Predicting Diagnosis of Liver Disease

```r
# Load libraries
library(tidyverse)
```

```
## -- Attaching packages -------------------------------------- tidyverse 1.3.0 --
```

```
## v ggplot2 3.3.3     v purrr   0.3.4
## v tibble  3.0.6     v dplyr   1.0.4
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.1
```

```
## -- Conflicts ----------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```r
library(dplyr)
library(ISLR)
library(janitor)
```

```
##
## Attaching package: 'janitor'
```

```
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```r
library(AppliedPredictiveModeling)
library(caret)
```

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

```
##
## Attaching package: 'caret'
```

```
## The following object is masked from 'package:purrr':
##
##     lift
```

```r
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
library(pROC)
```

```
## Type 'citation("pROC")' for a citation.
```

```
##
## Attaching package: 'pROC'
```

```
## The following objects are masked from 'package:stats':
##
##      cov, smooth, var
```

```
library(MASS)
```

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

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

```
library(readxl)
library(glmnet)
```

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

```
##
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
##
##      expand, pack, unpack
```

```
## Loaded glmnet 4.1
```

```
library(mlbench)
library(pdp)
```

```
##
## Attaching package: 'pdp'
```

```
## The following object is masked from 'package:purrr':
##
##      partial
```

```
library(vip)
```

```
##
## Attaching package: 'vip'
```

```
## The following object is masked from 'package:utils':
##
##      vi
```

```
library(klaR)
library(rpart)
library(rpart.plot)
library(randomForest)
```

```
## randomForest 4.6-14
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

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

```
## The following object is masked from 'package:ggplot2':
##
##      margin
```

```
library(ranger)
```

```
##
## Attaching package: 'ranger'
```

```
## The following object is masked from 'package:randomForest':
##
##      importance
```

```
library(ISLR)
library(caret)
library(e1071)
library(kernlab)
```

```
##
## Attaching package: 'kernlab'
```

```
## The following object is masked from 'package:purrr':
##
##      cross
```

```
## The following object is masked from 'package:ggplot2':
##
##      alpha
```

```
library(DALEX)
```

```
## Registered S3 method overwritten by 'DALEX':
##   method             from
##   print.description  questionr
```

```
## Welcome to DALEX (version: 2.2.0).
## Find examples and detailed introduction at: http://ema.drwhy.ai/


##
## Attaching package: 'DALEX'

## The following object is masked from 'package:dplyr':
##
##     explain

library(gbm)


## Loaded gbm 2.1.8

library(ROCR)
```

Import data

```
liver_df = read_excel("./data/liver.xlsx") %>%
  mutate(outcome = ifelse(is_patient == 1, "yes", "no"), outcome = as.factor(outcome)) %>%
  dplyr::select(-is_patient) %>%
  clean_names %>%
  rename(
    aspartate_aminotransferase = sgpt,
    alamine_aminotransferase = sgot,
    albumin_globulin_ratio = ag_ratio,
    alkaline_phosphate = alkphos) %>%
  drop_na

liver_df$gender=factor(x=liver_df$gender,levels = c('Female','Male'),labels=c(0, 1))
liver_df$gender = as.double(liver_df$gender)
# female = '1', male = '2'
```

Exploratory Data Analysis

```
# Feature plots
theme1 <- transparentTheme(trans = .4)
trellis.par.set(theme1)
featurePlot(x = liver_df[, 1:10],
            y = liver_df$outcome,
            scales = list(x = list(relation = "free"),
                          y = list(relation = "free")),
            plot = "density", pch = "|",
            auto.key = list(columns = 2))
```
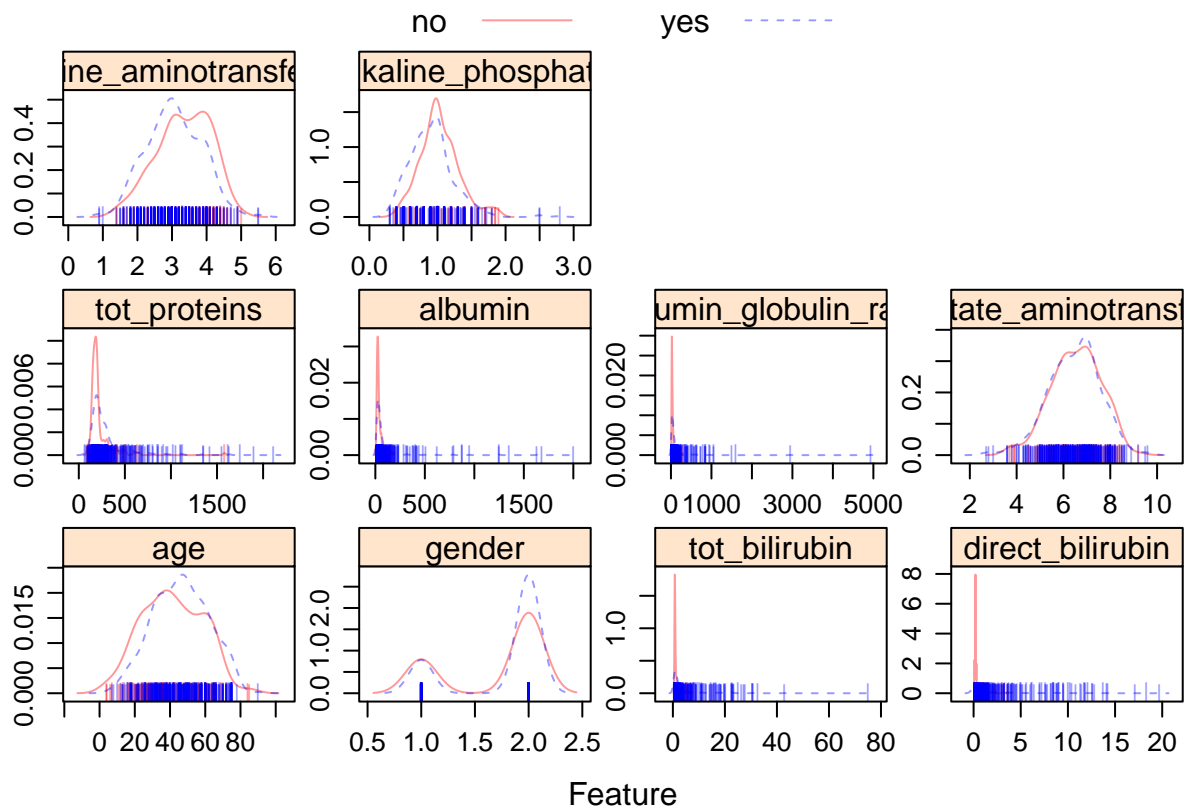
```r
# dataset with all the log-transformed predictor variables
liver_df1 =
  liver_df %>%
  mutate(logtot_bilirubin = log(tot_bilirubin) +1,
         logdirect_bilirubin = log(direct_bilirubin) +1,
         logtot_proteins = log(tot_proteins) +1,
         logalbumin = log(albumin) +1,
         loggender = log(gender) +1,
         logalbumin_globulin_ratio = log(albumin_globulin_ratio) +1,
         logage = log(age) +1,
         logaspartate_aminotransferase = log(aspartate_aminotransferase) +1,
         logalamine_transferase = log(alamine_aminotransferase ) +1,
         logalkaline_phosphate = log(alkaline_phosphate) +1) %>%
         dplyr::select(logage, loggender, logtot_bilirubin, logdirect_bilirubin, logtot_proteins,
                   logalbumin, logalbumin_globulin_ratio, logaspartate_aminotransferase,
                   logalamine_transferase, logalkaline_phosphate, outcome)


theme1 <- transparentTheme(trans = .4)
trellis.par.set(theme1)
featurePlot(x = liver_df1[, 1:10],
            y = liver_df1$outcome,
            scales = list(x = list(relation = "free"),
                          y = list(relation = "free")),
            plot = "density", pch = "|",
            auto.key = list(columns = 2))
```
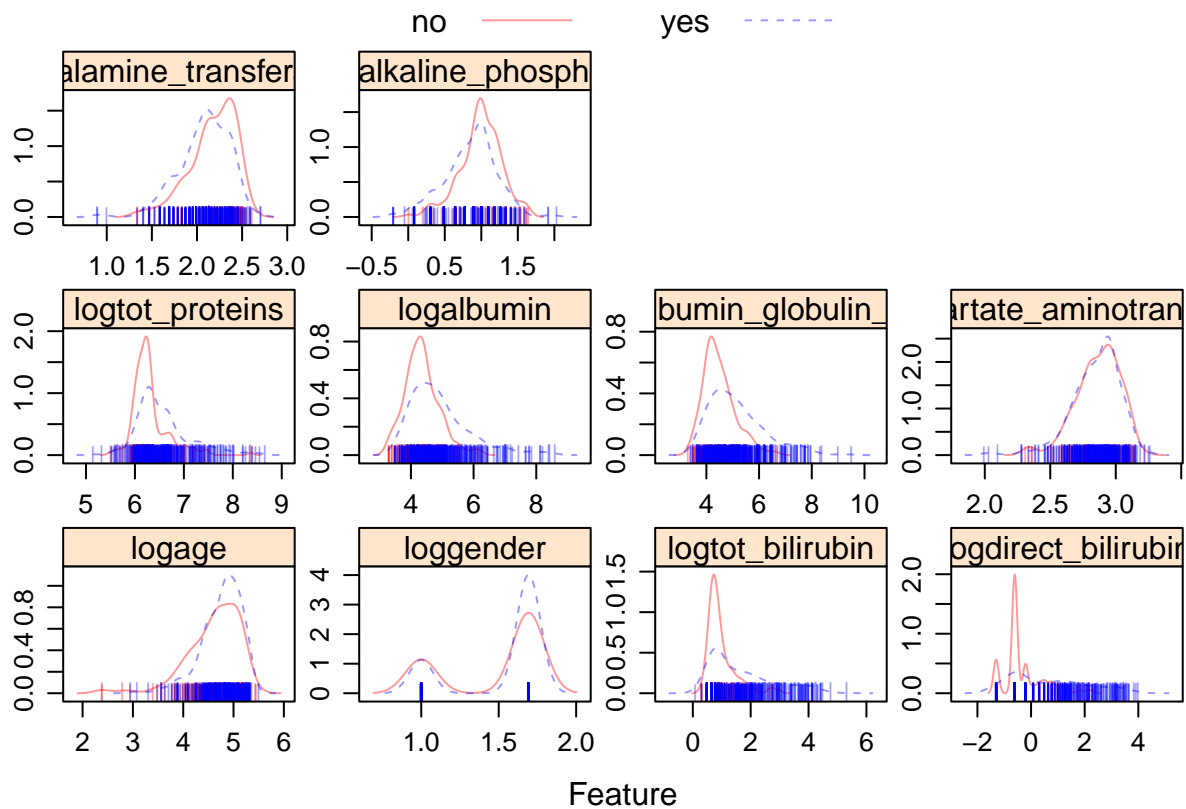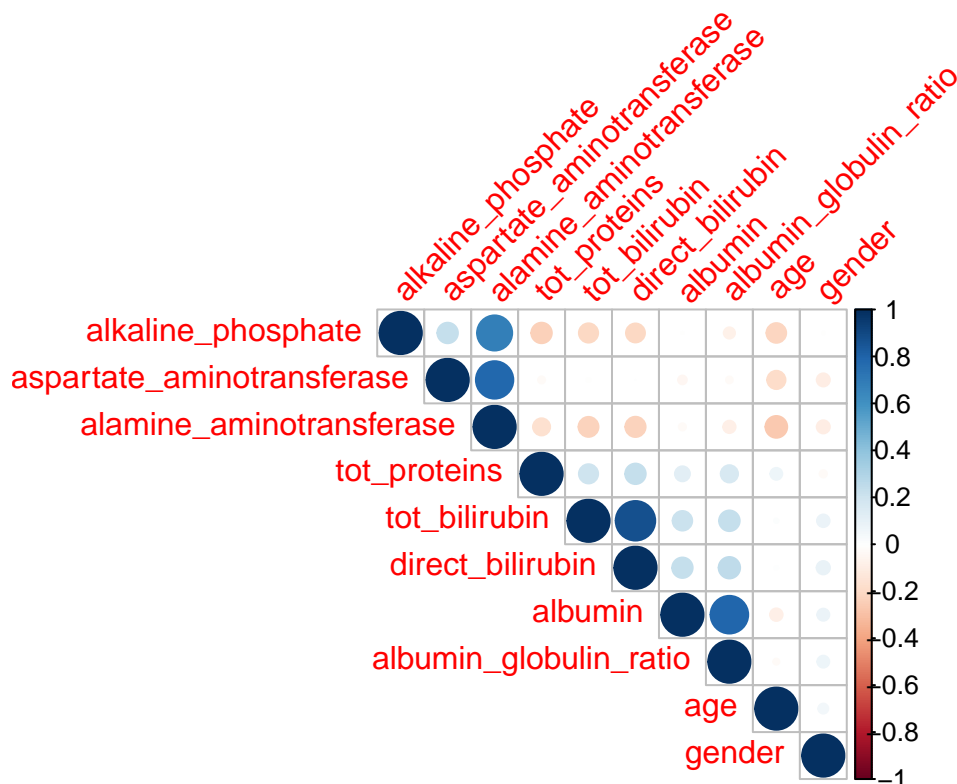
```
# Correlation plot
corrplot(cor(liver_df[,-11]), tl.srt = 45, order = 'hclust', type = 'upper')
```

```
table(liver_df$outcome)
```

```
##
##  no yes
## 165 414
```

Data Partition

```
#Create Training and Test Datasets
set.seed(10)
dim(liver_df1)
```

```
## [1] 579  11
```

```
rowTrain <- createDataPartition(y = liver_df1$outcome,
                                p = 0.8,
                                list = FALSE)

liver.train = liver_df1[rowTrain, ]
liver.test = liver_df1[-rowTrain, ]
```

Logistic Regression

```
#Fit Logistic Regression Model with all predictors
glm.fit <- glm(outcome ~ ., data = liver_df1,
               subset = rowTrain,
               family = binomial(link = "logit"))
summary(glm.fit)
```

```
##
## Call:
## glm(formula = outcome ~ ., family = binomial(link = "logit"),
##     data = liver_df1, subset = rowTrain)
##
## Deviance Residuals:
##     Min      1Q   Median      3Q      Max
## -2.8567  -1.0195   0.4202   0.8414   1.6584
##
## Coefficients:
##                          Estimate Std. Error z value Pr(>|z|)
## (Intercept)             -15.11618    4.47123  -3.381 0.000723 ***
## logage                    0.74111    0.26049   2.845 0.004440 **
## loggender                 0.24539    0.37642   0.652 0.514469
## logtot_bilirubin          0.54443    0.53800   1.012 0.311554
## logdirect_bilirubin      -0.04189    0.35933  -0.117 0.907183
## logtot_proteins           0.31927    0.30501   1.047 0.295219
```

```
## logalbumin                        0.75082    0.28262    2.657 0.007893 **
## logalbumin_globulin_ratio         0.13377    0.25062    0.534 0.593500
## logaspartate_aminotransferase     5.03133    2.53732    1.983 0.047375 *
## logalamine_transferase           -4.88216    2.53278   -1.928 0.053906 .
## logalkaline_phosphate             1.55808    1.26055    1.236 0.216445
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 554.14  on 463  degrees of freedom
## Residual deviance: 456.81  on 453  degrees of freedom
## AIC: 478.81
##
## Number of Fisher Scoring iterations: 5
```

