```r
#libs
require("ROSE")
```

```
## Loading required package: ROSE

## Warning: package 'ROSE' was built under R version 3.3.3

## Loaded ROSE 0.0-3
```

```r
require("pROC")
```

```
## Loading required package: pROC

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

##
## Attaching package: 'pROC'

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

```r
require("rpart")
```

```
## Loading required package: rpart
```

```r
require("rpart.plot")
```

```
## Loading required package: rpart.plot

## Warning: package 'rpart.plot' was built under R version 3.3.3
```

```r
require("caret")
```

```
## Loading required package: caret

## Loading required package: lattice

## Loading required package: ggplot2
```

```r
require("randomForest")
```

```
## Loading required package: randomForest

## Warning: package 'randomForest' was built under R version 3.3.3

## randomForest 4.6-12

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

##
## Attaching package: 'randomForest'

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

```r
require("e1071")
```

```
## Loading required package: e1071
```

```r
#main file
cc <- data.frame(read.csv("data/cc.csv"))
cc <- cc[,c(2:31)]
```

```r
#check balance
fraud <- nrow(cc[cc$Class == 1,])
notFraud <- nrow(cc) - fraud
paste("fraud: ", fraud, "|| not fraud: ", notFraud)
```

```
## [1] "fraud:  492 || not fraud:  284315"
```

```r
#make the size smaller for easier use
set.seed(65)
cc_simp <- cc[sample(nrow(cc), 25000), ]
fraud <- nrow(cc_simp[cc_simp$Class == 1,])
notFraud <- nrow(cc_simp) - fraud
paste("fraud: ", fraud, "|| not fraud: ", notFraud)
```

```
## [1] "fraud:  43 || not fraud:  24957"
```

```r
#split data for testing models
trainLength <- floor(.7*nrow(cc_simp))
testLength <- nrow(cc_simp) - trainLength

train_model <- cc_simp[1:trainLength,]
train_eval <- cc_simp[(trainLength + 1):nrow(cc_simp),]

#over and undersample, to meet in the middle
fraud <- nrow(train_model[train_model$Class == 1,])
notFraud <- nrow(train_model) - fraud
paste("fraud: ", fraud, "|| not fraud: ", notFraud)
```

```
## [1] "fraud:  29 || not fraud:  17471"
```

```r
train_model <- ovun.sample(Class ~ ., data = train_model, method = "both", p = 0.5, N = fraud+notFraud,


#functions for sd and se
mysd <- function(predict, target) {
  diff_sq <- (predict - mean(target))^2
  return(mean(sqrt(diff_sq)))
}

myse <- function(predict, target) {
  diff_sq <- (predict - target)^2
  return(mean(sqrt(diff_sq)))
}


#Model1 - Multiple Linear Regression - Base Line
mlr1 <- glm(Class~., data = train_model)
BIC(mlr1)
```

```
## [1] 2539.374
```

```r
predict_mlr1 <- predict(mlr1, train_eval, type = 'response')
table(train_eval$Class, predict_mlr1 > 0.5)
```

```
##
##     FALSE TRUE
##   0  7311  175
```

```
##   1     4   10
```

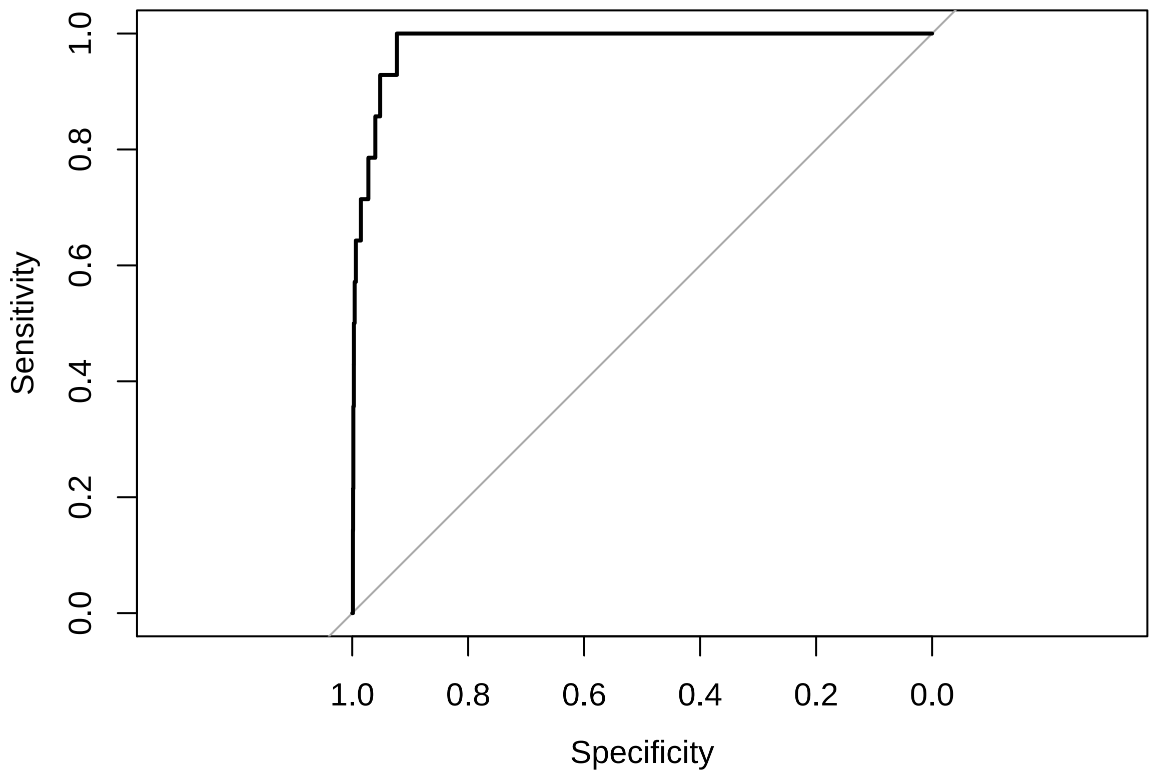
```r
mysd(predict_mlr1, train_eval$Class)
```

```
## [1] 0.1904235
```

```r
myse(predict_mlr1, train_eval$Class)
```

```
## [1] 0.190571
```

```r
auc_mlr1 <- roc(train_eval$Class, predict_mlr1)
plot(auc_mlr1)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_mlr1)
##
## Data: predict_mlr1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9835
```

```r
#Model2 - Poisson Model
poisson1 <- glm(Class ~ ., family = "poisson", data = train_model)
```

```
## Warning: glm.fit: fitted rates numerically 0 occurred
```

```r
BIC(poisson1)
```

```
## [1] 21673.2
```

```r
predict_poisson1 <- predict(poisson1, train_eval, type = 'response')
table(train_eval$Class, predict_poisson1 > 0.5)
```

```
##
##     FALSE TRUE
##   0  7327  159
##   1     7    7
```

