Bank fraud machine learning

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R Markdown

```
#load packages
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```
#Load the train and test dataset

train<-read.csv("/Users/user/Music/machine learning R/fraud_train.csv")

test<-read.csv("/Users/user/Music/machine learning R/fraud_test.csv")
```

```
#create column to differentiate train and test dataset
train$isTrain<-"yes"
test$isTrain<-"no"

#combine train and test datasets
comb<-rbind(train,test)
```

```
missing_values<-colSums(is.na(comb))
missing_values
```

```
##   Sector_score    LOCATION_ID         PARA_A        Score_A         Risk_A
##              9              0             20             29             12
##         PARA_B        Score_B         Risk_B          TOTAL        numbers
##             26             36             17             27             26
##         Risk_C    Money_Value       Score_MV         Risk_D  District_Loss
##             38             24             21              8             27
##           PROB         RiSk_E        History           Prob         Risk_F
##             30             11             49             22             45
##          Score  Inherent_Risk   CONTROL_RISK Detection_Risk     Audit_Risk
##             21             32             12             52             11
##           Risk        isTrain
##              0              0
```

```r
names(comb)
```

```
##  [1] "Sector_score"   "LOCATION_ID"    "PARA_A"         "Score_A"
##  [5] "Risk_A"         "PARA_B"         "Score_B"        "Risk_B"
##  [9] "TOTAL"          "numbers"        "Risk_C"         "Money_Value"
## [13] "Score_MV"       "Risk_D"         "District_Loss"  "PROB"
## [17] "RiSk_E"         "History"        "Prob"           "Risk_F"
## [21] "Score"          "Inherent_Risk"  "CONTROL_RISK"   "Detection_Risk"
## [25] "Audit_Risk"     "Risk"           "isTrain"
```

```r
features<-c("Sector_score", "PARA_A" ,"Score_A" ,  "Risk_A", "PARA_B","Score_B","Risk_B","TOTAL","numbe

comb<-comb[,features]
str(comb)
```

```
## 'data.frame':    775 obs. of  26 variables:
##  $ Sector_score  : num  3.89 3.89 3.89 3.89 3.89 3.89 3.89 3.89 3.89 3.89 ...
##  $ PARA_A        : num  0 0 0 NA 1.1 8.4 NA 5.47 0 1.95 ...
##  $ Score_A       : num  NA 0.2 0.2 0.2 0.4 0.6 0.6 0.6 0.2 0.4 ...
##  $ Risk_A        : num  0 0 0 0 0.44 ...
##  $ PARA_B        : num  4.83 10.8 0.08 0.83 7.41 ...
##  $ Score_B       : num  0.2 0.6 0.2 0.2 0.4 0.6 0.2 0.4 0.2 0.4 ...
##  $ Risk_B        : num  0.966 6.48 0.016 0.166 2.964 ...
##  $ TOTAL         : num  4.83 10.8 0.08 0.83 8.51 ...
##  $ numbers       : num  5 6 5 5 5 5.5 5 5 5 5 ...
##  $ Risk_C        : num  1 3.6 1 1 1 2.2 1 1 1 1 ...
##  $ Money_Value   : num  0.94 11.75 0 2.95 44.95 ...
##  $ Score_MV      : num  0.2 0.6 0.2 0.2 0.6 0.4 0.2 0.6 0.2 0.4 ...
##  $ Risk_D        : num  0.188 7.05 0 0.59 26.97 ...
##  $ District_Loss : int  2 2 2 2 2 2 2 2 2 2 ...
##  $ PROB          : num  0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 ...
##  $ RiSk_E        : num  0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 ...
##  $ History       : int  0 0 0 0 0 NA 0 1 0 0 ...
##  $ Prob          : num  0.2 NA 0.2 0.2 0.2 0.2 0.2 0.4 NA 0.2 ...
##  $ Risk_F        : num  0 0 0 0 0 0 0 0.4 0 0 ...
##  $ Score         : num  2 4.4 NA 2 NA 4.2 2.4 3.6 2 3 ...
##  $ Inherent_Risk : num  2.55 17.53 1.42 2.16 31.77 ...
##  $ CONTROL_RISK  : num  0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.8 0.4 0.4 ...
##  $ Detection_Risk: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 NA ...
##  $ Audit_Risk    : num  0.511 3.506 0.283 0.431 6.355 ...
##  $ Risk          : chr  "not.fraudulent" "fraudulent" "not.fraudulent" "not.fraudulent" ...
##  $ isTrain       : chr  "yes" "yes" "yes" "yes" ...
```

```r
# Impute missing values
pre.process<-preProcess(comb,method = "bagImpute")
imputed.data<-predict(pre.process,comb)
```

```r
comb<-imputed.data

comb$Risk<-as.factor(comb$Risk)
```

```r
#split dataset back to train and test set
train<-comb[comb$isTrain=="yes",]

test<-comb[comb$isTrain=="no",]
```

```r
#remove variable isTrain from both train and test set

train$isTrain<-NULL

test$isTrain<-NULL
```