```
# Confusion Matrix
test.pred.prob <- predict(glm.fit, newdata = liver_df1[-rowTrain,], type = "response")
test.pred <- rep("no", length(test.pred.prob))
test.pred[test.pred.prob > 0.5] <- "yes"
confusionMatrix(data = as.factor(test.pred), reference = liver_df1$outcome[-rowTrain],
                positive = "yes")
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction no yes
##        no   7   5
##        yes 26  77
##
##                Accuracy : 0.7304
##                  95% CI : (0.6397, 0.8089)
##     No Information Rate : 0.713
##     P-Value [Acc > NIR] : 0.383747
##
##                   Kappa : 0.1866
##
##  Mcnemar's Test P-Value : 0.000328
##
##             Sensitivity : 0.9390
##             Specificity : 0.2121
##          Pos Pred Value : 0.7476
##          Neg Pred Value : 0.5833
##              Prevalence : 0.7130
##          Detection Rate : 0.6696
##    Detection Prevalence : 0.8957
##       Balanced Accuracy : 0.5756
##
##        'Positive' Class : yes
##
```

```
# ROC Curve
roc.glm <- roc(liver_df1$outcome[-rowTrain], test.pred.prob)
```

```
## Setting levels: control = no, case = yes

## Setting direction: controls < cases
```

```r
plot(roc.glm, legacy.axes = TRUE, print.auc = TRUE)
plot(smooth(roc.glm), col = 4, add = TRUE)
```
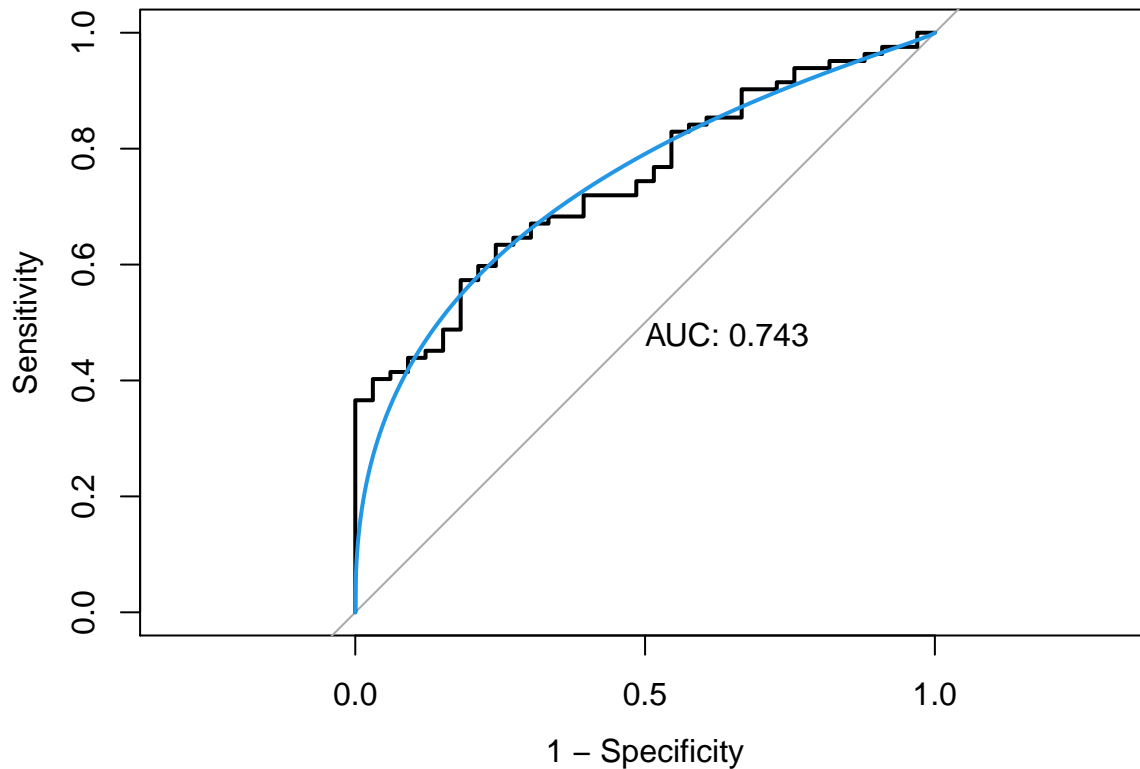


```r
# Fit a logistic regression with CARET
set.seed(10)
ctrl1 <- trainControl(method = "cv",
                      summaryFunction = twoClassSummary,
                      classProbs = TRUE)
model.glm <- train(x = liver_df1[rowTrain,1:10],
                   y = liver_df1$outcome[rowTrain],
                   method = "glm",
                   preProcess = c("center", "scale"),
                   metric = "ROC",
                   trControl = ctrl1)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

Regularized logistic regression

```r
ctrl2 <- trainControl(method = "cv",
                      summaryFunction = twoClassSummary,
                      classProbs = TRUE)

set.seed(10)
glmnGrid <- expand.grid(.alpha = seq(0,1,length =6),
                        .lambda = exp(seq(-6,0,length =20)))
model.glmn <- train(x=liver_df1[rowTrain,1:10],
                    y=liver_df1$outcome[rowTrain],
                    method ="glmnet",
                    #preProcess = c("center", "scale"),
                    tuneGrid =glmnGrid,
                    metric ="ROC",
                    trControl =ctrl2)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```r
ggplot(model.glmn,xTrans = function(x)log(x), highlight = TRUE)
```
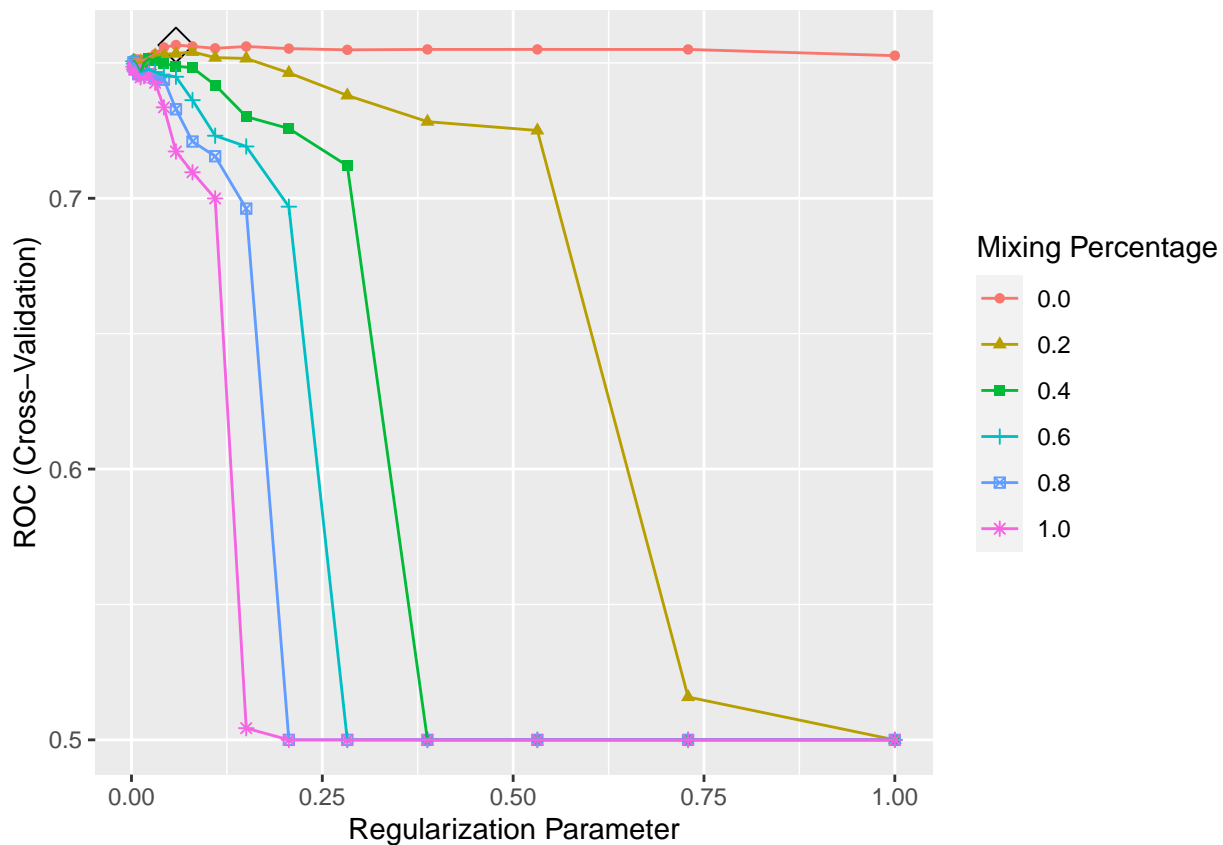
```
max(model.glmn$result$ROC)
```

```
## [1] 0.7565993
```

```
model.glmn$bestTune # alpha of 0 indicates a ridge regression.
```

```
##    alpha      lambda
## 11     0 0.05830279
```

```
coef(model.glmn$finalModel, s = model.glmn$bestTune$lambda)
```

```
## 11 x 1 sparse Matrix of class "dgCMatrix"
##                                    1
## (Intercept)                -6.8753424
## logage                      0.5276037
## loggender                   0.2611549
## logtot_bilirubin            0.2293340
## logdirect_bilirubin         0.1501621
## logtot_proteins             0.2906986
## logalbumin                  0.3735016
## logalbumin_globulin_ratio   0.2415046
## logaspartate_aminotransferase  0.3935637
## logalamine_transferase     -0.4353867
## logalkaline_phosphate      -0.3668267
```

MARS

```
set.seed(10)
model.mars <- train(x = liver_df1[rowTrain,1:10],
                    y = liver_df1$outcome[rowTrain],
                    method = "earth",
                    tuneGrid = expand.grid(degree = 1:3, nprune = 2:20),
                    metric = "ROC",
                    trControl = ctrl2)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Loading required package: earth

## Loading required package: Formula

## Loading required package: plotmo

## Loading required package: plotrix

## Loading required package: TeachingDemos

##
## Attaching package: 'TeachingDemos'

## The following object is masked from 'package:klaR':
##
##      triplot

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```
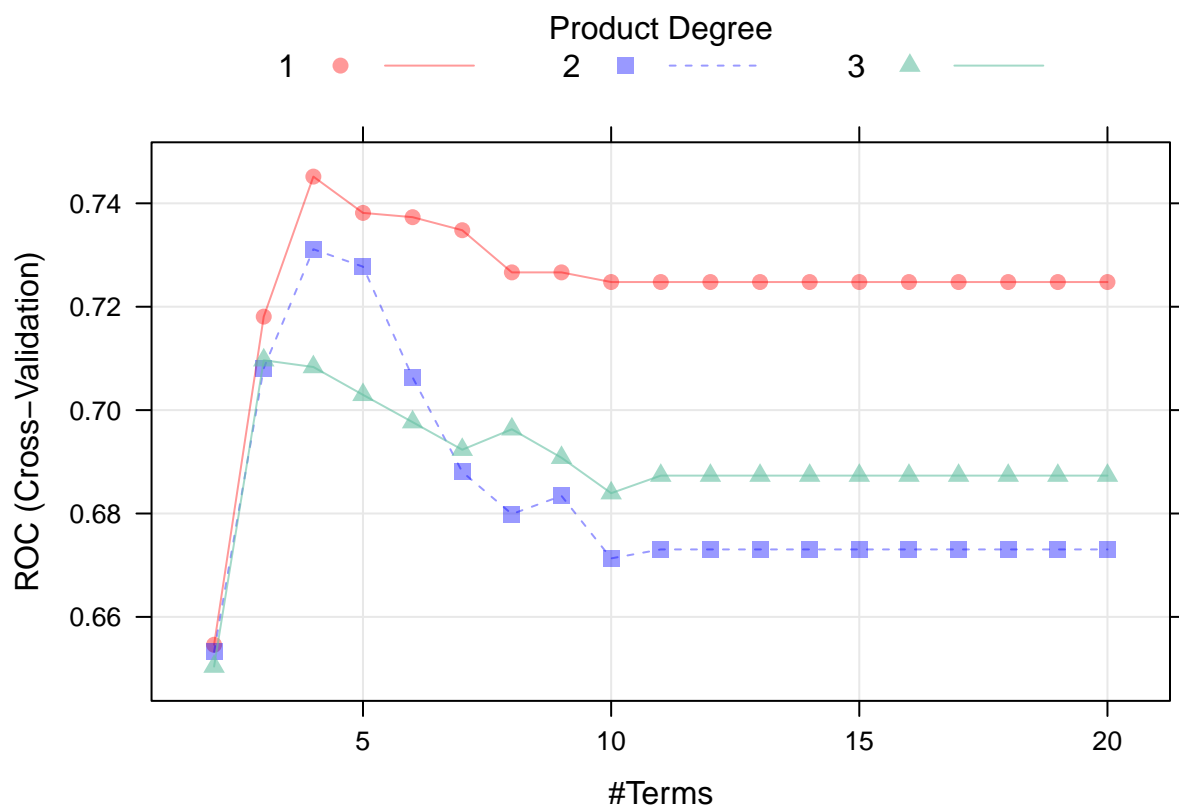
```
plot(model.mars)
```

```
coef(model.mars$finalModel)
```

```
##                     (Intercept) h(logdirect_bilirubin- -0.609438)
##                       1.9750727                        0.5984348
##         h(5.70048-logalbumin)              h(5.31749-logage)
##                      -0.8982652                       -0.7549458
```

```
vip(model.mars$finalModel)
```

KNN

```
set.seed(10)

model.knn <- train(x = liver_df1[rowTrain,1:10],
                   y = liver_df1$outcome[rowTrain],
                   method = "knn",
                   preProcess = c("center", "scale"),
                   tuneGrid = data.frame(k = seq(1, 200, by = 5)),
                   trControl = ctrl1)
```