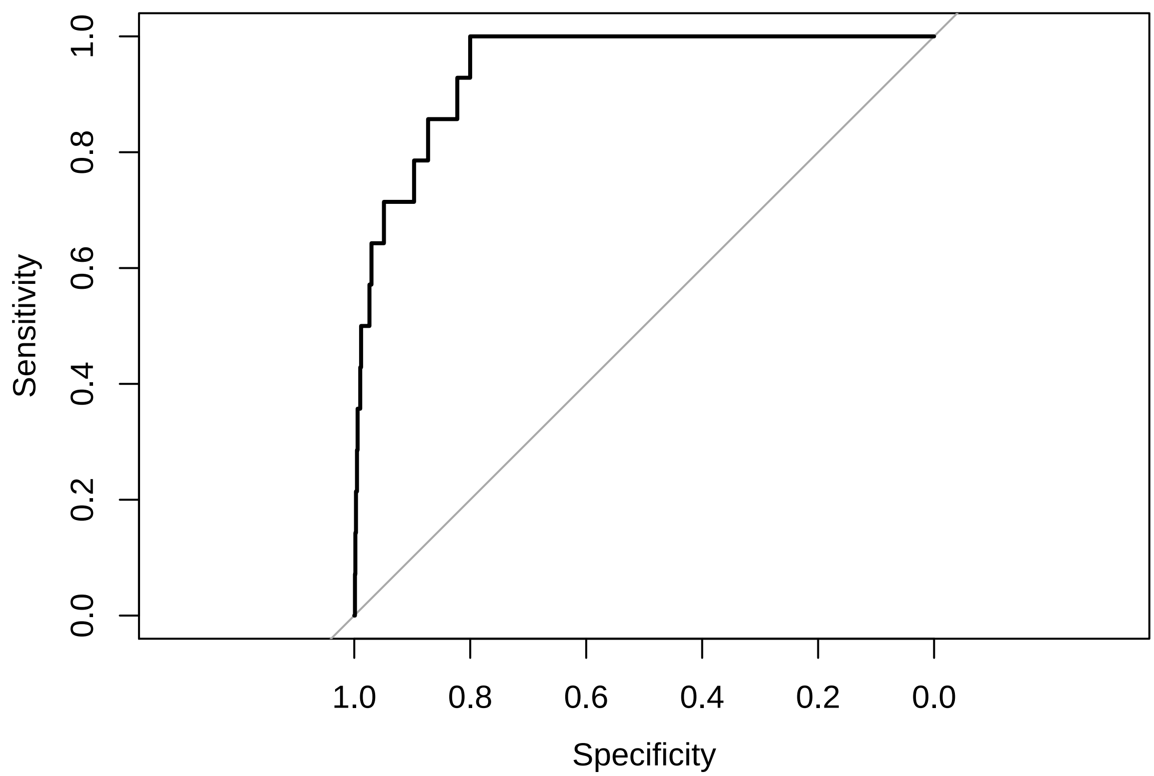
```r
mysd(predict_poisson1, train_eval$Class)
```

```
## [1] 883.6743
```

```r
myse(predict_poisson1, train_eval$Class)
```

```
## [1] 883.675
```

```r
auc_poisson <- roc(train_eval$Class, predict_poisson1)
plot(auc_poisson)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_poisson1)
##
## Data: predict_poisson1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9462
```

```r
#logit model
logit1 <- glm(Class ~., family = binomial(link='logit'), data = train_model)
```

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

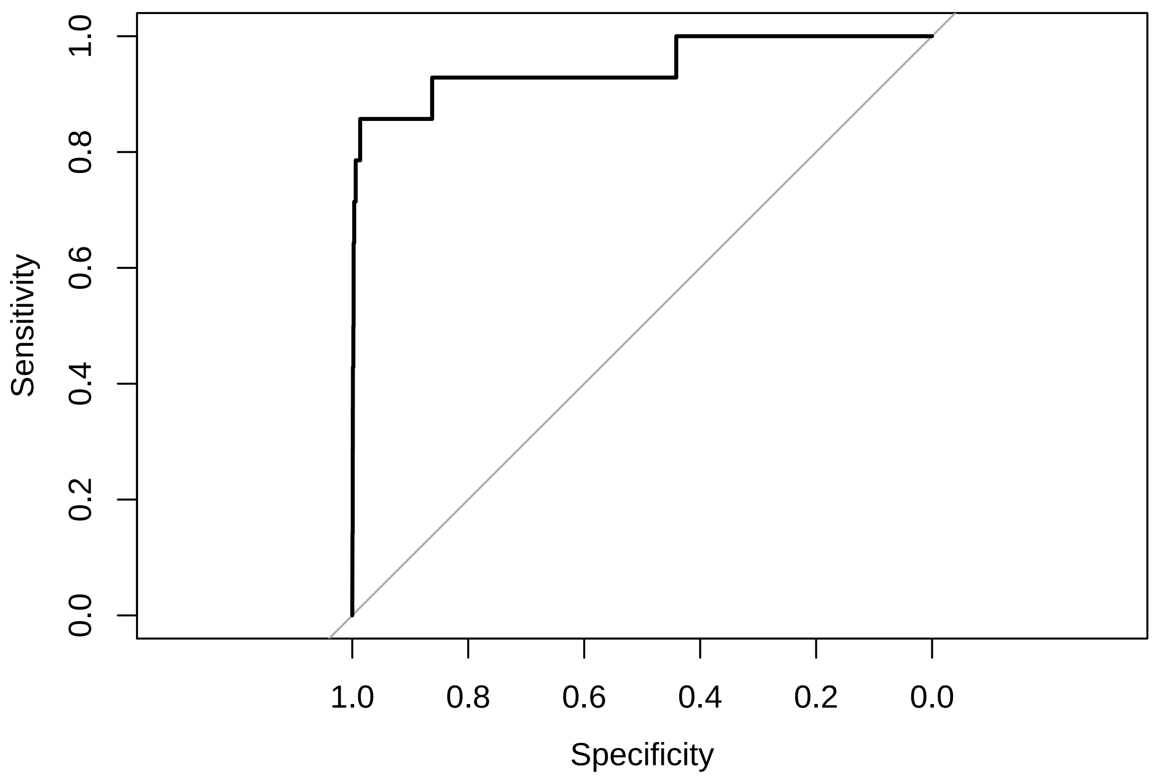
```r
BIC(logit1)
```

```
## [1] 2136.936
```

```r
predict_logit1 <- predict(logit1, train_eval, type = 'response')
table(train_eval$Class, predict_logit1 > 0.5)
```

```
##
##      FALSE TRUE
##   0  7331  155
##   1     2   12
```

```r
auc_logit1 <- roc(train_eval$Class, predict_logit1)
plot(auc_logit1)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_logit1)
##
## Data: predict_logit1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9479
```

```r
# backward stepwise
stepwise1 <- glm(Class ~ ., data = train_model)
backward <- step(stepwise1, trace = 0)
BIC(backward)
```

```
## [1] 2521.888
```

```r
predict_backward <- predict(backward, train_eval, type = 'response')
table(train_eval$Class, predict_backward > 0.5)
```

```
##
##     FALSE TRUE
##   0  7308  178
##   1     4   10
```

