  58.00
## - LOC643008       1     0.00  58.00
## - SLC2A3          1     0.00  58.00
## - PECI.1          1     0.00  58.00
## <none>                  0.00  60.00
## - STK32B          1    36.96  94.96
## - LymphNodes      1   576.70 634.70
##
## Step:  AIC=58
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + OXCT1 + MMP9 +
##     KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + AP2B1 + IGFBP5 + HRASLS + PALM2.AKAP2 +
##     LGP2 + Contig20217_RC + EGLN1
##
##                  Df Deviance    AIC
## - AP2B1           1     0.00  56.00
## - Contig20217_RC  1     0.00  56.00
## - BBC3            1     0.00  56.00
## - TSPYL5          1     0.00  56.00
## - MTDH            1     0.00  56.00
## - EGLN1           1     0.00  56.00
## - PALM2.AKAP2     1     0.00  56.00
## - DCK             1     0.00  56.00
## - IGFBP5          1     0.00  56.00
## - FGF18           1     0.00  56.00
## - DIAPH3.1        1     0.00  56.00
## - LGP2            1     0.00  56.00
## - KNTC2           1     0.00  56.00
## - C16orf61        1     0.00  56.00
## - GPR180          1     0.00  56.00
## - MMP9            1     0.00  56.00
## - Diam            1     0.00  56.00
## - HRASLS          1     0.00  56.00
```

```
## - OXCT1           1     0.00  56.00
## - MCM6            1     0.00  56.00
## - SLC2A3          1     0.00  56.00
## - PECI.1          1     0.00  56.00
## - LOC643008       1     0.00  56.00
## - Contig32125_RC  1     0.00  56.00
## - Contig63649_RC  1     0.00  56.00
## - UCHL5           1     0.00  56.00
## <none>                  0.00  58.00
## - STK32B          1    37.53  93.53
## - LymphNodes      1   792.96 848.96
##
## Step:  AIC=56
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + OXCT1 + MMP9 +
##     KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + IGFBP5 + HRASLS + PALM2.AKAP2 + LGP2 +
##     Contig20217_RC + EGLN1
##
##                  Df Deviance    AIC
## - Contig20217_RC  1     0.00  54.00
## - BBC3            1     0.00  54.00
## - TSPYL5          1     0.00  54.00
## - MTDH            1     0.00  54.00
## - IGFBP5          1     0.00  54.00
## - DCK             1     0.00  54.00
## - EGLN1           1     0.00  54.00
## - PALM2.AKAP2     1     0.00  54.00
## - DIAPH3.1        1     0.00  54.00
## - FGF18           1     0.00  54.00
## - MMP9            1     0.00  54.00
## - C16orf61        1     0.00  54.00
## - Diam            1     0.00  54.00
## - KNTC2           1     0.00  54.00
## - GPR180          1     0.00  54.00
## - OXCT1           1     0.00  54.00
## - HRASLS          1     0.00  54.00
## - LGP2            1     0.00  54.00
## - MCM6            1     0.00  54.00
## - SLC2A3          1     0.00  54.00
## - PECI.1          1     0.00  54.00
## - UCHL5           1     0.00  54.00
## - LOC643008       1     0.00  54.00
## - Contig63649_RC  1     0.00  54.00
## - Contig32125_RC  1     0.00  54.00
## <none>                  0.00  56.00
## - STK32B          1    41.03  95.03
## - LymphNodes      1   792.96 846.96
##
## Step:  AIC=54
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + OXCT1 + MMP9 +
##     KNTC2 + GPR180 + UCHL5 + MTDH + STK32B + DCK + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + IGFBP5 + HRASLS + PALM2.AKAP2 + LGP2 +
```