```
## Warning in train.default(x = liver_df1[rowTrain, 1:10], y =
## liver_df1$outcome[rowTrain], : The metric "Accuracy" was not in the result set.
## ROC will be used instead.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```
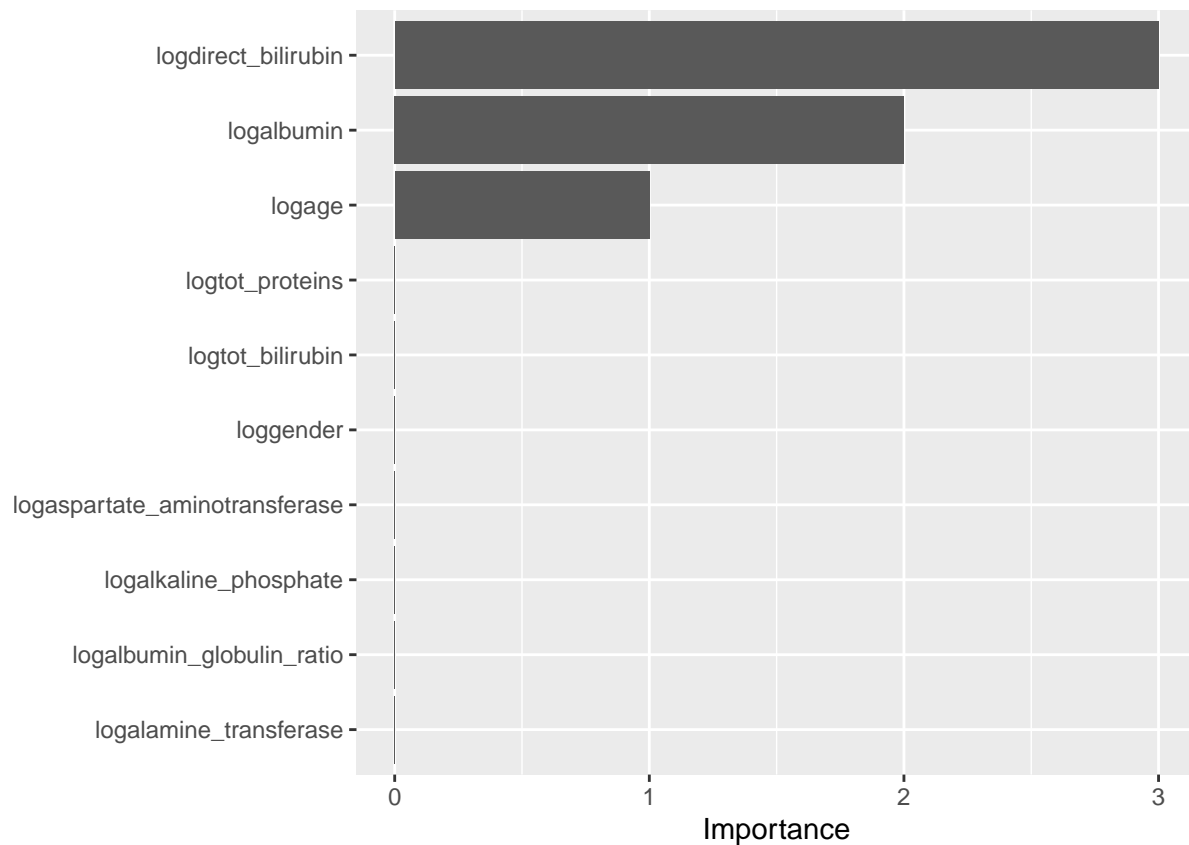
```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```
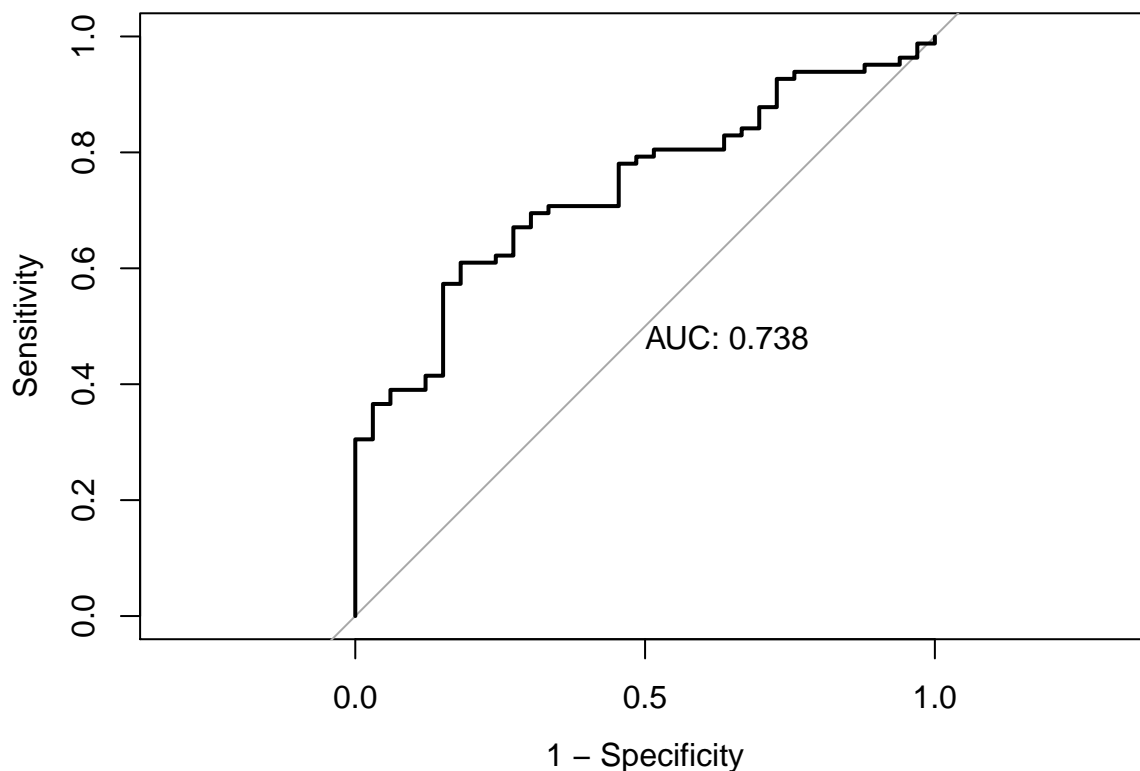
```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```
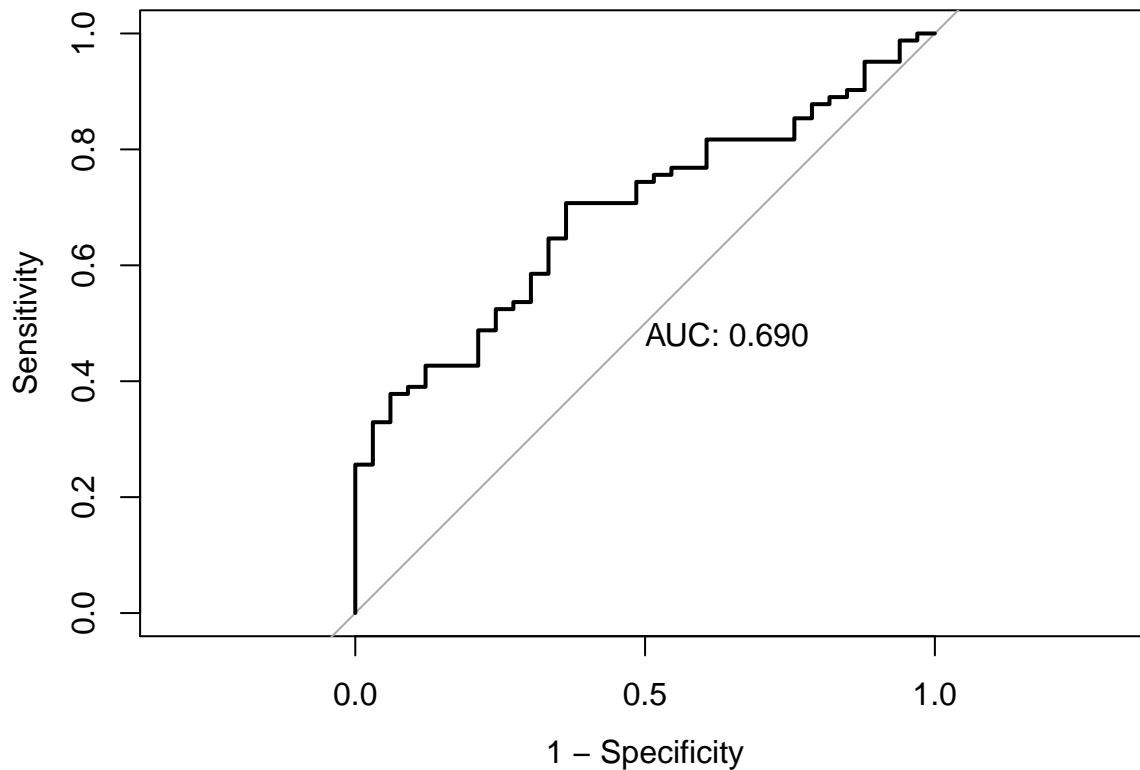
```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
liver_df1$outcome[-rowTrain]
```

```
##   [1] yes yes no  no  yes yes yes yes yes yes yes no  yes no  yes yes no  yes
##  [19] yes yes yes yes yes no  no  yes yes yes yes no  yes no  yes yes yes yes
##  [37] yes yes yes no  no  yes yes yes yes no  no  yes no  yes no  yes yes yes
##  [55] yes yes yes no  yes yes no  no  no  yes yes yes yes yes yes no  no  no
##  [73] yes yes no  yes yes yes yes yes no  yes yes yes yes yes yes no  yes no
##  [91] no  yes yes yes no  yes yes yes yes no  yes no  no  no  yes yes yes yes
## [109] yes yes yes yes yes yes no
## Levels: no yes
```

```
model.knn$bestTune
```

```
##    k
## 6 26
```

```
pred_knn = predict(model.knn, newdata = liver.test, type = 'prob')
roc_knn <- roc(liver_df1$outcome[-rowTrain], pred_knn[,2])
```

```
## Setting levels: control = no, case = yes
```

```
## Setting direction: controls < cases
```

```
plot.roc(roc_knn, legacy.axes = TRUE, print.auc = TRUE)
```
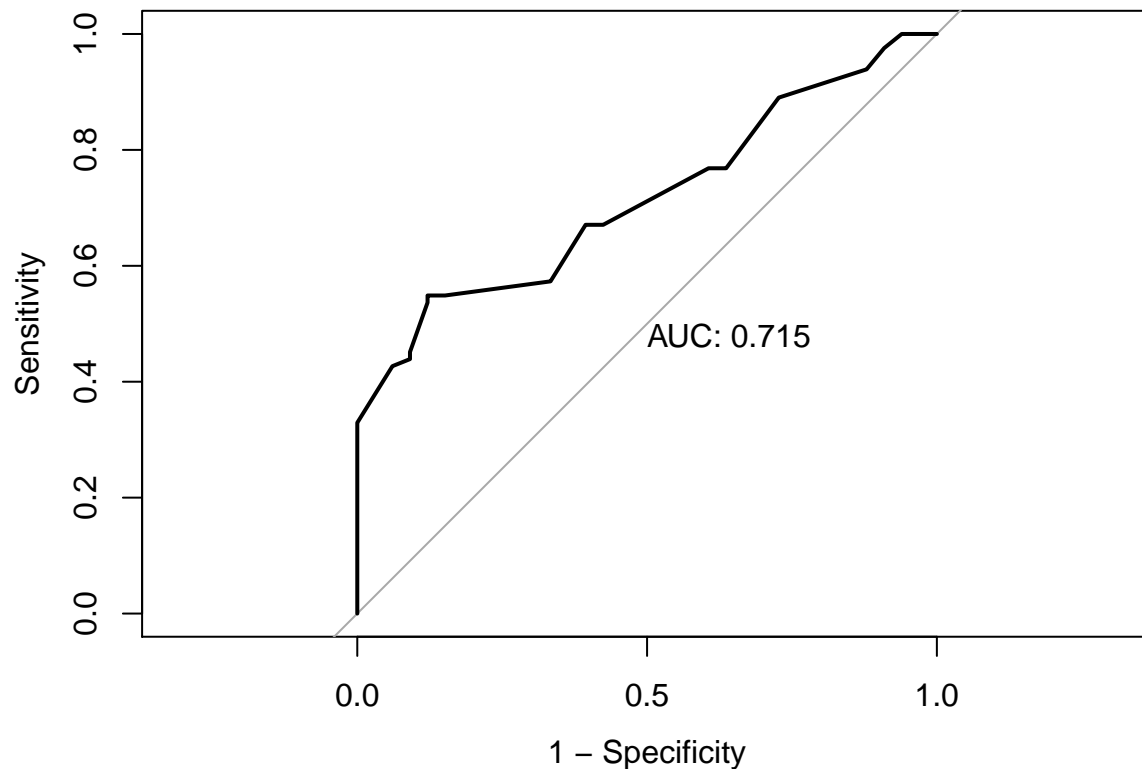

LDA

```
set.seed(10)
lda.fit <- lda(outcome~.,
               data = liver.train)

set.seed(10)
model.lda <- train(x = liver_df1[rowTrain,1:10],
                   y = liver_df1$outcome[rowTrain],
                   method = "lda",
                   metric = "ROC",
                   trControl = ctrl1)
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```r
lda.pred <- predict(lda.fit, newdata = liver.test)
roc.lda <- roc(liver_df1[-rowTrain,]$outcome, lda.pred$posterior[,2])
```

```
## Setting levels: control = no, case = yes

## Setting direction: controls < cases
```

```r
plot(roc.lda, legacy.axes = TRUE, print.auc = TRUE)
```

QDA

```
set.seed(10)
qda.fit <- qda(outcome~.,
                data = liver.train)

set.seed(10)
model.qda <- train(x = liver_df1[rowTrain,1:10],
                    y = liver_df1$outcome[rowTrain],
                    method = "qda",
                    metric = "ROC",
                    trControl = ctrl1)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
qda.pred <- predict(qda.fit, newdata = liver.test)
roc.qda <- roc(liver_df1[-rowTrain,]$outcome, qda.pred$posterior[,2])
```

```
## Setting levels: control = no, case = yes

## Setting direction: controls < cases
```

```
plot(roc.qda, legacy.axes = TRUE, print.auc = TRUE)
```

Sensitivity

AUC: 0.690

1 – Specificity

```
auc <- c(roc.lda$auc[1], roc.qda$auc[1])
```

Naive Bayes

```
nbGrid <- expand.grid(usekernel = c(FALSE,TRUE),
                      fL = 1,
                      adjust = seq(.2, 5, by = .2))
model.nb <- train(x = liver_df1[rowTrain,1:10],
                  y = liver_df1$outcome[rowTrain],
                  method = "nb",
                  tuneGrid = nbGrid,
                  metric = "ROC",
                  trControl = ctrl1)
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
```

```
## observation 19

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 19

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 34


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.


## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12


## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 33
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 12
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 14

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 42
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```
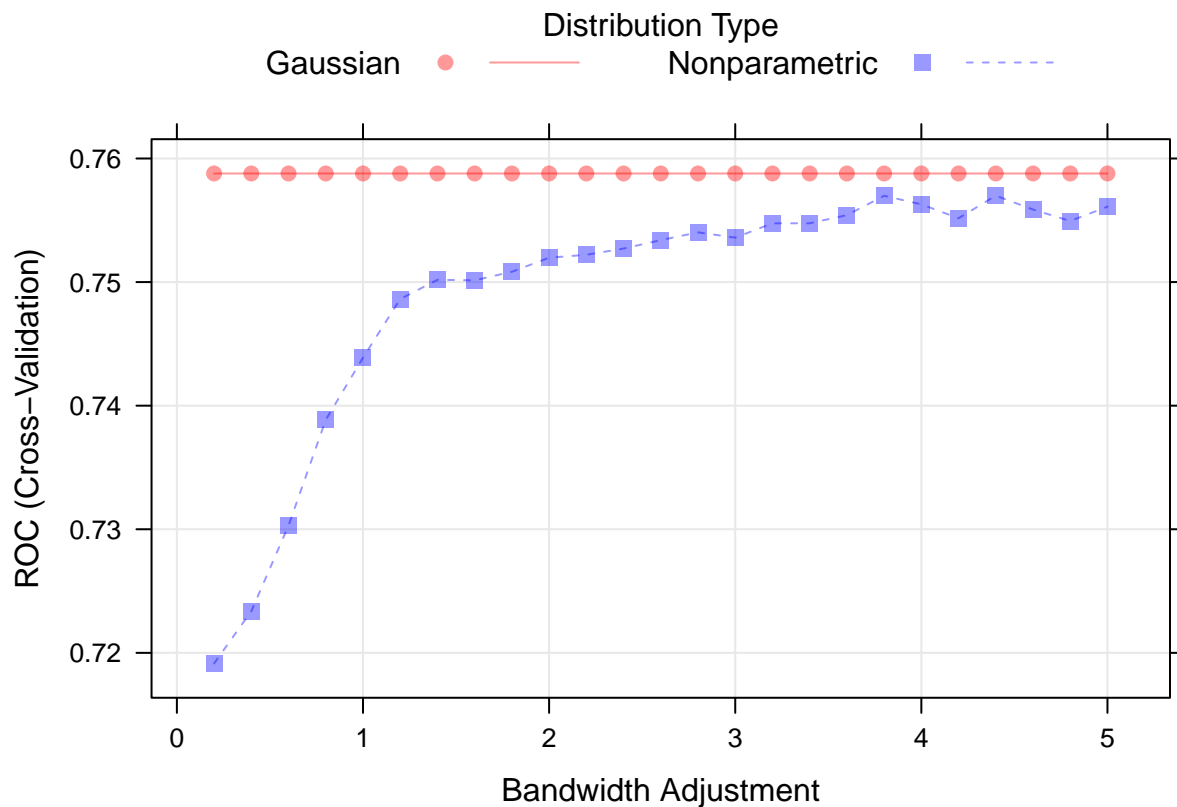
```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 43
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 22