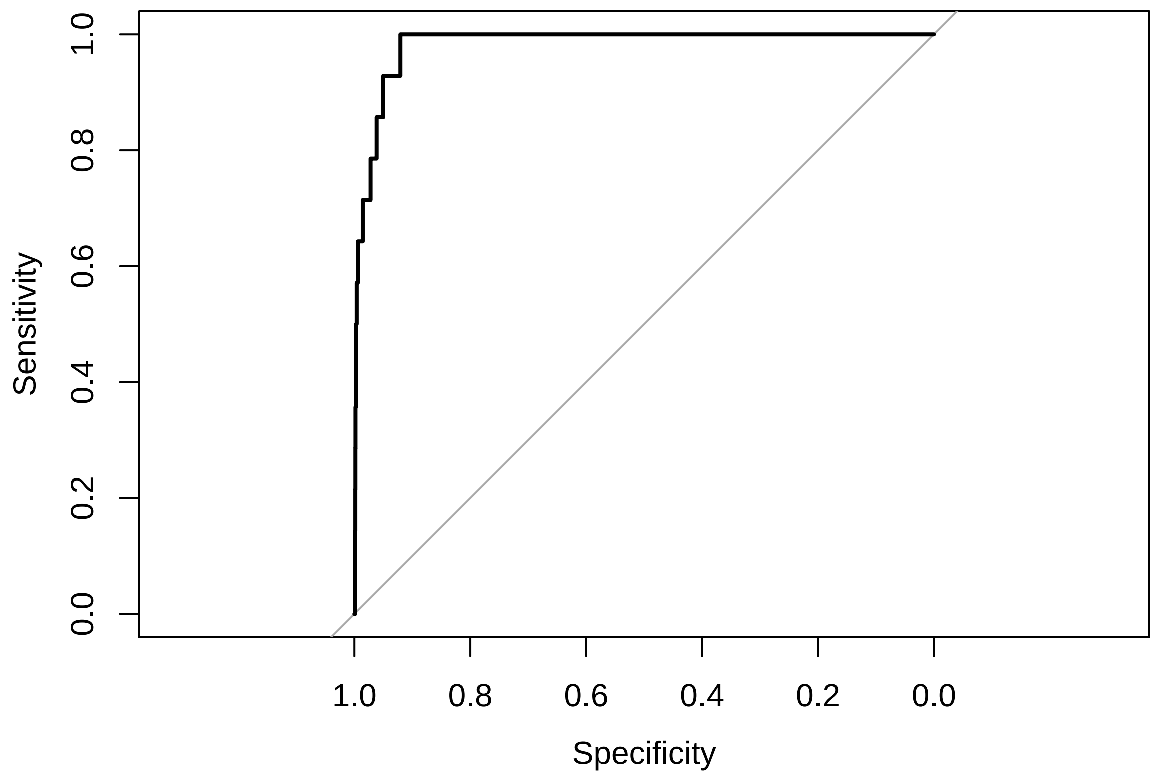
```r
mysd(predict_backward, train_eval$Class)
```

```
## [1] 0.1902448
```

```r
myse(predict_backward, train_eval$Class)
```

```
## [1] 0.1903997
```

```r
auc_backward <- roc(train_eval$Class, predict_backward)
plot(auc_backward)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_backward)
##
## Data: predict_backward in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9833
```

```r
#forward stepwise
stepwise2 <- glm(Class ~ 1,data = train_model)
```

```r
forward <- step(stepwise2, scope = list(lower=formula(stepwise2), upper=formula(stepwise1)), direction =
BIC(forward)
```

```
## [1] 2531.2
```

```r
predict_forward <- predict(forward, train_eval, type = 'response')
table(train_eval$Class, predict_forward > 0.5)
```

```
##
##     FALSE TRUE
##   0  7308  178
##   1     4   10
```

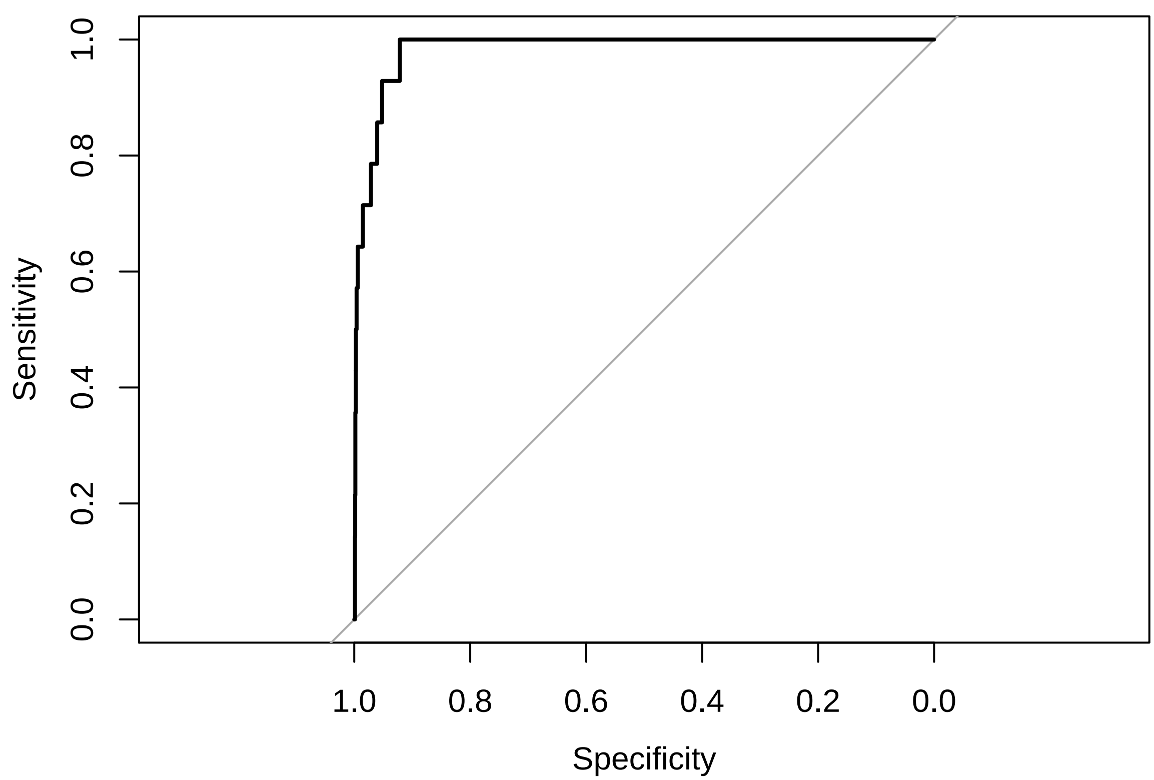
```r
mysd(predict_forward, train_eval$Class)
```

```
## [1] 0.1902565
```

```r
myse(predict_forward, train_eval$Class)
```

```
## [1] 0.1904115
```

```r
auc_forward <- roc(train_eval$Class, predict_forward)
plot(auc_forward)
```