```
##     EGLN1
##
##                   Df Deviance    AIC
## - MTDH             1    0.000 52.000
## - BBC3             1    0.000 52.000
## - TSPYL5           1    0.000 52.000
## - DCK              1    0.000 52.000
## - PALM2.AKAP2      1    0.000 52.000
## - DIAPH3.1         1    0.000 52.000
## - IGFBP5           1    0.000 52.000
## - EGLN1            1    0.000 52.000
## - FGF18            1    0.000 52.000
## - GPR180           1    0.000 52.000
## - C16orf61         1    0.000 52.000
## - MMP9             1    0.000 52.000
## - Diam             1    0.000 52.000
## - OXCT1            1    0.000 52.000
## - KNTC2            1    0.000 52.000
## - MCM6             1    0.000 52.000
## - HRASLS           1    0.000 52.000
## - SLC2A3           1    0.000 52.000
## - LGP2             1    0.000 52.000
## - PECI.1           1    0.000 52.000
## - LOC643008        1    0.000 52.000
## - UCHL5            1    0.000 52.000
## - Contig63649_RC   1    0.000 52.000
## <none>                  0.000 54.000
## - LymphNodes       1   33.131 85.131
## - Contig32125_RC   1   35.997 87.997
## - STK32B           1   43.800 95.800
##
## Step:  AIC=52
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + BBC3 + C16orf61 + OXCT1 + MMP9 +
##     KNTC2 + GPR180 + UCHL5 + STK32B + DCK + SLC2A3 + PECI.1 +
##     LOC643008 + MCM6 + IGFBP5 + HRASLS + PALM2.AKAP2 + LGP2 +
##     EGLN1
##
##                   Df Deviance    AIC
## - BBC3             1    0.000 50.000
## - PALM2.AKAP2      1    0.000 50.000
## - TSPYL5           1    0.000 50.000
## - GPR180           1    0.000 50.000
## - DIAPH3.1         1    0.000 50.000
## - FGF18            1    0.000 50.000
## - IGFBP5           1    0.000 50.000
## - C16orf61         1    0.000 50.000
## - Diam             1    0.000 50.000
## - MCM6             1    0.000 50.000
## - MMP9             1    0.000 50.000
## - HRASLS           1    0.000 50.000
## - EGLN1            1    0.000 50.000
## - LGP2             1    0.000 50.000
## - OXCT1            1    0.000 50.000
```

```
## - LOC643008       1    0.000 50.000
## - DCK             1    0.000 50.000
## - UCHL5           1    0.000 50.000
## - KNTC2           1    0.000 50.000
## <none>                 0.000 52.000
## - SLC2A3          1   27.794 77.794
## - PECI.1          1   29.845 79.845
## - LymphNodes      1   36.168 86.168
## - Contig32125_RC  1   38.266 88.266
## - STK32B          1   43.805 93.805
## - Contig63649_RC  1   44.163 94.163
##
## Step:  AIC=50
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + C16orf61 + OXCT1 + MMP9 + KNTC2 +
##     GPR180 + UCHL5 + STK32B + DCK + SLC2A3 + PECI.1 + LOC643008 +
##     MCM6 + IGFBP5 + HRASLS + PALM2.AKAP2 + LGP2 + EGLN1
##
##                  Df Deviance    AIC
## - PALM2.AKAP2     1     0.00  48.00
## - TSPYL5          1     0.00  48.00
## - GPR180          1     0.00  48.00
## - DIAPH3.1        1     0.00  48.00
## - C16orf61        1     0.00  48.00
## - IGFBP5          1     0.00  48.00
## - FGF18           1     0.00  48.00
## - Diam            1     0.00  48.00
## - MMP9            1     0.00  48.00
## - HRASLS          1     0.00  48.00
## - OXCT1           1     0.00  48.00
## - DCK             1     0.00  48.00
## - UCHL5           1     0.00  48.00
## - EGLN1           1     0.00  48.00
## <none>                  0.00  50.00
## - LOC643008       1    24.76  72.76
## - LGP2            1    28.24  76.24
## - SLC2A3          1    31.48  79.48
## - PECI.1          1    33.24  81.24
## - LymphNodes      1    37.68  85.68
## - Contig32125_RC  1    43.26  91.26
## - Contig63649_RC  1    44.86  92.86
## - STK32B          1    46.47  94.47
## - MCM6            1   792.96 840.96
## - KNTC2           1   865.05 913.05
##
## Step:  AIC=48
## Event ~ Diam + LymphNodes + TSPYL5 + Contig63649_RC + FGF18 +
##     DIAPH3.1 + Contig32125_RC + C16orf61 + OXCT1 + MMP9 + KNTC2 +
##     GPR180 + UCHL5 + STK32B + DCK + SLC2A3 + PECI.1 + LOC643008 +
##     MCM6 + IGFBP5 + HRASLS + LGP2 + EGLN1
##
##                  Df Deviance    AIC
## - TSPYL5          1    0.000 46.000
## - GPR180          1    0.000 46.000
```