## Warning: Setting row names on a tibble is deprecated.

## Warning: Setting row names on a tibble is deprecated.
```

```
plot(model.nb)
```


CLASSIFICATION TREE

```
set.seed(1)
tree1 = rpart(formula = outcome ~ ., data = liver_df1, subset = rowTrain,
              control = rpart.control(cp = 0))
rpart.plot(tree1)
```
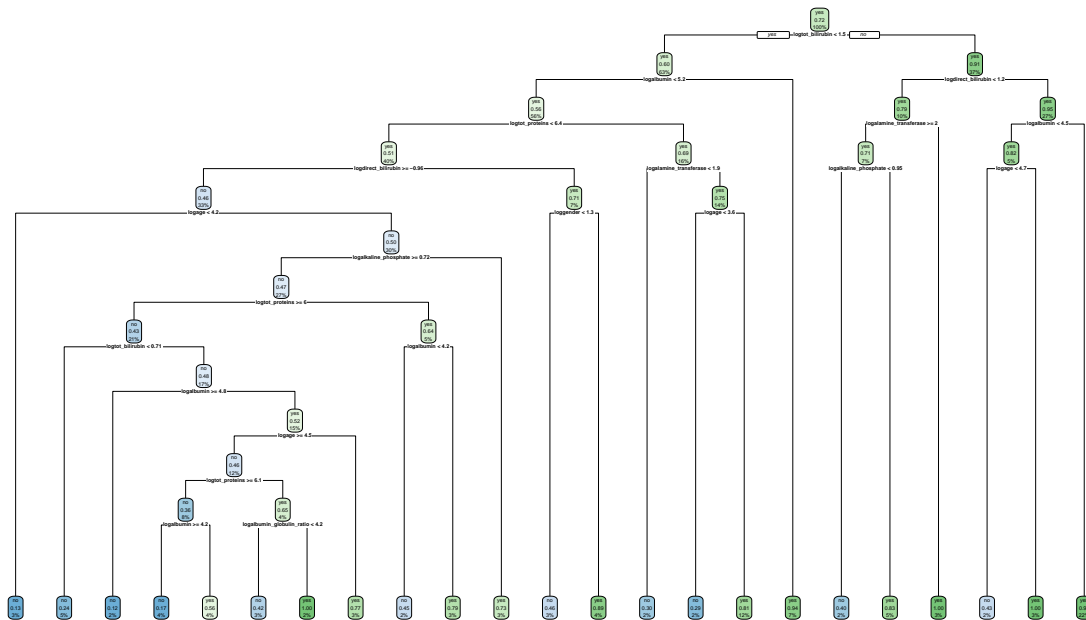
```
summary(tree1)
```

```
## Call:
## rpart(formula = outcome ~ ., data = liver_df1, subset = rowTrain,
##     control = rpart.control(cp = 0))
##   n= 464
##
##             CP nsplit rel error   xerror       xstd
## 1 0.020833333      0 1.0000000 1.000000 0.07362462
## 2 0.015151515     13 0.6590909 1.106061 0.07578043
## 3 0.007575758     15 0.6287879 1.159091 0.07671724
## 4 0.005050505     17 0.6136364 1.136364 0.07632688
## 5 0.003787879     20 0.5984848 1.143939 0.07645884
## 6 0.000000000     22 0.5909091 1.166667 0.07684370
##
## Variable importance
##             logtot_bilirubin                      logalbumin
##                           17                              16
##         logdirect_bilirubin      logalbumin_globulin_ratio
##                           15                              12
##                       logage                  logtot_proteins
##                           10                               9
##         logalkaline_phosphate         logalamine_transferase
##                            8                               7
## logaspartate_aminotransferase                        loggender
##                            4                               2
##
## Node number 1: 464 observations,    complexity param=0.02083333
##   predicted class=yes  expected loss=0.2844828  P(node) =1
##     class counts:   132    332
##    probabilities: 0.284 0.716
##   left son=2 (292 obs) right son=3 (172 obs)
##   Primary splits:
```

```
##         logtot_bilirubin            < 1.500316    to the left,   improve=20.03768, (0 missing)
##         logdirect_bilirubin         < 1.047655    to the left,   improve=20.00634, (0 missing)
##         logalbumin_globulin_ratio < 4.749435      to the left,   improve=16.12799, (0 missing)
##         logalbumin                  < 4.901922    to the left,   improve=15.55523, (0 missing)
##         logtot_proteins             < 6.344721    to the left,   improve=14.80449, (0 missing)
##   Surrogate splits:
##         logdirect_bilirubin         < 0.7100908   to the left,  agree=0.961, adj=0.895, (0 split)
##         logalbumin_globulin_ratio < 5.085941      to the left,  agree=0.759, adj=0.349, (0 split)
##         logalbumin                  < 4.979638    to the left,  agree=0.726, adj=0.262, (0 split)
##         logtot_proteins             < 6.50938     to the left,  agree=0.705, adj=0.203, (0 split)
##         logalkaline_phosphate       < 0.60693     to the right, agree=0.700, adj=0.192, (0 split)
##
## Node number 2: 292 observations,    complexity param=0.02083333
##   predicted class=yes  expected loss=0.3972603  P(node) =0.6293103
##     class counts:    116    176
##    probabilities: 0.397 0.603
##   left son=4 (258 obs) right son=5 (34 obs)
##   Primary splits:
##         logalbumin                  < 5.188621    to the left,   improve=8.815097, (0 missing)
##         logtot_proteins             < 6.354222    to the left,   improve=7.181825, (0 missing)
##         logalbumin_globulin_ratio < 4.749435      to the left,   improve=6.393377, (0 missing)
##         logalkaline_phosphate       < 1.014779    to the right,  improve=3.147865, (0 missing)
##         logage                      < 4.238486    to the left,   improve=3.026965, (0 missing)
##   Surrogate splits:
##         logalbumin_globulin_ratio      < 5.584915   to the left,   agree=0.938, adj=0.471, (0 split)
##         logdirect_bilirubin            < 0.9473197  to the left,   agree=0.887, adj=0.029, (0 split)
##         logtot_proteins                < 7.219583   to the left,   agree=0.887, adj=0.029, (0 split)
##         logaspartate_aminotransferase < 2.294633   to the right,  agree=0.887, adj=0.029, (0 split)
##
## Node number 3: 172 observations,    complexity param=0.005050505
##   predicted class=yes  expected loss=0.09302326  P(node) =0.3706897
##     class counts:     16    156
##    probabilities: 0.093 0.907
##   left son=6 (48 obs) right son=7 (124 obs)
##   Primary splits:
##         logdirect_bilirubin     < 1.222343    to the left,   improve=1.7705680, (0 missing)
##         logage                  < 4.650574    to the left,   improve=1.6902540, (0 missing)
##         logtot_bilirubin        < 2.011436    to the left,   improve=1.6342660, (0 missing)
##         logalamine_transferase < 1.810683     to the right,  improve=0.9617174, (0 missing)
##         logalkaline_phosphate  < 0.4456687    to the right,  improve=0.8728799, (0 missing)
##   Surrogate splits:
##         logtot_bilirubin            < 1.974382    to the left,   agree=0.959, adj=0.854, (0 split)
##         logalamine_transferase      < 2.44685     to the right,  agree=0.744, adj=0.083, (0 split)
##         logalbumin_globulin_ratio < 4.154959      to the left,   agree=0.733, adj=0.042, (0 split)
##         logalkaline_phosphate       < 1.307377    to the right,  agree=0.727, adj=0.021, (0 split)
##
## Node number 4: 258 observations,    complexity param=0.02083333
##   predicted class=yes  expected loss=0.4418605  P(node) =0.5560345
##     class counts:    114    144
##    probabilities: 0.442 0.558
##   left son=8 (184 obs) right son=9 (74 obs)
##   Primary splits:
##         logtot_proteins         < 6.354222    to the left,   improve=3.563981, (0 missing)
##         logage                  < 4.238486    to the left,   improve=3.207967, (0 missing)
```

```
##          logalbumin               < 3.970086    to the left,   improve=2.376053, (0 missing)
##          logalkaline_phosphate  < 1.121865    to the right, improve=1.959765, (0 missing)
##          logalamine_transferase < 2.238269    to the right, improve=1.929906, (0 missing)
##    Surrogate splits:
##          logage                           < 3.917405    to the right, agree=0.752, adj=0.135, (0 split)
##          logalbumin                       < 4.839394    to the left,   agree=0.729, adj=0.054, (0 split)
##          logaspartate_aminotransferase < 3.122244    to the left,   agree=0.721, adj=0.027, (0 split)
##          logalamine_transferase         < 2.657093    to the left,   agree=0.721, adj=0.027, (0 split)
##          logalkaline_phosphate          < 0.1563003  to the right, agree=0.721, adj=0.027, (0 split)
##
## Node number 5: 34 observations
##   predicted class=yes  expected loss=0.05882353  P(node) =0.07327586
##       class counts:      2     32
##     probabilities: 0.059 0.941
##
## Node number 6: 48 observations,     complexity param=0.005050505
##   predicted class=yes  expected loss=0.2083333  P(node) =0.1034483
##       class counts:     10     38
##     probabilities: 0.208 0.792
##   left son=12 (34 obs) right son=13 (14 obs)
##   Primary splits:
##          logalamine_transferase         < 1.974382    to the right, improve=1.7156860, (0 missing)
##          logage                           < 4.650574    to the left,   improve=1.6119180, (0 missing)
##          logaspartate_aminotransferase < 2.695574    to the right, improve=1.2387390, (0 missing)
##          logalkaline_phosphate          < 0.5662497  to the right, improve=1.0964910, (0 missing)
##          logalbumin_globulin_ratio     < 4.713275    to the right, improve=0.8757576, (0 missing)
##    Surrogate splits:
##          logalkaline_phosphate          < 0.5662497  to the right, agree=0.917, adj=0.714, (0 split)
##          logaspartate_aminotransferase < 2.667529    to the right, agree=0.854, adj=0.500, (0 split)
##          logtot_proteins                < 7.365312    to the left,   agree=0.792, adj=0.286, (0 split)
##          logalbumin                     < 3.861793    to the right, agree=0.771, adj=0.214, (0 split)
##
## Node number 7: 124 observations,     complexity param=0.003787879
##   predicted class=yes  expected loss=0.0483871  P(node) =0.2672414
##       class counts:      6    118
##     probabilities: 0.048 0.952
##   left son=14 (22 obs) right son=15 (102 obs)
##   Primary splits:
##          logalbumin                       < 4.481122    to the left,   improve=0.9523317, (0 missing)
##          logtot_proteins                  < 6.200401    to the left,   improve=0.7844925, (0 missing)
##          logalbumin_globulin_ratio      < 4.511434    to the left,   improve=0.4298134, (0 missing)
##          logage                           < 4.921924    to the left,   improve=0.4193548, (0 missing)
##          logdirect_bilirubin            < 2.294633    to the left,   improve=0.4193548, (0 missing)
##    Surrogate splits:
##          logalbumin_globulin_ratio < 4.701226    to the left,   agree=0.847, adj=0.136, (0 split)
##          logtot_proteins           < 5.668046    to the left,   agree=0.831, adj=0.045, (0 split)
##
## Node number 8: 184 observations,     complexity param=0.02083333
##   predicted class=yes  expected loss=0.4945652  P(node) =0.3965517
##       class counts:     91     93
##     probabilities: 0.495 0.505
##   left son=16 (153 obs) right son=17 (31 obs)
##   Primary splits:
##          logdirect_bilirubin             < -0.9560115 to the right, improve=3.110362, (0 missing)
```

```
##        logage                          < 4.238486    to the left,   improve=2.928155, (0 missing)
##        logalamine_transferase          < 2.238269    to the right,  improve=2.436100, (0 missing)
##        logtot_bilirubin                < 1.047655    to the right,  improve=1.989634, (0 missing)
##        logaspartate_aminotransferase   < 2.766405    to the right,  improve=1.916667, (0 missing)
##   Surrogate splits:
##        logtot_bilirubin < 0.5662497  to the right, agree=0.88, adj=0.29, (0 split)
##
## Node number 9: 74 observations,     complexity param=0.02083333
##   predicted class=yes  expected loss=0.3108108  P(node) =0.1594828
##     class counts:    23    51
##    probabilities: 0.311 0.689
##   left son=18 (10 obs) right son=19 (64 obs)
##   Primary splits:
##        logalamine_transferase          < 1.854189    to the left,   improve=3.502703, (0 missing)
##        logage                          < 3.602003    to the left,   improve=3.460278, (0 missing)
##        logaspartate_aminotransferase   < 2.800024    to the left,   improve=2.241164, (0 missing)
##        logdirect_bilirubin             < -0.9560115  to the left,   improve=2.127434, (0 missing)
##        logtot_bilirubin                < 0.835748     to the left,   improve=1.571124, (0 missing)
##   Surrogate splits:
##        logalkaline_phosphate           < 0.417624    to the left,   agree=0.919, adj=0.4, (0 split)
##        logaspartate_aminotransferase   < 2.658183    to the left,   agree=0.905, adj=0.3, (0 split)
##
## Node number 12: 34 observations,     complexity param=0.005050505
##   predicted class=yes  expected loss=0.2941176  P(node) =0.07327586
##     class counts:    10    24
##    probabilities: 0.294 0.706
##   left son=24 (10 obs) right son=25 (24 obs)
##   Primary splits:
##        logalkaline_phosphate           < 0.9473197   to the left,   improve=2.650980, (0 missing)
##        logaspartate_aminotransferase   < 2.816419    to the left,   improve=2.513251, (0 missing)
##        logalamine_transferase          < 2.266848    to the left,   improve=2.360504, (0 missing)
##        logtot_proteins                 < 6.339936    to the right,  improve=1.728758, (0 missing)
##        logalbumin_globulin_ratio       < 4.713275    to the right,  improve=1.342944, (0 missing)
##   Surrogate splits:
##        logalamine_transferase < 2.081662   to the left,  agree=0.824, adj=0.4, (0 split)
##        loggender              < 1.346574   to the left,  agree=0.765, adj=0.2, (0 split)
##        logtot_proteins        < 6.880868   to the right, agree=0.765, adj=0.2, (0 split)
##
## Node number 13: 14 observations
##   predicted class=yes  expected loss=0  P(node) =0.03017241
##     class counts:     0    14
##    probabilities: 0.000 1.000
##
## Node number 14: 22 observations,     complexity param=0.003787879
##   predicted class=yes  expected loss=0.1818182  P(node) =0.04741379
##     class counts:     4    18
##    probabilities: 0.182 0.818
##   left son=28 (7 obs) right son=29 (15 obs)
##   Primary splits:
##        logage                   < 4.749435    to the left,   improve=3.1168830, (0 missing)
##        logalkaline_phosphate    < 0.417624    to the right,  improve=1.4545450, (0 missing)
##        logtot_proteins          < 6.20304     to the left,   improve=1.2502160, (0 missing)
##        logalamine_transferase   < 1.810683    to the right,  improve=1.0069930, (0 missing)
##        logalbumin               < 4.177185    to the right,  improve=0.5121212, (0 missing)
```