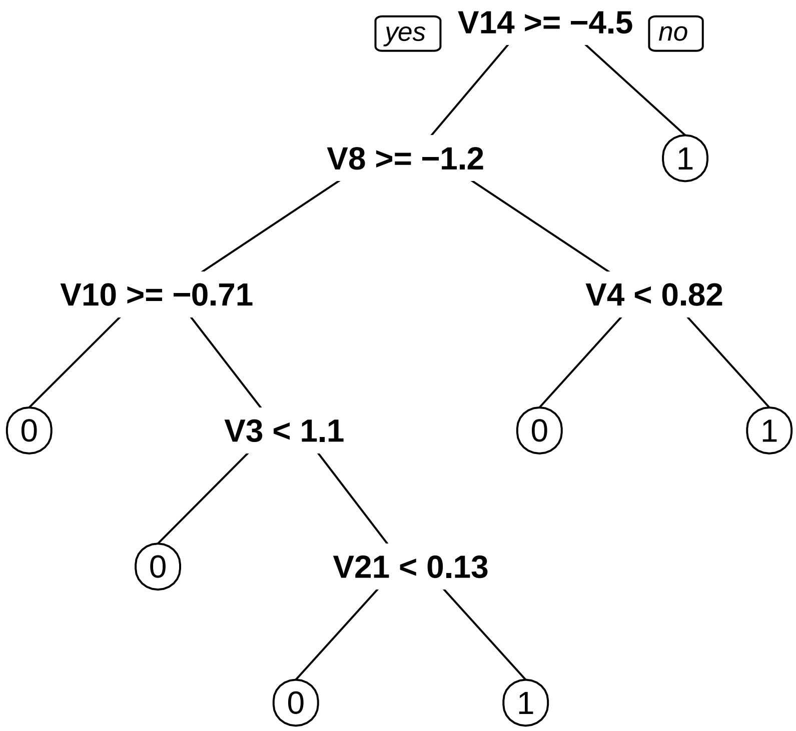

```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_forward)
##
## Data: predict_forward in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
```

```
## Area under the curve: 0.9834
```

```r
# decision tree
decision <- rpart(Class ~ ., data = train_model, method = "class")
prp(decision)
predict_decision <- predict(decision, train_eval, type = "class")
confusionMatrix(train_eval$Class, predict_decision)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 7291  195
##          1    3   11
##
##                Accuracy : 0.9736
##                  95% CI : (0.9697, 0.9771)
##     No Information Rate : 0.9725
##     P-Value [Acc > NIR] : 0.3009
##
##                   Kappa : 0.0968
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.9996
##             Specificity : 0.0534
##          Pos Pred Value : 0.9740
##          Neg Pred Value : 0.7857
##              Prevalence : 0.9725
##          Detection Rate : 0.9721
##    Detection Prevalence : 0.9981
##       Balanced Accuracy : 0.5265
##
##        'Positive' Class : 0
##
```

```r
# decision tree
decision <- rpart(Class ~ ., data = train_model, method = "class")
prp(decision)
```




```
predict_decision <- predict(decision, train_eval, type = "class")
confusionMatrix(train_eval$Class, predict_decision)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 7291  195
##          1    3   11
##
##                Accuracy : 0.9736
##                  95% CI : (0.9697, 0.9771)
##     No Information Rate : 0.9725
##     P-Value [Acc > NIR] : 0.3009
##
##                   Kappa : 0.0968
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.9996
##             Specificity : 0.0534
##          Pos Pred Value : 0.9740
##          Neg Pred Value : 0.7857
##              Prevalence : 0.9725
##          Detection Rate : 0.9721
##    Detection Prevalence : 0.9981
##       Balanced Accuracy : 0.5265
```

```
##
##        'Positive' Class : 0
##
```

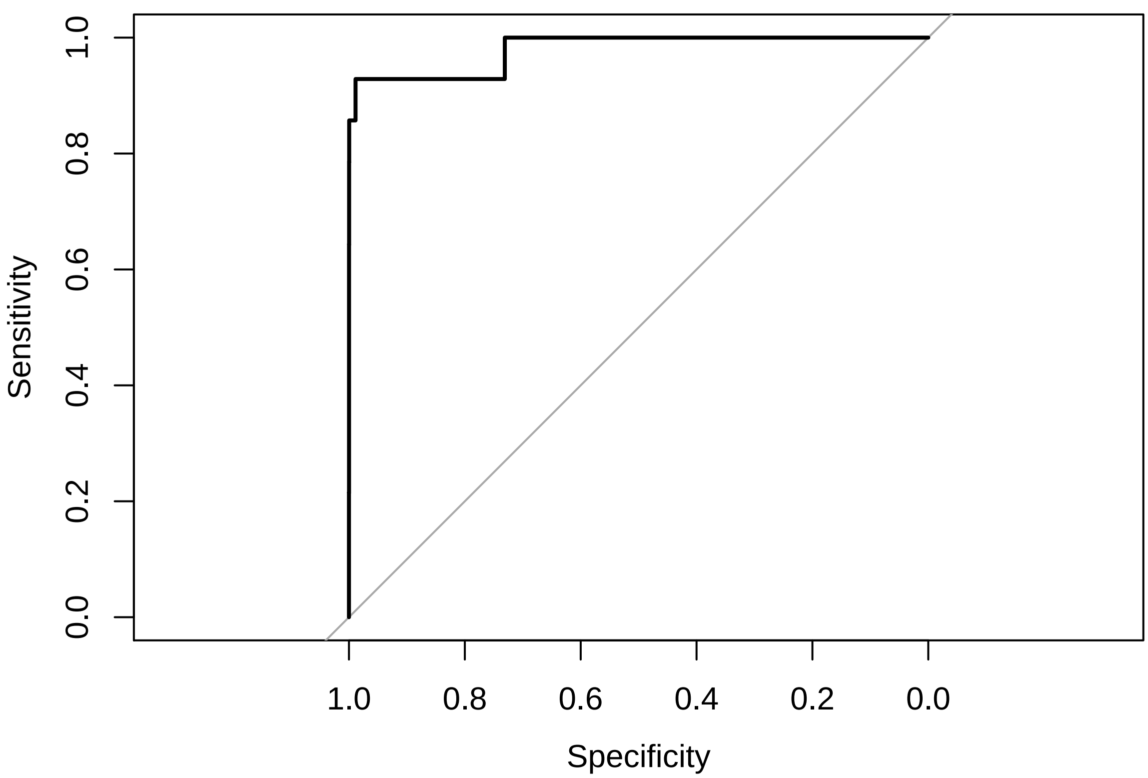
```r
#decision tree random forest (kind of broke with raw data)
rforest <- randomForest(Class ~ ., data = train_model)
```

```
## Warning in randomForest.default(m, y, ...): The response has five or fewer
## unique values. Are you sure you want to do regression?
```

```r
predict_rforest <- predict(rforest, train_eval)
table(train_eval$Class, predict_rforest > 0.5)
```

```
##
##     FALSE TRUE
##   0  7485    1
##   1     6    8
```

```r
auc_rforest <- roc(train_eval$Class, predict_rforest)
plot(auc_rforest)
```