```
## - Diam            1    0.000 46.000
## - DIAPH3.1        1    0.000 46.000
## - FGF18           1    0.000 46.000
## - C16orf61        1    0.000 46.000
## - IGFBP5          1    0.000 46.000
## <none>                 0.000 48.000
## - MMP9            1   25.940 71.940
## - UCHL5           1   29.266 75.266
## - LOC643008       1   29.799 75.799
## - KNTC2           1   30.305 76.305
## - DCK             1   32.197 78.197
## - LGP2            1   32.856 78.856
## - SLC2A3          1   33.687 79.687
## - MCM6            1   34.820 80.820
## - EGLN1           1   35.995 81.995
## - HRASLS          1   40.177 86.177
## - LymphNodes      1   41.291 87.291
## - Contig32125_RC  1   43.960 89.960
## - OXCT1           1   44.924 90.924
## - Contig63649_RC  1   47.128 93.128
## - STK32B          1   49.981 95.981
## - PECI.1          1   50.730 96.730
##
## Step:  AIC=46
## Event ~ Diam + LymphNodes + Contig63649_RC + FGF18 + DIAPH3.1 +
##     Contig32125_RC + C16orf61 + OXCT1 + MMP9 + KNTC2 + GPR180 +
##     UCHL5 + STK32B + DCK + SLC2A3 + PECI.1 + LOC643008 + MCM6 +
##     IGFBP5 + HRASLS + LGP2 + EGLN1
##
##                  Df Deviance    AIC
## - GPR180          1     0.00  44.00
## - Diam            1     0.00  44.00
## - DIAPH3.1        1     0.00  44.00
## <none>                  0.00  46.00
## - C16orf61        1    32.95  76.95
## - IGFBP5          1    34.74  78.74
## - MMP9            1    36.03  80.03
## - MCM6            1    36.32  80.32
## - DCK             1    37.28  81.28
## - KNTC2           1    37.84  81.84
## - LOC643008       1    37.95  81.95
## - EGLN1           1    38.19  82.19
## - SLC2A3          1    39.26  83.26
## - LGP2            1    39.61  83.61
## - UCHL5           1    41.32  85.32
## - HRASLS          1    45.25  89.25
## - LymphNodes      1    45.66  89.66
## - Contig32125_RC  1    45.83  89.83
## - OXCT1           1    49.17  93.17
## - STK32B          1    50.05  94.05
## - Contig63649_RC  1    50.39  94.39
## - PECI.1          1    51.72  95.72
## - FGF18           1   720.87 764.87
##
```

```
## Step:  AIC=44
## Event ~ Diam + LymphNodes + Contig63649_RC + FGF18 + DIAPH3.1 +
##     Contig32125_RC + C16orf61 + OXCT1 + MMP9 + KNTC2 + UCHL5 +
##     STK32B + DCK + SLC2A3 + PECI.1 + LOC643008 + MCM6 + IGFBP5 +
##     HRASLS + LGP2 + EGLN1
##
##                   Df Deviance    AIC
## <none>                 0.000 44.000
## - DIAPH3.1         1   26.360 68.360
## - Diam             1   28.951 70.951
## - DCK              1   37.901 79.901
## - EGLN1            1   41.703 83.703
## - SLC2A3           1   43.681 85.681
## - MMP9             1   44.116 86.116
## - MCM6             1   44.449 86.449
## - C16orf61         1   44.816 86.816
## - IGFBP5           1   45.088 87.088
## - LGP2             1   46.204 88.204
## - FGF18            1   46.497 88.497
## - LOC643008        1   46.574 88.574
## - OXCT1            1   50.068 92.068
## - KNTC2            1   50.319 92.319
## - HRASLS           1   50.872 92.872
## - Contig32125_RC   1   50.980 92.980
## - LymphNodes       1   51.955 93.955
## - PECI.1           1   52.005 94.005
## - UCHL5            1   52.094 94.094
## - STK32B           1   54.506 96.506
## - Contig63649_RC   1   56.760 98.760
```

We can see that we start with AIC 154 and the lowest AIC that can be obtained is 44. So we can see that forward model is better than the backward model.