```
##    Surrogate splits:
##        logtot_bilirubin               < 2.638572   to the right, agree=0.773, adj=0.286, (0 split)
##        logalbumin                     < 4.177185   to the right, agree=0.773, adj=0.286, (0 split)
##        logaspartate_aminotransferase < 3.008192   to the right, agree=0.773, adj=0.286, (0 split)
##        logalamine_transferase         < 2.292376   to the right, agree=0.773, adj=0.286, (0 split)
##        logalkaline_phosphate          < 0.835748   to the right, agree=0.773, adj=0.286, (0 split)
##
## Node number 15: 102 observations
##   predicted class=yes  expected loss=0.01960784  P(node) =0.2198276
##     class counts:     2   100
##    probabilities: 0.020 0.980
##
## Node number 16: 153 observations,    complexity param=0.02083333
##   predicted class=no    expected loss=0.4640523  P(node) =0.3297414
##     class counts:    82    71
##    probabilities: 0.536 0.464
##   left son=32 (15 obs) right son=33 (138 obs)
##   Primary splits:
##        logage                         < 4.238486   to the left,  improve=3.637908, (0 missing)
##        logalamine_transferase         < 2.115007   to the right, improve=1.990289, (0 missing)
##        logaspartate_aminotransferase < 2.677053   to the right, improve=1.915946, (0 missing)
##        logalkaline_phosphate          < 0.7189405  to the right, improve=1.784320, (0 missing)
##        logtot_bilirubin               < 1.299418   to the right, improve=1.513577, (0 missing)
##
## Node number 17: 31 observations,    complexity param=0.007575758
##   predicted class=yes  expected loss=0.2903226  P(node) =0.06681034
##     class counts:     9    22
##    probabilities: 0.290 0.710
##   left son=34 (13 obs) right son=35 (18 obs)
##   Primary splits:
##        loggender                      < 1.346574   to the left,  improve=2.7571000, (0 missing)
##        logtot_proteins                < 6.114955   to the left,  improve=2.2447820, (0 missing)
##        logage                         < 4.901922   to the left,  improve=1.1103280, (0 missing)
##        logalbumin_globulin_ratio      < 4.276967   to the left,  improve=0.9758742, (0 missing)
##        logaspartate_aminotransferase < 2.695574   to the left,  improve=0.9481066, (0 missing)
##    Surrogate splits:
##        logaspartate_aminotransferase < 2.86381    to the right, agree=0.774, adj=0.462, (0 split)
##        logage                         < 4.400642   to the left,  agree=0.710, adj=0.308, (0 split)
##        logalbumin_globulin_ratio      < 4.276967   to the left,  agree=0.710, adj=0.308, (0 split)
##        logalamine_transferase         < 2.178537   to the right, agree=0.677, adj=0.231, (0 split)
##        logtot_proteins                < 6.198482   to the right, agree=0.645, adj=0.154, (0 split)
##
## Node number 18: 10 observations
##   predicted class=no    expected loss=0.3  P(node) =0.02155172
##     class counts:     7     3
##    probabilities: 0.700 0.300
##
## Node number 19: 64 observations,    complexity param=0.02083333
##   predicted class=yes  expected loss=0.25  P(node) =0.137931
##     class counts:    16    48
##    probabilities: 0.250 0.750
##   left son=38 (7 obs) right son=39 (57 obs)
##   Primary splits:
##        logage                         < 3.602003   to the left,  improve=3.3884710, (0 missing)
```

```
##         logalkaline_phosphate  < 0.6778215   to the right, improve=1.3090910, (0 missing)
##         logdirect_bilirubin    < 0.195281    to the left,  improve=0.9824561, (0 missing)
##         logtot_proteins        < 6.683487    to the right, improve=0.8097166, (0 missing)
##         logtot_bilirubin       < 0.835748    to the left,  improve=0.7843137, (0 missing)
##
## Node number 24: 10 observations
##   predicted class=no    expected loss=0.4  P(node) =0.02155172
##     class counts:     6     4
##    probabilities: 0.600 0.400
##
## Node number 25: 24 observations
##   predicted class=yes  expected loss=0.1666667  P(node) =0.05172414
##     class counts:     4    20
##    probabilities: 0.167 0.833
##
## Node number 28: 7 observations
##   predicted class=no    expected loss=0.4285714  P(node) =0.01508621
##     class counts:     4     3
##    probabilities: 0.571 0.429
##
## Node number 29: 15 observations
##   predicted class=yes  expected loss=0  P(node) =0.03232759
##     class counts:     0    15
##    probabilities: 0.000 1.000
##
## Node number 32: 15 observations
##   predicted class=no    expected loss=0.1333333  P(node) =0.03232759
##     class counts:    13     2
##    probabilities: 0.867 0.133
##
## Node number 33: 138 observations,    complexity param=0.02083333
##   predicted class=no    expected loss=0.5  P(node) =0.2974138
##     class counts:    69    69
##    probabilities: 0.500 0.500
##   left son=66 (123 obs) right son=67 (15 obs)
##   Primary splits:
##       logalkaline_phosphate        < 0.7189405  to the right, improve=1.832520, (0 missing)
##       logaspartate_aminotransferase < 2.677053   to the right, improve=1.730408, (0 missing)
##       logalamine_transferase       < 2.115007   to the right, improve=1.630435, (0 missing)
##       logtot_proteins              < 6.027159   to the right, improve=1.433766, (0 missing)
##       logalbumin                   < 4.817652   to the right, improve=1.234789, (0 missing)
##   Surrogate splits:
##       logalamine_transferase < 1.810683   to the right, agree=0.913, adj=0.2, (0 split)
##
## Node number 34: 13 observations
##   predicted class=no    expected loss=0.4615385  P(node) =0.02801724
##     class counts:     7     6
##    probabilities: 0.538 0.462
##
## Node number 35: 18 observations
##   predicted class=yes  expected loss=0.1111111  P(node) =0.0387931
##     class counts:     2    16
##    probabilities: 0.111 0.889
##
```

```
## Node number 38: 7 observations
##   predicted class=no    expected loss=0.2857143  P(node) =0.01508621
##       class counts:     5     2
##      probabilities: 0.714 0.286
##
## Node number 39: 57 observations
##   predicted class=yes   expected loss=0.1929825  P(node) =0.1228448
##       class counts:    11    46
##      probabilities: 0.193 0.807
##
## Node number 66: 123 observations,    complexity param=0.02083333
##   predicted class=no    expected loss=0.4715447  P(node) =0.2650862
##       class counts:    65    58
##      probabilities: 0.528 0.472
##   left son=132 (98 obs) right son=133 (25 obs)
##   Primary splits:
##       logtot_proteins          < 6.027159   to the right, improve=1.7808130, (0 missing)
##       logalbumin_globulin_ratio < 5.255588   to the right, improve=1.6037690, (0 missing)
##       logtot_bilirubin         < 1.138816   to the right, improve=1.0911140, (0 missing)
##       logalbumin               < 4.817652   to the right, improve=0.9550338, (0 missing)
##       logalamine_transferase   < 2.47011    to the right, improve=0.9550338, (0 missing)
##   Surrogate splits:
##       logtot_bilirubin              < 0.5662497  to the right, agree=0.813, adj=0.08, (0 split)
##       logalbumin_globulin_ratio     < 5.57402    to the left,  agree=0.805, adj=0.04, (0 split)
##       logaspartate_aminotransferase < 3.110195   to the left,  agree=0.805, adj=0.04, (0 split)
##
## Node number 67: 15 observations
##   predicted class=yes  expected loss=0.2666667  P(node) =0.03232759
##       class counts:     4    11
##      probabilities: 0.267 0.733
##
## Node number 132: 98 observations,    complexity param=0.02083333
##   predicted class=no    expected loss=0.4285714  P(node) =0.2112069
##       class counts:    56    42
##      probabilities: 0.571 0.429
##   left son=264 (21 obs) right son=265 (77 obs)
##   Primary splits:
##       logtot_bilirubin         < 0.7100908  to the left,  improve=1.9393940, (0 missing)
##       logalbumin               < 4.806416   to the right, improve=1.1636360, (0 missing)
##       logalkaline_phosphate    < 1.284924   to the left,  improve=1.0409640, (0 missing)
##       logalbumin_globulin_ratio < 4.020127   to the right, improve=0.7459207, (0 missing)
##       logage                   < 5.182021   to the left,  improve=0.6545455, (0 missing)
##   Surrogate splits:
##       logalamine_transferase < 1.810683   to the left,  agree=0.806, adj=0.095, (0 split)
##
## Node number 133: 25 observations,    complexity param=0.007575758
##   predicted class=yes  expected loss=0.36  P(node) =0.05387931
##       class counts:     9    16
##      probabilities: 0.360 0.640
##   left son=266 (11 obs) right son=267 (14 obs)
##   Primary splits:
##       logalbumin                   < 4.198465   to the left,  improve=1.3511690, (0 missing)
##       logalamine_transferase       < 2.208849   to the left,  improve=1.2472730, (0 missing)
##       logalbumin_globulin_ratio    < 4.238486   to the left,  improve=1.0755560, (0 missing)
```

```
##         logaspartate_aminotransferase < 2.987781   to the left,  improve=0.9168254, (0 missing)
##         logage                       < 4.959678   to the right, improve=0.8692063, (0 missing)
##   Surrogate splits:
##         logalbumin_globulin_ratio < 4.238486   to the left,  agree=0.76, adj=0.455, (0 split)
##         logage                    < 4.624252   to the right, agree=0.64, adj=0.182, (0 split)
##         logtot_bilirubin          < 0.5662497  to the left,  agree=0.64, adj=0.182, (0 split)
##         logdirect_bilirubin       < -0.4067054 to the right, agree=0.64, adj=0.182, (0 split)
##         logalamine_transferase    < 2.208849   to the left,  agree=0.64, adj=0.182, (0 split)
##
## Node number 264: 21 observations
##   predicted class=no   expected loss=0.2380952  P(node) =0.04525862
##     class counts:    16     5
##    probabilities: 0.762 0.238
##
## Node number 265: 77 observations,    complexity param=0.02083333
##   predicted class=no   expected loss=0.4805195  P(node) =0.1659483
##     class counts:    40    37
##    probabilities: 0.519 0.481
##   left son=530 (8 obs) right son=531 (69 obs)
##   Primary splits:
##         logalbumin                   < 4.806416   to the right, improve=2.2567760, (0 missing)
##         logtot_bilirubin             < 1.138816   to the right, improve=1.2987010, (0 missing)
##         logaspartate_aminotransferase < 2.658183  to the right, improve=1.2966310, (0 missing)
##         logdirect_bilirubin          < 0.3980136  to the right, improve=0.9488048, (0 missing)
##         logalbumin_globulin_ratio    < 5.034201   to the right, improve=0.9488048, (0 missing)
##   Surrogate splits:
##         logage                    < 4.314021   to the left,  agree=0.922, adj=0.25, (0 split)
##         logalbumin_globulin_ratio < 5.194907   to the right, agree=0.922, adj=0.25, (0 split)
##
## Node number 266: 11 observations
##   predicted class=no   expected loss=0.4545455  P(node) =0.0237069
##     class counts:     6     5
##    probabilities: 0.545 0.455
##
## Node number 267: 14 observations
##   predicted class=yes  expected loss=0.2142857  P(node) =0.03017241
##     class counts:     3    11
##    probabilities: 0.214 0.786
##
## Node number 530: 8 observations
##   predicted class=no   expected loss=0.125  P(node) =0.01724138
##     class counts:     7     1
##    probabilities: 0.875 0.125
##
## Node number 531: 69 observations,    complexity param=0.02083333
##   predicted class=yes  expected loss=0.4782609  P(node) =0.1487069
##     class counts:    33    36
##    probabilities: 0.478 0.522
##   left son=1062 (56 obs) right son=1063 (13 obs)
##   Primary splits:
##         logage                       < 4.465247   to the right, improve=1.9622550, (0 missing)
##         logalbumin_globulin_ratio    < 4.636199   to the left,  improve=1.7162640, (0 missing)
##         logaspartate_aminotransferase < 2.658183  to the right, improve=0.9429793, (0 missing)
##         logtot_bilirubin             < 1.222343   to the right, improve=0.7347826, (0 missing)
```

```
##         logalbumin                         < 4.238486   to the right, improve=0.5536281, (0 missing)
##   Surrogate splits:
##         logaspartate_aminotransferase < 2.557646   to the right, agree=0.826, adj=0.077, (0 split)
##         logalamine_transferase        < 1.89588    to the right, agree=0.826, adj=0.077, (0 split)
##
## Node number 1062: 56 observations,    complexity param=0.02083333
##   predicted class=no    expected loss=0.4642857  P(node) =0.1206897
##     class counts:    30    26
##    probabilities: 0.536 0.464
##   left son=2124 (36 obs) right son=2125 (20 obs)
##   Primary splits:
##         logtot_proteins            < 6.126931   to the right, improve=2.146032, (0 missing)
##         logalbumin                 < 4.238486   to the right, improve=1.880369, (0 missing)
##         logtot_bilirubin           < 1.222343   to the right, improve=1.653061, (0 missing)
##         logage                     < 4.624252   to the left,  improve=1.256670, (0 missing)
##         logalbumin_globulin_ratio  < 4.636199   to the left,  improve=1.251082, (0 missing)
##   Surrogate splits:
##         logalbumin                         < 3.802901   to the right, agree=0.732, adj=0.25, (0 split)
##         logdirect_bilirubin                < 0.195281   to the left,  agree=0.696, adj=0.15, (0 split)
##         logaspartate_aminotransferase < 2.618947   to the right, agree=0.696, adj=0.15, (0 split)
##         logalamine_transferase        < 1.935901   to the right, agree=0.696, adj=0.15, (0 split)
##         logtot_bilirubin              < 1.222343   to the left,  agree=0.661, adj=0.05, (0 split)
##
## Node number 1063: 13 observations
##   predicted class=yes   expected loss=0.2307692  P(node) =0.02801724
##     class counts:     3    10
##    probabilities: 0.231 0.769
##
## Node number 2124: 36 observations,    complexity param=0.01515152
##   predicted class=no    expected loss=0.3611111  P(node) =0.07758621
##     class counts:    23    13
##    probabilities: 0.639 0.361
##   left son=4248 (18 obs) right son=4249 (18 obs)
##   Primary splits:
##         logalbumin                         < 4.238486   to the right, improve=2.7222220, (0 missing)
##         logage                             < 4.663233   to the left,  improve=0.8278599, (0 missing)
##         logtot_proteins                    < 6.198482   to the left,  improve=0.8278599, (0 missing)
##         logaspartate_aminotransferase < 2.816419   to the left,  improve=0.8278599, (0 missing)
##         logalbumin_globulin_ratio     < 4.511434   to the right, improve=0.7188034, (0 missing)
##   Surrogate splits:
##         logalbumin_globulin_ratio     < 4.113268   to the right, agree=0.722, adj=0.444, (0 split)
##         logage                             < 4.624252   to the left,  agree=0.611, adj=0.222, (0 split)
##         logaspartate_aminotransferase < 2.980978   to the right, agree=0.611, adj=0.222, (0 split)
##         loggender                          < 1.346574   to the right, agree=0.583, adj=0.167, (0 split)
##         logtot_bilirubin                   < 1.222343   to the right, agree=0.583, adj=0.167, (0 split)
##
## Node number 2125: 20 observations,    complexity param=0.01515152
##   predicted class=yes   expected loss=0.35  P(node) =0.04310345
##     class counts:     7    13
##    probabilities: 0.350 0.650
##   left son=4250 (12 obs) right son=4251 (8 obs)
##   Primary splits:
##         logalbumin_globulin_ratio     < 4.156774   to the left,  improve=3.266667, (0 missing)
##         logalbumin                         < 3.970086   to the left,  improve=2.016667, (0 missing)
```

96