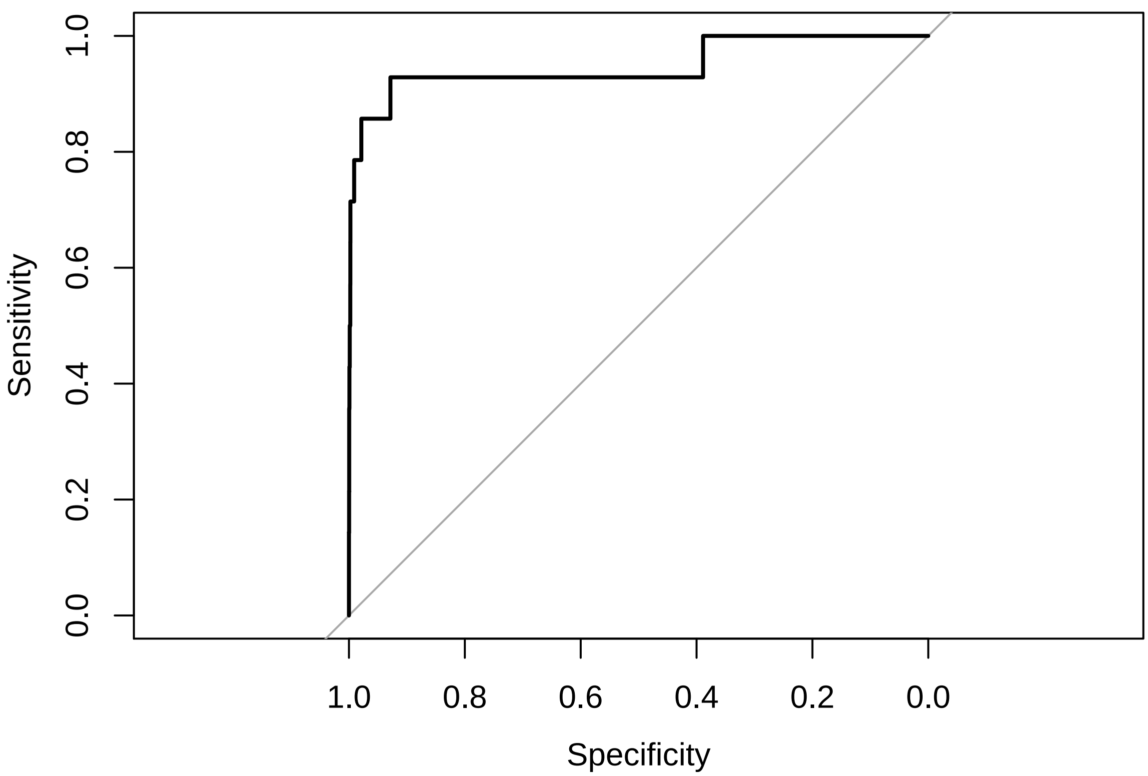



```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_rforest)
##
## Data: predict_rforest in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9798
```

```r
#svm (kind of broken with raw data)
svm <- svm(Class ~ ., data = train_model)
predict_svm <- predict(svm, train_eval)
table(train_eval$Class, predict_svm > 0.5)
```

```
##
##     FALSE TRUE
##   0  7448   38
##   1     4   10
```

```r
auc_svm <- roc(train_eval$Class, predict_svm)
plot(auc_svm)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_svm)
##
## Data: predict_svm in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9483
```

```r
#tables only
table(train_eval$Class, predict_mlr1 > 0.5)
```

```
##
##     FALSE TRUE
##   0  7311  175
##   1     4   10
```

```r
table(train_eval$Class, predict_poisson1 > 0.5)
```

```
##
##     FALSE TRUE
##   0  7327  159
##   1     7    7
```

```r
table(train_eval$Class, predict_logit1 > 0.5)
```

```
##
##     FALSE TRUE
##   0  7331  155
##   1     2   12
```

```r
table(train_eval$Class, predict_backward > 0.5)
```

```
##
##     FALSE TRUE
##   0  7308  178
##   1     4   10
```

```r
table(train_eval$Class, predict_forward > 0.5)
```

```
##
##     FALSE TRUE
##   0  7308  178
##   1     4   10
```

```r
confusionMatrix(train_eval$Class, predict_decision)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 7291  195
##          1    3   11
##
##                Accuracy : 0.9736
##                  95% CI : (0.9697, 0.9771)
##     No Information Rate : 0.9725
##     P-Value [Acc > NIR] : 0.3009
##
##                   Kappa : 0.0968
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.9996
##             Specificity : 0.0534
##          Pos Pred Value : 0.9740
##          Neg Pred Value : 0.7857
##              Prevalence : 0.9725
##          Detection Rate : 0.9721
##    Detection Prevalence : 0.9981
##       Balanced Accuracy : 0.5265
##
##        'Positive' Class : 0
##
```

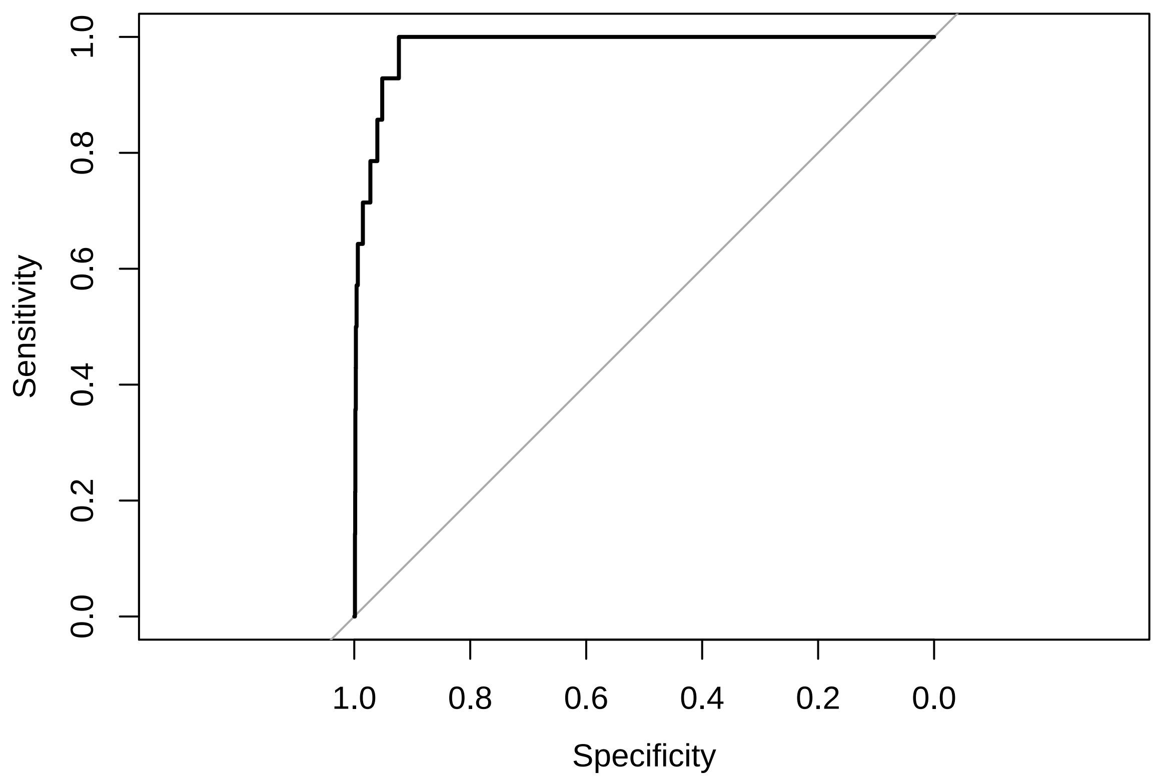
```r
table(train_eval$Class, predict_rforest > 0.5)
```

```
##
##     FALSE TRUE
##   0  7485    1
##   1     6    8
```

```r
table(train_eval$Class, predict_svm > 0.5)
```

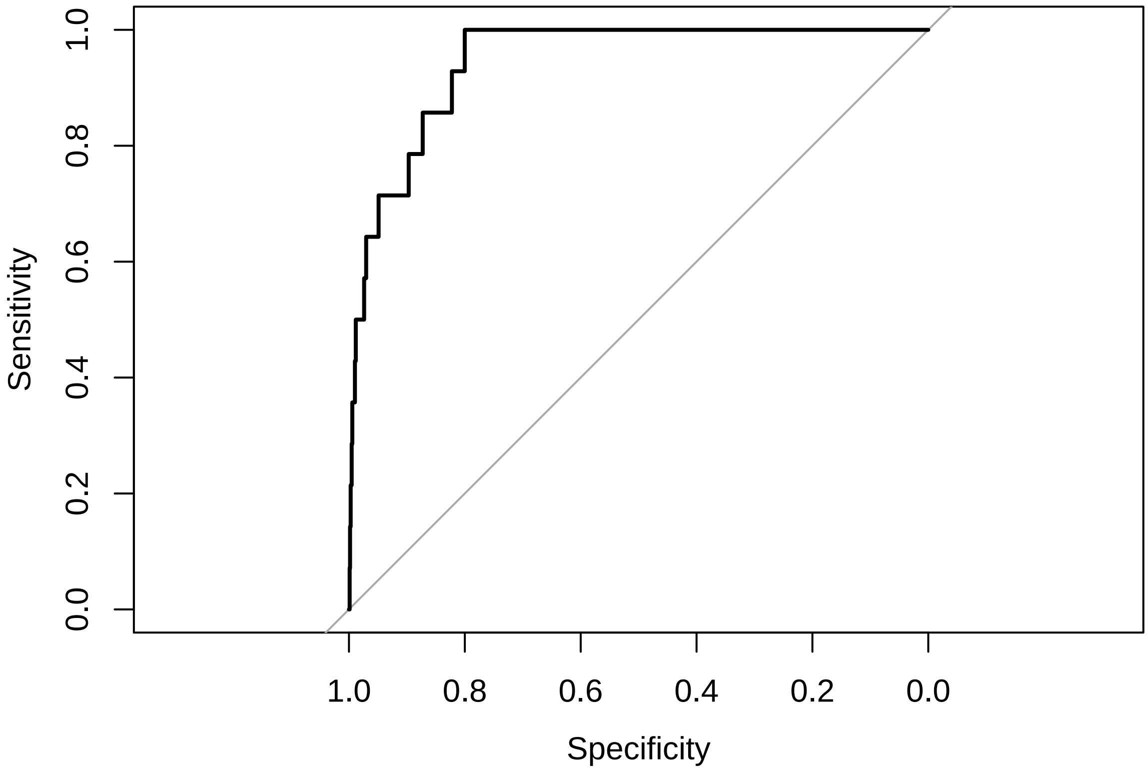
```
##
##     FALSE TRUE
##   0  7448   38
##   1     4   10
```

```r
#AUC plots only
plot(auc_mlr1)
```



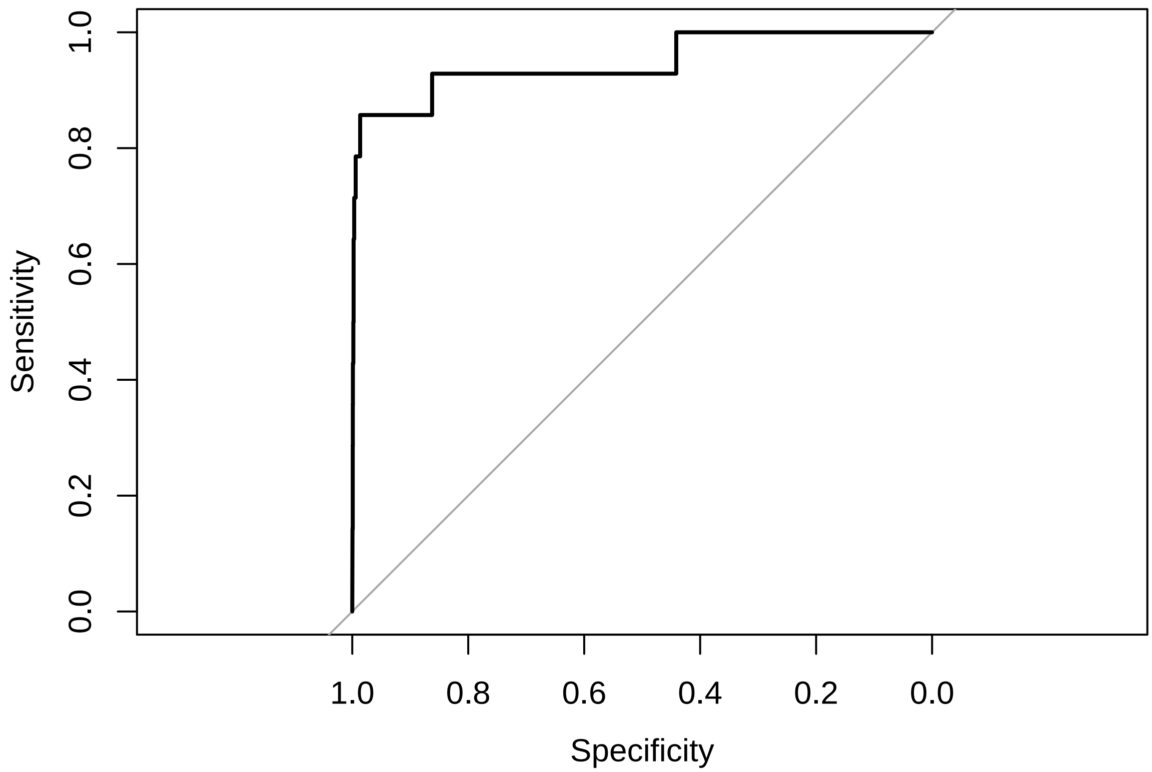

```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_mlr1)
##
## Data: predict_mlr1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9835
```

```r
plot(auc_poisson)
```