```
##       logage                         < 4.783931   to the left,  improve=1.056044, (0 missing)
##       logtot_proteins                < 6.072039   to the left,  improve=0.900000, (0 missing)
##       logaspartate_aminotransferase  < 2.924222   to the left,  improve=0.900000, (0 missing)
##   Surrogate splits:
##       logage                         < 4.941535   to the left,  agree=0.75, adj=0.375, (0 split)
##       logalbumin                     < 4.364912   to the left,  agree=0.70, adj=0.250, (0 split)
##       logaspartate_aminotransferase  < 2.736604   to the right, agree=0.70, adj=0.250, (0 split)
##       logalamine_transferase         < 2.115007   to the right, agree=0.70, adj=0.250, (0 split)
##       logalkaline_phosphate          < 1.284924   to the left,  agree=0.70, adj=0.250, (0 split)
##
## Node number 4248: 18 observations
##   predicted class=no   expected loss=0.1666667  P(node) =0.0387931
##     class counts:    15     3
##    probabilities: 0.833 0.167
##
## Node number 4249: 18 observations
##   predicted class=yes  expected loss=0.4444444  P(node) =0.0387931
##     class counts:     8    10
##    probabilities: 0.444 0.556
##
## Node number 4250: 12 observations
##   predicted class=no   expected loss=0.4166667  P(node) =0.02586207
##     class counts:     7     5
##    probabilities: 0.583 0.417
##
## Node number 4251: 8 observations
##   predicted class=yes  expected loss=0  P(node) =0.01724138
##     class counts:     0     8
##    probabilities: 0.000 1.000
```

RANDOM FORESTS

```
ctrl3 <- trainControl(method = "cv", summaryFunction = twoClassSummary, classProbs = TRUE)
```

```
model.rf2 <- train(outcome~., data = liver_df1, subset = rowTrain, method = "rpart",
                 trControl = ctrl3, metric = "ROC")
RF.pred <- predict(model.rf2, newdata = liver_df1[-rowTrain, ])

confu_dtree <- confusionMatrix(RF.pred, liver_df1[-rowTrain, ]$outcome)
confu_dtree
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction no yes
##       no   0   0
##       yes 33  82
##
##              Accuracy : 0.713
##                95% CI : (0.6212, 0.7935)
```

```
##       No Information Rate : 0.713
##       P-Value [Acc > NIR] : 0.5468
##
##                     Kappa : 0
##
##   Mcnemar's Test P-Value : 2.54e-08
##
##                Sensitivity : 0.000
##                Specificity : 1.000
##            Pos Pred Value :    NaN
##            Neg Pred Value : 0.713
##                 Prevalence : 0.287
##             Detection Rate : 0.000
##      Detection Prevalence : 0.000
##         Balanced Accuracy : 0.500
##
##           'Positive' Class : no
##
```

```r
#set.seed(1)
#rf2.final.per <- ranger(outcome ~ . ,
                        #data = liver_df1[rowTrain,],
                        #mtry = model.rf2$bestTune[[1]],
                        #splitrule = "gini",
                        #min.node.size = model.rf2$bestTune[[3]],
                        #importance = "permutation",
                        #scale.permutation.importance = TRUE)

#barplot(sort(ranger::importance(rf2.final.per), decreasing = FALSE),
        #las = 2, horiz = TRUE, cex.names = 0.7,
        #col = colorRampPalette(colors = c("cyan","blue"))(19))
```

#SVM

```r
set.seed(10)
svm.linear2.model <- train(
  outcome ~.,
  data = liver.train,
  method = "svmLinear2",
  trControl = ctrl3,
  #preProcess = c("center", "scale"),
  tuneGrid =data.frame(cost =exp(seq(-10,1,len=20))),
  )
```

```
## Warning in train.default(x, y, weights = w, ...): The metric "Accuracy" was not
## in the result set. ROC will be used instead.
```

```r
plot(svm.linear2.model, highlight = TRUE, xTrans = log)
```
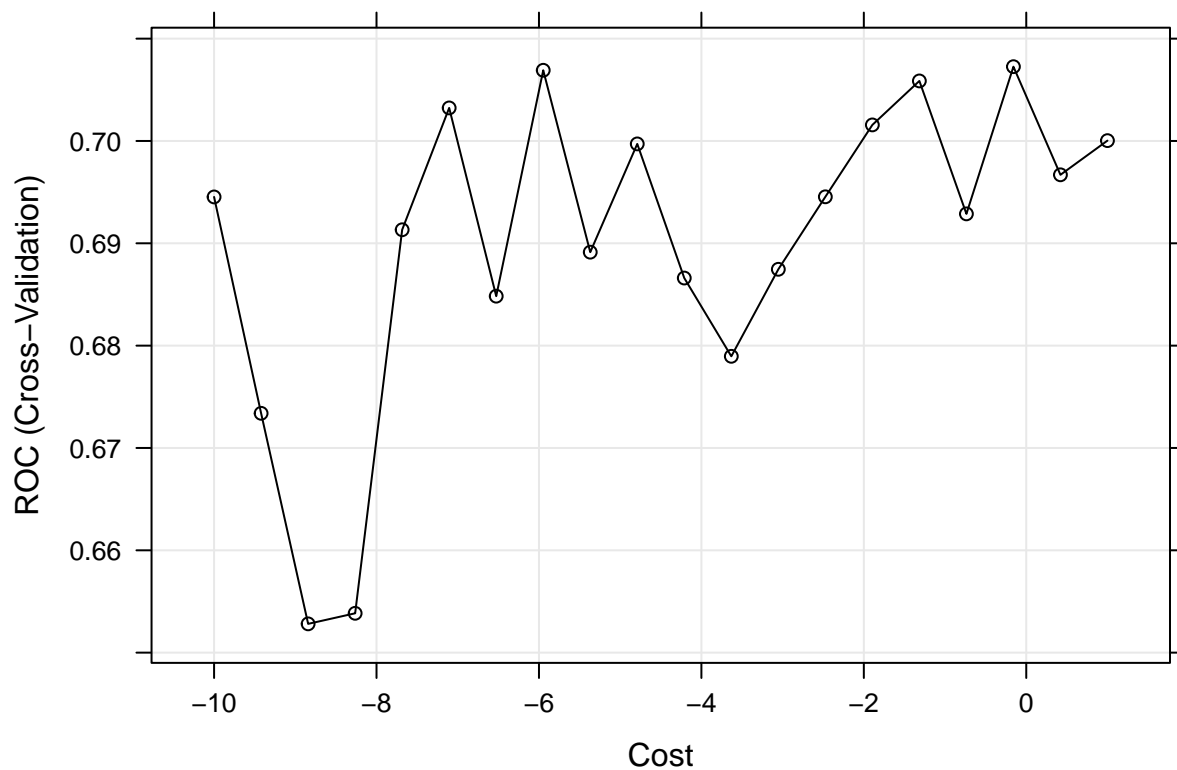
```
svm.linear2.model$bestTune
```

```
##         cost
## 18 0.8539397
```

```
svm.linear2.model$finalModel
```

```
##
## Call:
## svm.default(x = as.matrix(x), y = y, kernel = "linear", cost = param$cost,
##     probability = classProbs)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  linear
##        cost:  0.8539397
##
## Number of Support Vectors:  288
```

```
max(svm.linear2.model$result$ROC)
```

```
## [1] 0.7072594
```

```
ggplot(svm.linear2.model, highlight = TRUE)
```
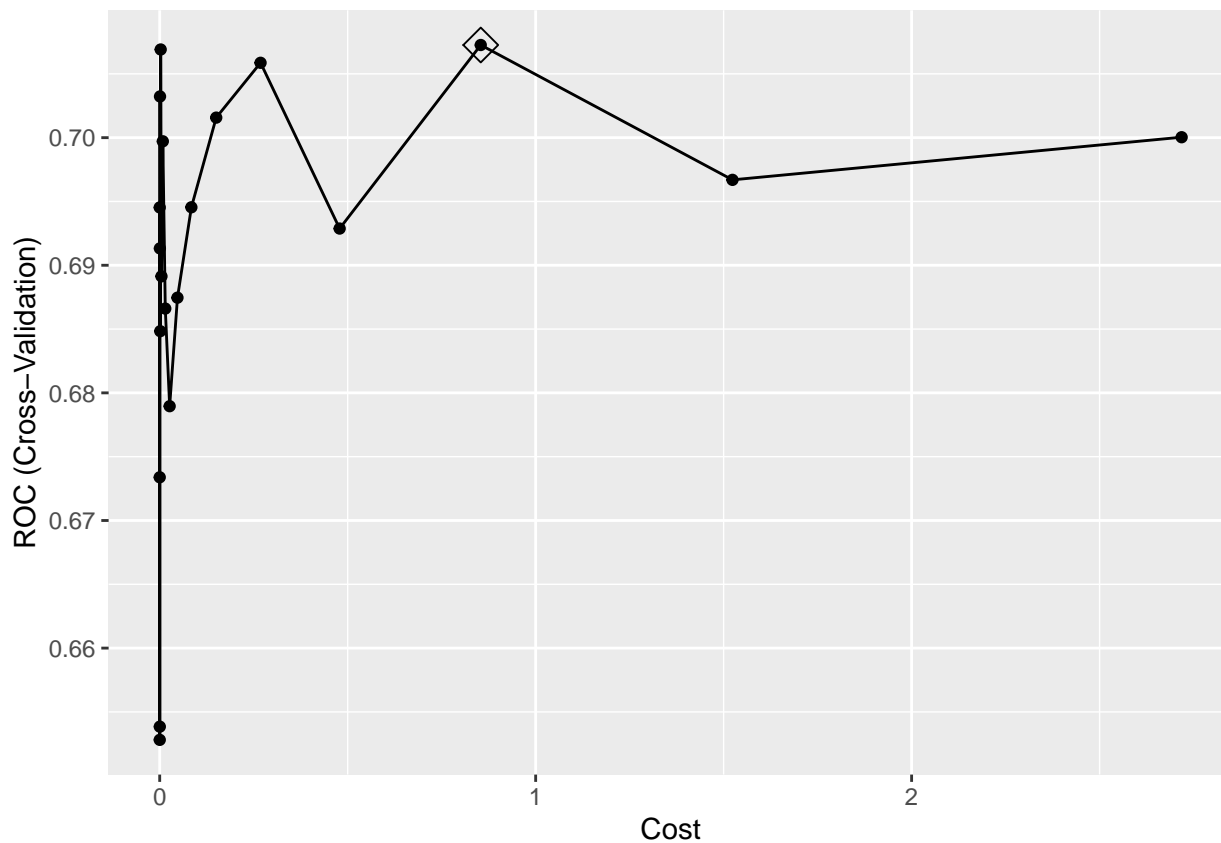
```r
svmr.grid <- expand.grid(C = exp(seq(-1, 4,len = 10)), sigma = exp(seq(-10,0,len = 10)))

# tunes over both cost and sigma
set.seed(10)
svmr.grid <- expand.grid(C = exp(seq(-10,1,len = 20)),
                         sigma = exp(seq(-8,0,len = 10)))
svm.radial.model <- train(outcome ~ . , liver_df1,
                  subset = rowTrain,
                  method = "svmRadial",
                  preProcess = c("center", "scale"),
                  trControl = ctrl3,
                  prob.model = TRUE,
                  tuneGrid = svmr.grid, metric = "ROC")
```

```
## maximum number of iterations reached 1.0162e-05 -1.0162e-05maximum number of iterations reached 2.090
```

```r
plot(svm.radial.model, highlight = TRUE)
```
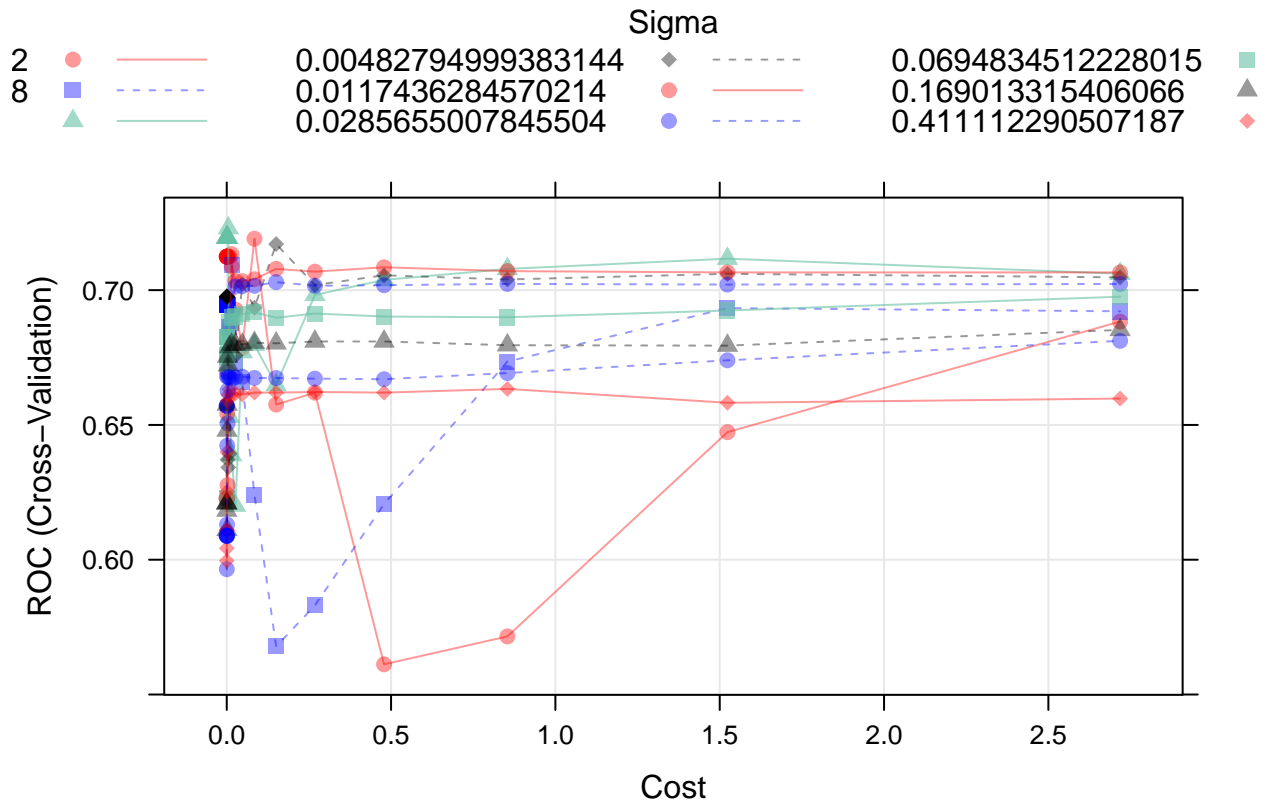
```
svm.radial.model$bestTune
```

```
##        sigma           C
## 83 0.00198483 0.004661486
```

```
svm.radial.model$finalModel
```

```
## Support Vector Machine object of class "ksvm"
##
## SV type: C-svc  (classification)
##  parameter : cost C = 0.00466148574327131
##
## Gaussian Radial Basis kernel function.
##  Hyperparameter : sigma =  0.0019848295804182
##
## Number of Support Vectors : 264
##
## Objective Function Value : -1.2306
## Training error : 0.284483
## Probability model included.
```