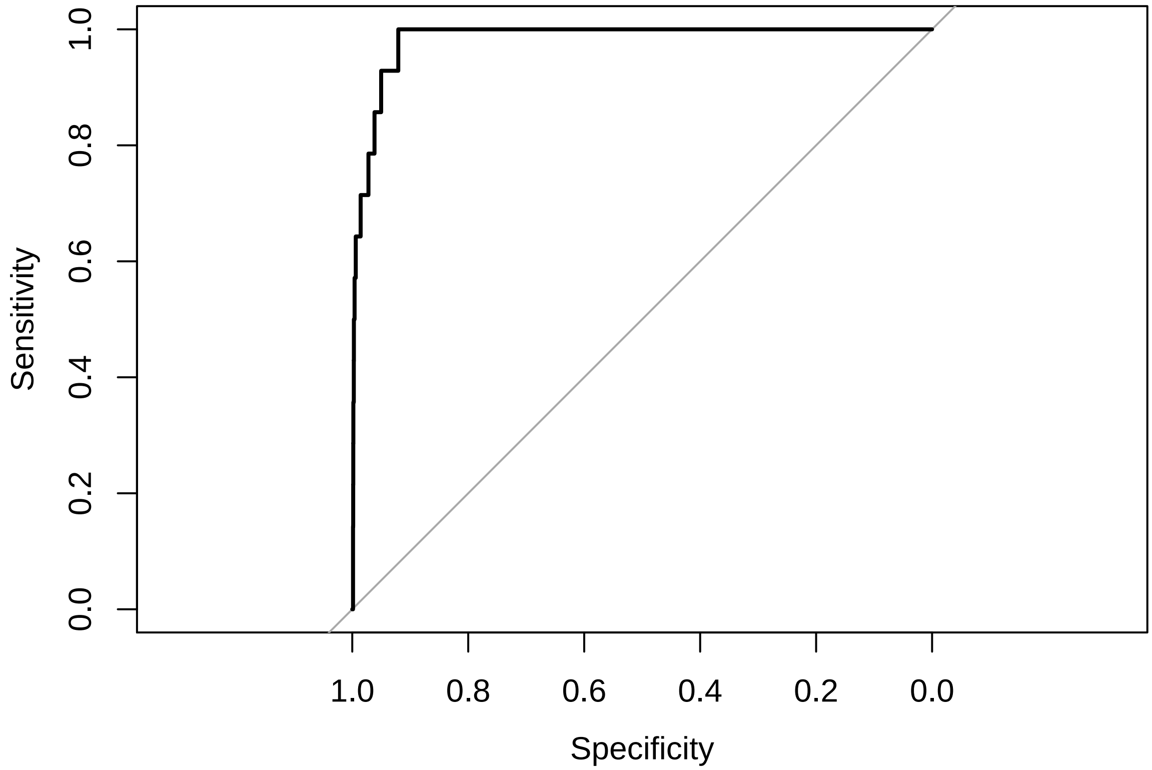

```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_poisson1)
##
## Data: predict_poisson1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9462
```

```r
plot(auc_logit1)
```



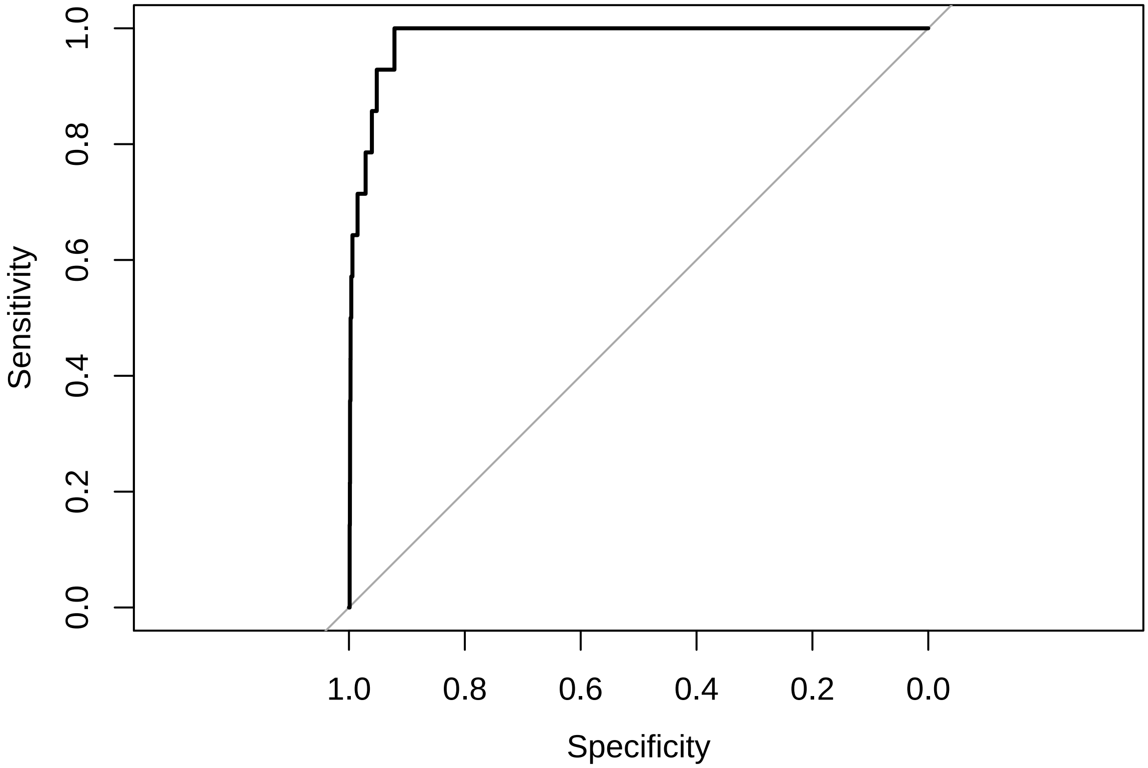

```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_logit1)
##
## Data: predict_logit1 in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9479
```

```
plot(auc_backward)
```



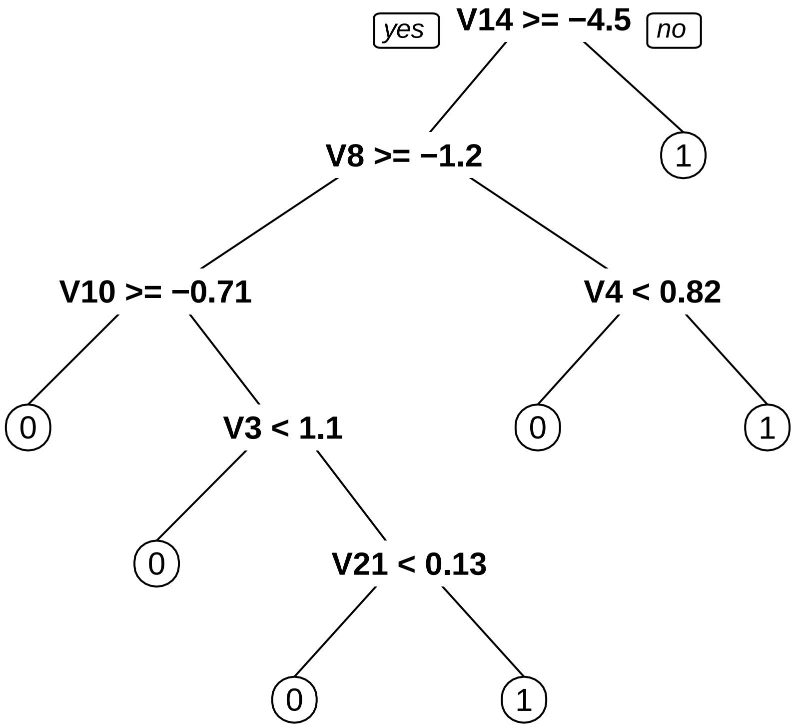

```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_backward)
##
## Data: predict_backward in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9833
```

```r
plot(auc_forward)
```