```
ggplot(svm.radial.model, highlight = TRUE)
```

```
## Warning: The shape palette can deal with a maximum of 6 discrete values because
## more than 6 becomes difficult to discriminate; you have 10. Consider
## specifying shapes manually if you must have them.
```

Warning: Removed 80 rows containing missing values (geom_point).
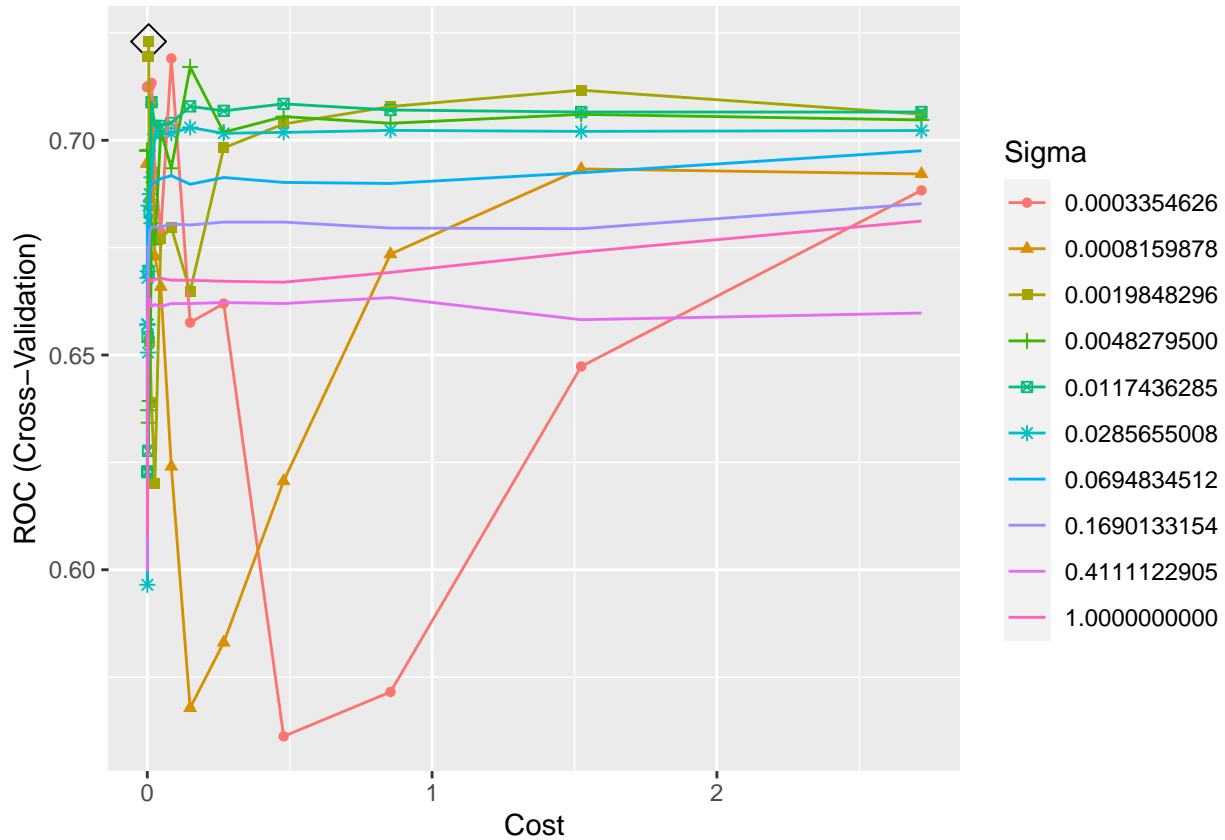

```
SVM.pred = predict(svm.radial.model, newdata = liver_df1[-rowTrain, ])
confusionMatrix(data = SVM.pred, reference = liver_df1[-rowTrain, ]$outcome)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction no yes
##        no   0   0
##        yes 33  82
##
##                Accuracy : 0.713
##                  95% CI : (0.6212, 0.7935)
##     No Information Rate : 0.713
##     P-Value [Acc > NIR] : 0.5468
##
##                   Kappa : 0
##
##  Mcnemar's Test P-Value : 2.54e-08
##
##             Sensitivity : 0.000
##             Specificity : 1.000
##          Pos Pred Value :   NaN
##          Neg Pred Value : 0.713
##              Prevalence : 0.287
```

```
##           Detection Rate : 0.000
##     Detection Prevalence : 0.000
##        Balanced Accuracy : 0.500
##
##         'Positive' Class : no
##
```

```r
x_train <- as.matrix(liver.train[,1:10])

explainer_svm <- explain(svm.radial.model,
                         label = "svmr",
                         data = x_train,
                         y = as.numeric(liver_df1$outcome[rowTrain] == "yes"),
                         verbose = FALSE)
vi_svm <- model_parts(explainer_svm)
plot(vi_svm)
```


Feature Importance
created for the svmr model
svmr
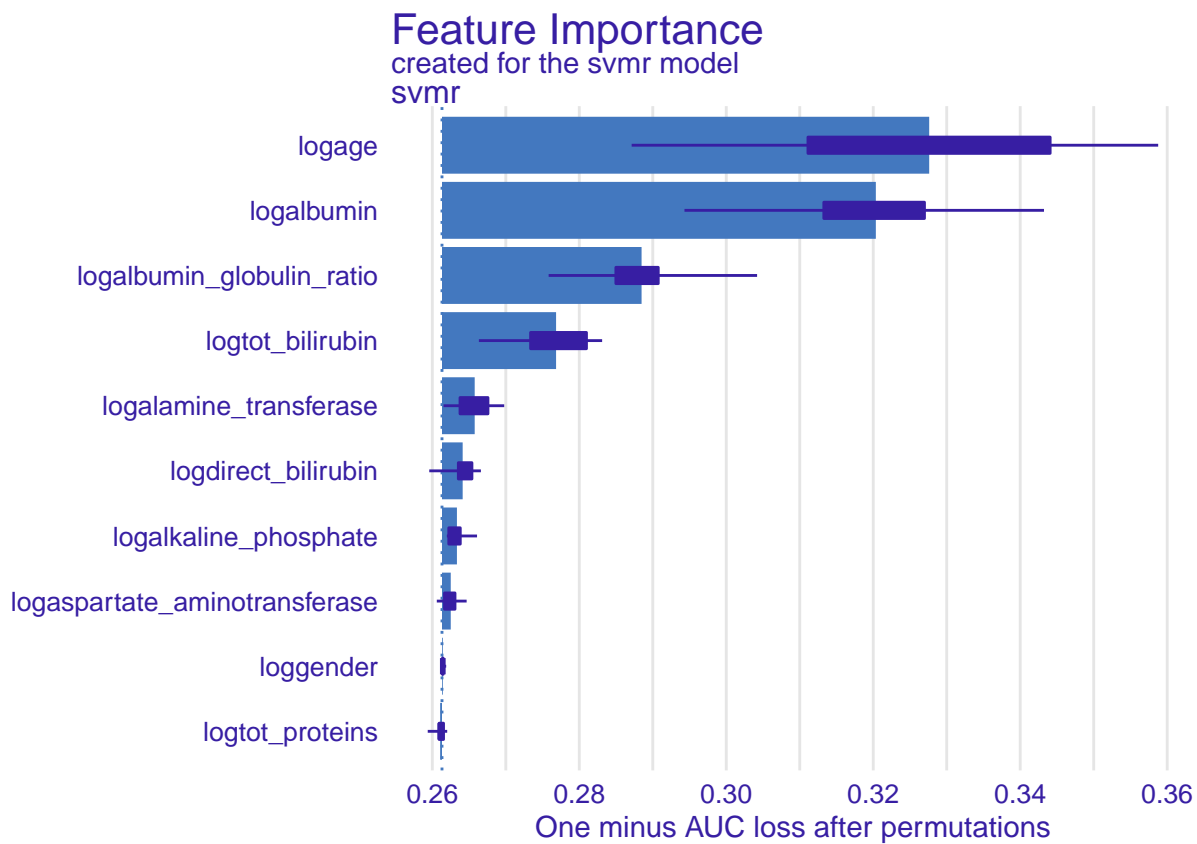
Boosting

```r
gbmA.grid <- expand.grid(n.trees = c(2000,3000,4000),
                         interaction.depth = 1:6,
                         shrinkage = c(0.001,0.003,0.005),
                         n.minobsinnode = 1)
```

```
ctrl.boost <- trainControl(method = "cv",
                           classProbs = TRUE,
                           summaryFunction = twoClassSummary)
set.seed(10)
gbmA.model <- train(outcome ~ . ,
                    data = liver.train,
                    tuneGrid = gbmA.grid,
                    trControl = ctrl.boost,
                    method = "gbm",
                    distribution = "adaboost",
                    metric = "ROC",
                    verbose = FALSE)

ggplot(gbmA.model, highlight = TRUE)
```
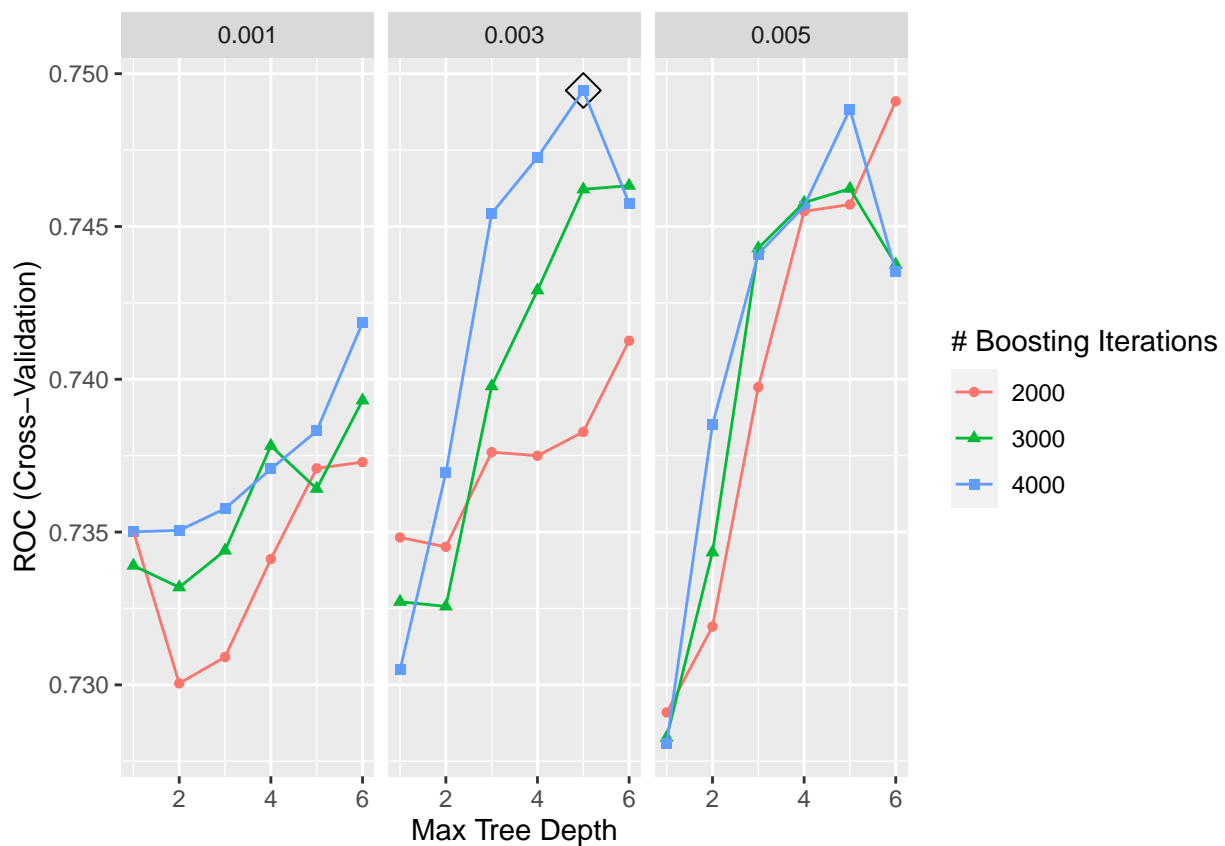


```
gbmImp <- varImp(gbmA.model, scale = FALSE)
plot(gbmImp)
```
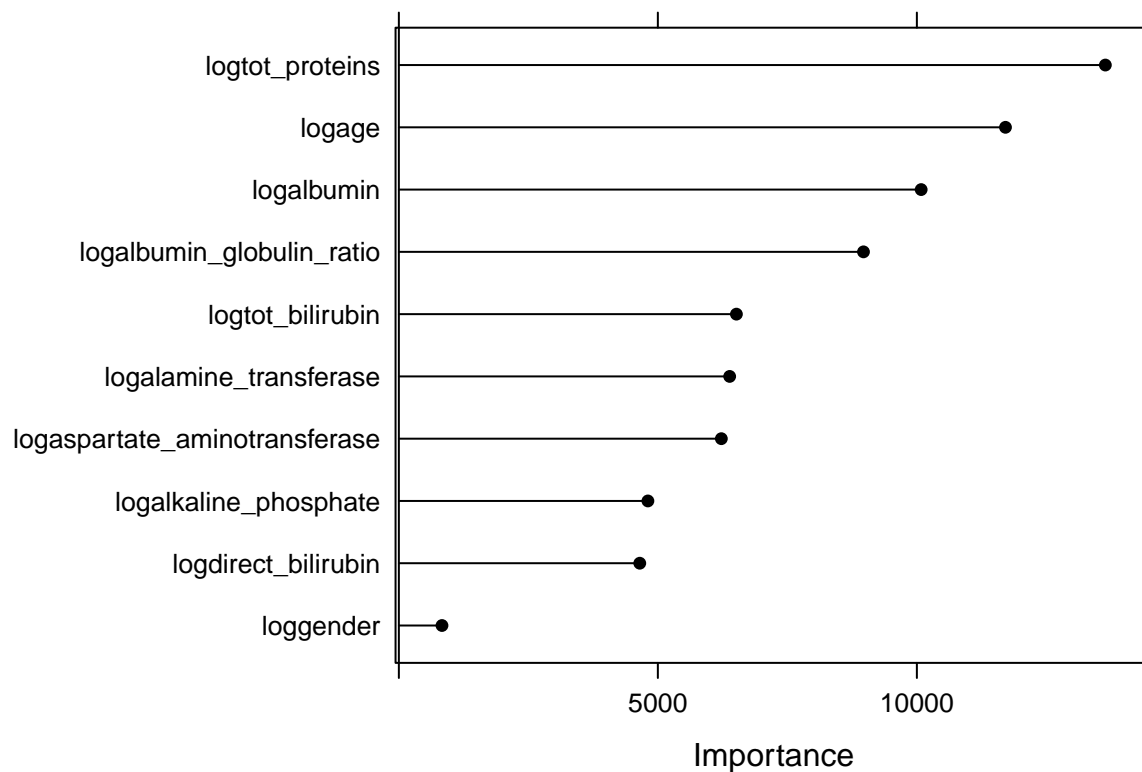
Let's select the Final Model by comparing each model's mean cross-validation AUC

```
res <- resamples(list(MARS = model.mars, RF = model.rf2, SVM = svm.radial.model, GBM = gbmA.model, LDA =
summary(res)
```