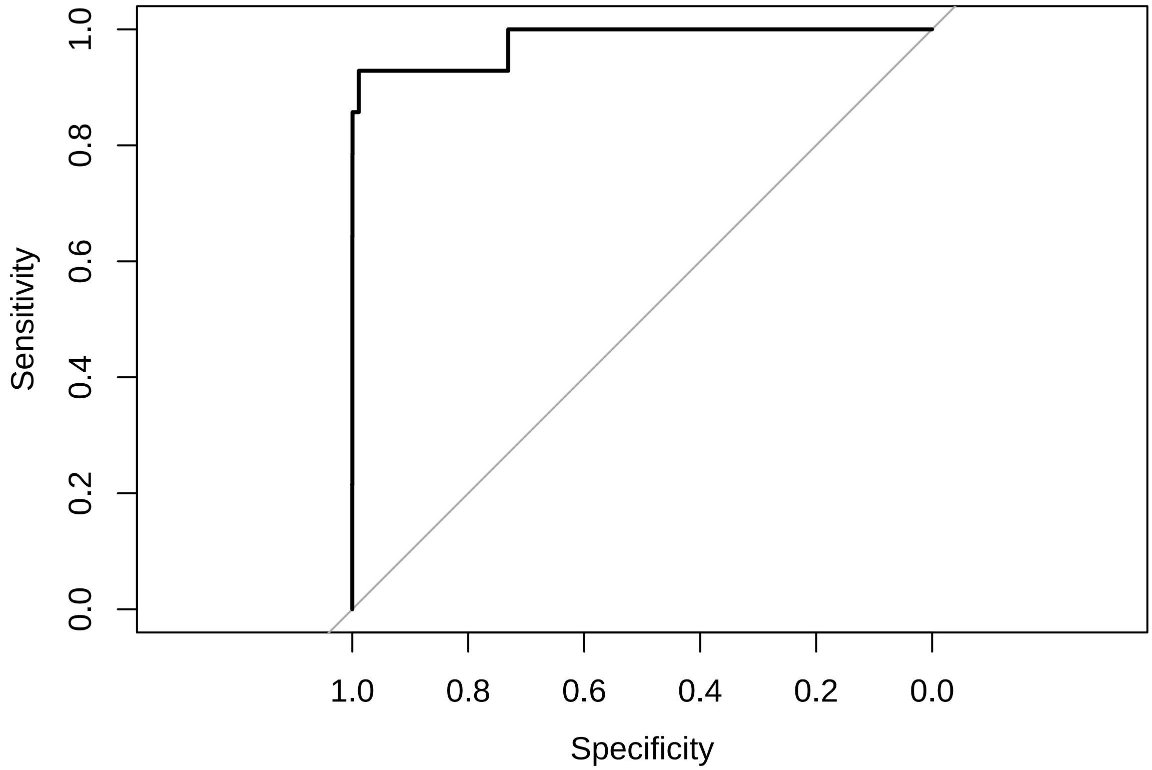



```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_forward)
##
## Data: predict_forward in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9834
```

```
prp(decision)
```

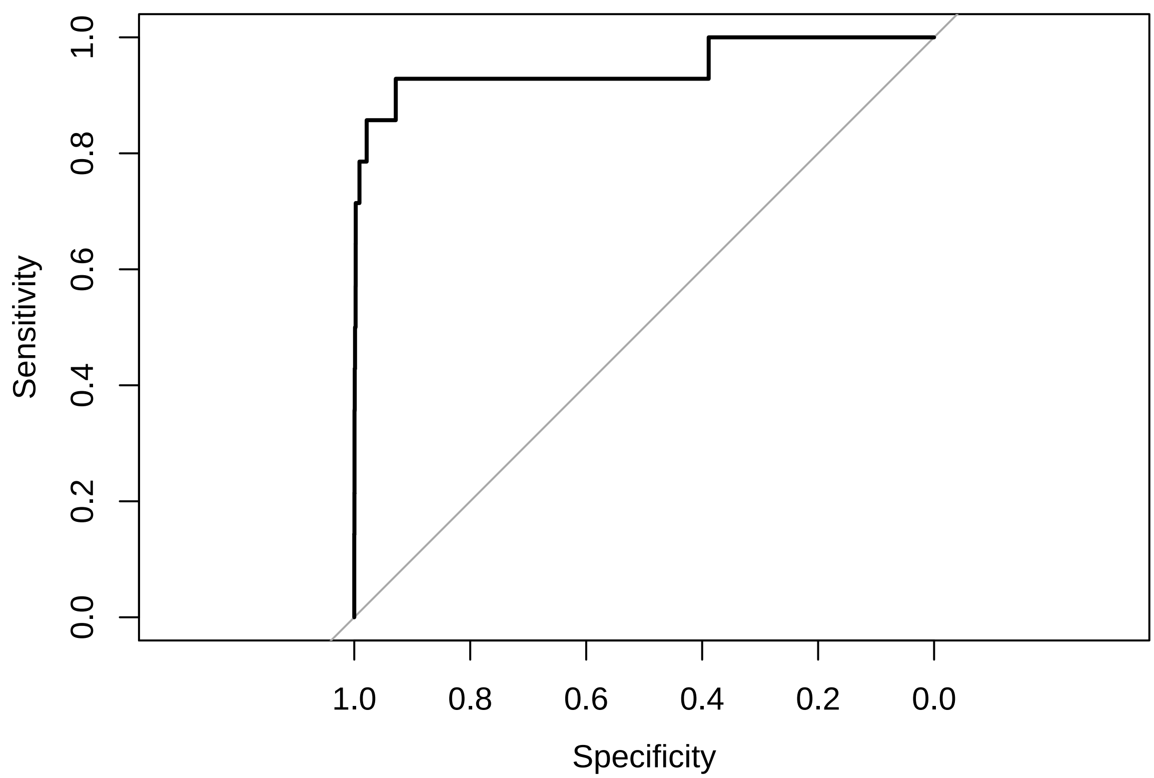



```
plot(auc_rforest)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_rforest)
##
## Data: predict_rforest in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9798
```

```
plot(auc_svm)
```




```
##
## Call:
## roc.default(response = train_eval$Class, predictor = predict_svm)
##
## Data: predict_svm in 7486 controls (train_eval$Class 0) < 14 cases (train_eval$Class 1).
## Area under the curve: 0.9483
```

```r
accuracy.meas(train_eval$Class, predict_mlr1)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_mlr1)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.054
## recall: 0.714
## F: 0.050
```

```r
accuracy.meas(train_eval$Class, predict_poisson1)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_poisson1)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.042
```

```
## recall: 0.500
## F: 0.039
```

```r
accuracy.meas(train_eval$Class, predict_logit1)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_logit1)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.072
## recall: 0.857
## F: 0.066
```

```r
accuracy.meas(train_eval$Class, predict_backward)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_backward)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.053
## recall: 0.714
## F: 0.050
```

```r
accuracy.meas(train_eval$Class, predict_forward)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_forward)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.053
## recall: 0.714
## F: 0.050
```

```r
accuracy.meas(train_eval$Class, predict_decision)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_decision)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.002
## recall: 1.000
## F: 0.002
```

```r
accuracy.meas(train_eval$Class, predict_rforest)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_rforest)
##
## Examples are labelled as positive when predicted is greater than 0.5
```

```
##
## precision: 0.889
## recall: 0.571
## F: 0.348
```

```r
accuracy.meas(train_eval$Class, predict_svm)
```

```
##
## Call:
## accuracy.meas(response = train_eval$Class, predicted = predict_svm)
##
## Examples are labelled as positive when predicted is greater than 0.5
##
## precision: 0.208
## recall: 0.714
## F: 0.161
```