```
##
## Call:
## summary.resamples(object = res)
##
## Models: MARS, RF, SVM, GBM, LDA, QDA, NB, GLM, KNN
## Number of resamples: 10
##
## ROC
##           Min.   1st Qu.    Median      Mean   3rd Qu.      Max. NA's
## MARS 0.5859729 0.6759907 0.7410678 0.7451725 0.8255911 0.8741259    0
## RF   0.6052036 0.6351981 0.6654155 0.6720250 0.6931818 0.7715618    0
## SVM  0.5588235 0.6829837 0.7424242 0.7229986 0.7601149 0.8391608    0
## GBM  0.6233766 0.6696147 0.7276155 0.7494515 0.8548951 0.8766234    0
## LDA  0.5542986 0.6978022 0.7412587 0.7413038 0.8030303 0.8868778    0
## QDA  0.5701357 0.6969697 0.7257742 0.7231053 0.7850483 0.8344988    0
## NB   0.6083916 0.7110390 0.7770465 0.7587873 0.8216783 0.8391608    0
## GLM  0.5656109 0.6900183 0.7365967 0.7446671 0.7995338 0.9140271    0
## KNN  0.5848416 0.6705794 0.8012821 0.7523192 0.8187731 0.8636364    0
##
```

```
## Sens
##          Min.      1st Qu.    Median     Mean      3rd Qu.     Max.  NA's
## MARS 0.07692308 0.07692308 0.2307692 0.2104396 0.3021978 0.3846154      0
## RF   0.07692308 0.17307692 0.2692308 0.2637363 0.3571429 0.3846154      0
## SVM  0.00000000 0.00000000 0.0000000 0.0000000 0.0000000 0.0000000      0
## GBM  0.21428571 0.23076923 0.2692308 0.3708791 0.5192308 0.6923077      0
## LDA  0.07692308 0.07692308 0.2197802 0.2252747 0.3076923 0.4615385      0
## QDA  0.61538462 0.63461538 0.7032967 0.7489011 0.8461538 0.9285714      0
## NB   0.61538462 0.72802198 0.8461538 0.7967033 0.8461538 0.9230769      0
## GLM  0.07692308 0.23076923 0.2307692 0.2796703 0.3392857 0.6153846      0
## KNN  0.07692308 0.15384615 0.1923077 0.2269231 0.2884615 0.4615385      0
##
## Spec
##          Min.      1st Qu.    Median     Mean      3rd Qu.     Max.  NA's
## MARS 0.8484848 0.9090909 0.9393939 0.9245098 0.9625668 0.9705882      0
## RF   0.7575758 0.8077094 0.8787879 0.8614973 0.9110963 0.9393939      0
## SVM  1.0000000 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000      0
## GBM  0.7878788 0.8484848 0.8787879 0.8705882 0.8814617 0.9393939      0
## LDA  0.8484848 0.8787879 0.8957219 0.9033868 0.9318182 1.0000000      0
## QDA  0.4705882 0.5757576 0.5909091 0.5844920 0.6060606 0.6666667      0
## NB   0.4242424 0.5334225 0.5909091 0.5811052 0.6060606 0.7272727      0
## GLM  0.7878788 0.8484848 0.8939394 0.8881462 0.9324866 1.0000000      0
## KNN  0.7878788 0.8484848 0.9242424 0.8947415 0.9407308 0.9696970      0
```

```r
bwplot(res, metric = "ROC")   #This line doesn't run
```
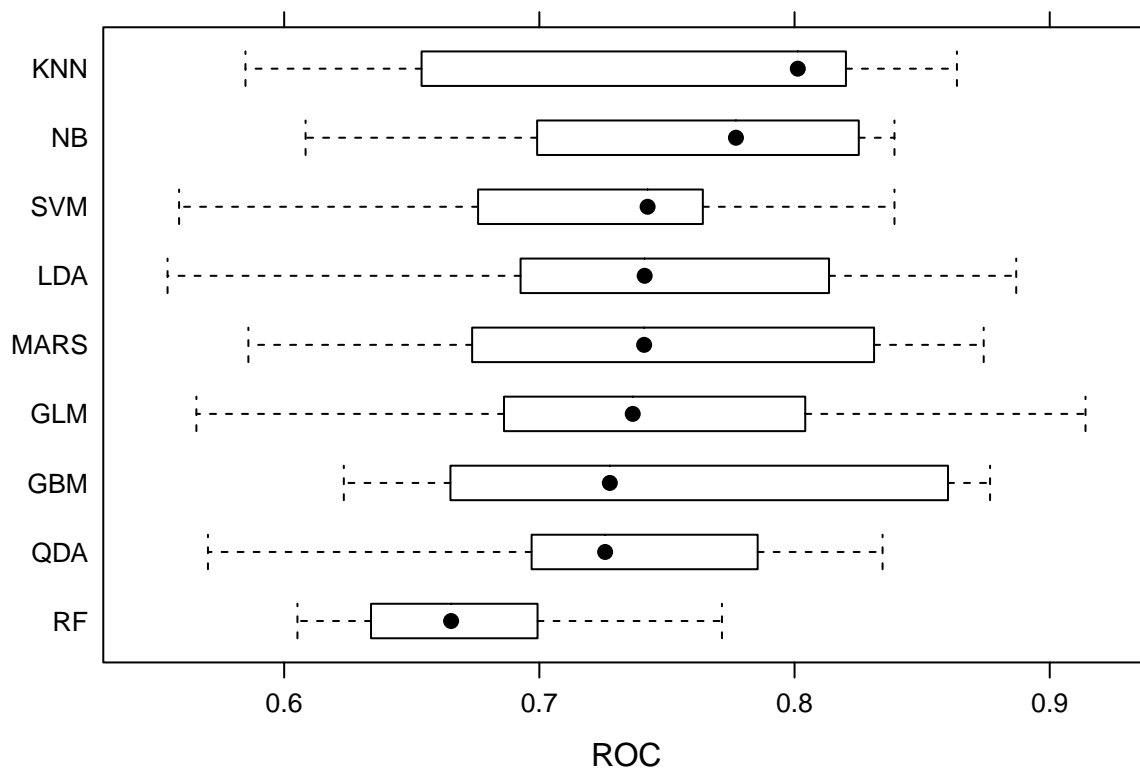


```r
res <- resamples(list(MARS = model.mars,
                      LDA = model.lda,
```

```
                     QDA = model.qda,
                     GLM = model.glm,
                     GLMN =model.glmn,
                     KNN = model.knn,
                     GBM = gbmA.model,
                     NB = model.nb,
                     RF = model.rf2,
                     SVM = svm.radial.model))
summary(res)
```

```
##
## Call:
## summary.resamples(object = res)
##
## Models: MARS, LDA, QDA, GLM, GLMN, KNN, GBM, NB, RF, SVM
## Number of resamples: 10
##
## ROC
##           Min.   1st Qu.    Median      Mean   3rd Qu.      Max. NA's
## MARS 0.5859729 0.6759907 0.7410678 0.7451725 0.8255911 0.8741259    0
## LDA  0.5542986 0.6978022 0.7412587 0.7413038 0.8030303 0.8868778    0
## QDA  0.5701357 0.6969697 0.7257742 0.7231053 0.7850483 0.8344988    0
## GLM  0.5656109 0.6900183 0.7365967 0.7446671 0.7995338 0.9140271    0
## GLMN 0.5701357 0.7053363 0.7552448 0.7565993 0.8232601 0.9004525    0
## KNN  0.5848416 0.6705794 0.8012821 0.7523192 0.8187731 0.8636364    0
## GBM  0.6233766 0.6696147 0.7276155 0.7494515 0.8548951 0.8766234    0
## NB   0.6083916 0.7110390 0.7770465 0.7587873 0.8216783 0.8391608    0
## RF   0.6052036 0.6351981 0.6654155 0.6720250 0.6931818 0.7715618    0
## SVM  0.5588235 0.6829837 0.7424242 0.7229986 0.7601149 0.8391608    0
##
## Sens
##            Min.    1st Qu.     Median      Mean   3rd Qu.      Max. NA's
## MARS 0.07692308 0.07692308 0.2307692 0.2104396 0.3021978 0.3846154    0
## LDA  0.07692308 0.07692308 0.2197802 0.2252747 0.3076923 0.4615385    0
## QDA  0.61538462 0.63461538 0.7032967 0.7489011 0.8461538 0.9285714    0
## GLM  0.07692308 0.23076923 0.2307692 0.2796703 0.3392857 0.6153846    0
## GLMN 0.07692308 0.07692308 0.1840659 0.1956044 0.2884615 0.3846154    0
## KNN  0.07692308 0.15384615 0.1923077 0.2269231 0.2884615 0.4615385    0
## GBM  0.21428571 0.23076923 0.2692308 0.3708791 0.5192308 0.6923077    0
## NB   0.61538462 0.72802198 0.8461538 0.7967033 0.8461538 0.9230769    0
## RF   0.07692308 0.17307692 0.2692308 0.2637363 0.3571429 0.3846154    0
## SVM  0.00000000 0.00000000 0.0000000 0.0000000 0.0000000 0.0000000    0
##
## Spec
##           Min.   1st Qu.    Median      Mean   3rd Qu.      Max. NA's
## MARS 0.8484848 0.9090909 0.9393939 0.9245098 0.9625668 0.9705882    0
## LDA  0.8484848 0.8787879 0.8957219 0.9033868 0.9318182 1.0000000    0
## QDA  0.4705882 0.5757576 0.5909091 0.5844920 0.6060606 0.6666667    0
## GLM  0.7878788 0.8484848 0.8939394 0.8881462 0.9324866 1.0000000    0
## GLMN 0.8787879 0.9090909 0.9104278 0.9245098 0.9393939 1.0000000    0
## KNN  0.7878788 0.8484848 0.9242424 0.8947415 0.9407308 0.9696970    0
## GBM  0.7878788 0.8484848 0.8787879 0.8705882 0.8814617 0.9393939    0
## NB   0.4242424 0.5334225 0.5909091 0.5811052 0.6060606 0.7272727    0
```

```
## RF    0.7575758 0.8077094 0.8787879 0.8614973 0.9110963 0.9393939    0
## SVM   1.0000000 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000    0
```

```r
bwplot(res, metric = "ROC")
```
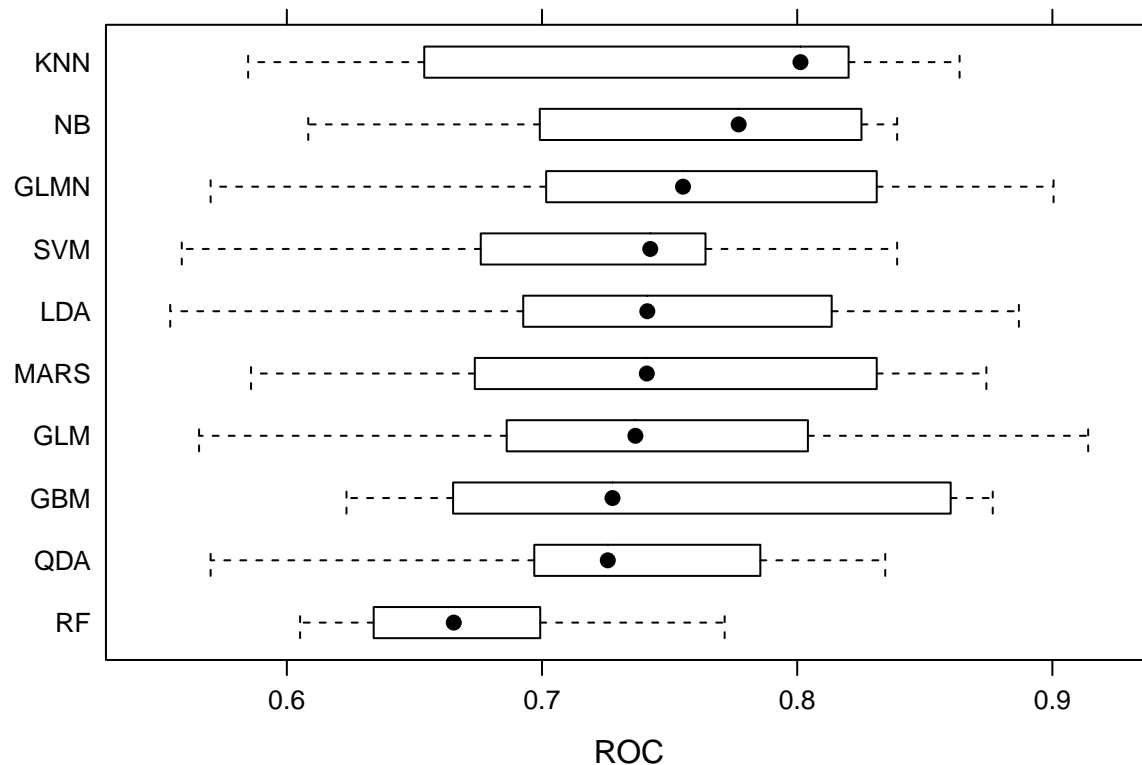


```r
#resamps_svm <- resamples(list(svmr = svm.radial.model, svml = svm.linear.model))
#summary(resamps_svm)
#bwplot(resamps_svm) #SVM
```

Let's look at the test set performance: comparing ROC MODELS

```r
mars.pred = predict(model.mars, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
RF.pred = predict(model.rf2, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
LDA.pred = predict(model.lda, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
QDA.pred = predict(model.qda, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
NB.pred = predict(model.nb, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 21
```

```
## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with
## observation 49
```

```
SVM.pred = predict(svm.radial.model, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
GBM.pred = predict(gbmA.model, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
GLM.pred = predict(model.glm, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
GLMN.pred = predict(model.glmn, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]
KNN.pred = predict(model.knn, newdata = liver_df1[-rowTrain, ], type = "prob")[,1]

roc.mars <- roc(liver_df1[-rowTrain, ]$outcome, mars.pred)
```

```
## Setting levels: control = no, case = yes
```

```
## Setting direction: controls > cases
```

```
roc.RF <- roc(liver_df1[-rowTrain, ]$outcome, RF.pred)
```

```
## Setting levels: control = no, case = yes
```

```
## Setting direction: controls < cases
```

```
roc.LDA <- roc(liver_df1[-rowTrain, ]$outcome, LDA.pred)
```

```
## Setting levels: control = no, case = yes
```

```
## Setting direction: controls > cases
```

```
roc.QDA <- roc(liver_df1[-rowTrain, ]$outcome, QDA.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.NB <- roc(liver_df1[-rowTrain, ]$outcome, NB.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.SVM <- roc(liver_df1[-rowTrain, ]$outcome, SVM.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.GBM <- roc(liver_df1[-rowTrain, ]$outcome, GBM.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.GLM <- roc(liver_df1[-rowTrain, ]$outcome, GLM.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.GLMN <- roc(liver_df1[-rowTrain, ]$outcome, GLMN.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
roc.KNN <- roc(liver_df1[-rowTrain, ]$outcome, KNN.pred)
```

```
## Setting levels: control = no, case = yes
## Setting direction: controls > cases
```

```
plot(roc.mars, col = 1)
plot(roc.RF, add = T, col = 2)
plot(roc.LDA, add = T, col = 3)
plot(roc.QDA, add = T, col = 4)
plot(roc.NB, add = T, col = 5)
plot(roc.GBM, add = T, col = 6)
plot(roc.GLM, add = T, col = 7)
plot(roc.GLMN, add = T, col = 8)
plot(roc.KNN, add = T, col = 9)
plot(roc.SVM, add = T, col =10)

auc <- c(roc.mars$auc[1], roc.RF$auc[1], roc.LDA$auc[1], roc.QDA$auc[1],
         roc.NB$auc[1], roc.GBM$auc[1], roc.GLM$auc[1], roc.GLMN$auc[1],
         roc.KNN$auc[1], roc.SVM$auc[1])
modelNames <- c("Mars","RF", "LDA", "QDA", "NB", "GBM", "GLM", "GLMN", "KNN", "SVM")

legend("bottomright", legend = paste0(modelNames, ": ", round(auc,3)), col = 1:10, lwd = 3, ncol = 2, c
```