##modeling #Logistic regression

```r
set.seed(8819)
control <- trainControl(
  method = "cv",                   # Cross-validation
  number = 10,                     # 10-fold CV
  classProbs = TRUE,               # Compute class probabilities
  summaryFunction = twoClassSummary, # Calculate ROC, Sensitivity, etc.
  savePredictions = TRUE
)

model.logit <- train(
Risk~.,
data = train,
method = "glm",
family = "binomial",
trControl = control,
preProcess = c("zv", "center", "scale"),
tuneLength = 16,
metric="ROC"
)
```

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

## Warning: glm.fit: algorithm did not converge

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

```r
pred_y = predict(model.logit,test)
```

```r
#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                 Reference
## Prediction       fraudulent not.fraudulent
##   fraudulent             81              2
##   not.fraudulent         10            139
##
##                Accuracy : 0.9483
##                  95% CI : (0.9114, 0.973)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : < 2e-16
##
##                   Kappa : 0.8898
##
##  Mcnemar's Test P-Value : 0.04331
##
##             Sensitivity : 0.8901
##             Specificity : 0.9858
##          Pos Pred Value : 0.9759
##          Neg Pred Value : 0.9329
##              Prevalence : 0.3922
##          Detection Rate : 0.3491
##    Detection Prevalence : 0.3578
##       Balanced Accuracy : 0.9380
##
##        'Positive' Class : fraudulent
##
```

#random forest

```r
set.seed(8819)

control <- trainControl(
  method = "cv",                  # Cross-validation
  number = 10,                    # 10-fold CV
  classProbs = TRUE,              # Compute class probabilities
  summaryFunction = twoClassSummary, # Calculate ROC, Sensitivity, etc.
  savePredictions = TRUE
)

model.rf <- train(
Risk~.,
data = train,
method = "rf",
metric="ROC",
trControl = control,
tuneLength = 16
)
```

```r
pred_y = predict(model.rf,test)



#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction       fraudulent not.fraudulent
##   fraudulent             91              0
##   not.fraudulent          0            141
##
##                Accuracy : 1
##                  95% CI : (0.9842, 1)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 1
##
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 1.0000
##              Prevalence : 0.3922
##          Detection Rate : 0.3922
##    Detection Prevalence : 0.3922
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : fraudulent
##
```

#Decision tree

```r
set.seed(8819)

control <- trainControl(
  method = "cv",                  # Cross-validation
  number = 10,                    # 10-fold CV
  classProbs = TRUE,              # Compute class probabilities
  summaryFunction = twoClassSummary, # Calculate ROC, Sensitivity, etc.
  savePredictions = TRUE
)

model.dtree <- train(
Risk~.,
data = train,
method = "rpart",
trControl = control,
```

```r
tuneLength = 16
)
```

```
## Warning in train.default(x, y, weights = w, ...): The metric "Accuracy" was not
## in the result set. ROC will be used instead.
```

```r
pred_y = predict(model.dtree,test)

#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                  Reference
## Prediction        fraudulent not.fraudulent
##   fraudulent               0              0
##   not.fraudulent          91            141
##
##                Accuracy : 0.6078
##                  95% CI : (0.5417, 0.671)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : 0.5287
##
##                   Kappa : 0
##
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.0000
##             Specificity : 1.0000
##          Pos Pred Value :    NaN
##          Neg Pred Value : 0.6078
##              Prevalence : 0.3922
##          Detection Rate : 0.0000
##    Detection Prevalence : 0.0000
##       Balanced Accuracy : 0.5000
##
##        'Positive' Class : fraudulent
##
```

```r
library(fastAdaboost)
set.seed(8819)

model.adaboost <- train(
Risk~.,
data = train,
method = "adaboost",
trControl = control,
metric="ROC",
tuneLength = 16
)
```

```r
pred_y = predict(model.adaboost,test)

#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                 Reference
## Prediction        fraudulent not.fraudulent
##   fraudulent              91              0
##   not.fraudulent           0            141
##
##                Accuracy : 1
##                  95% CI : (0.9842, 1)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 1
##
##  Mcnemar's Test P-Value : NA
##
##             Sensitivity : 1.0000
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 1.0000
##              Prevalence : 0.3922
##          Detection Rate : 0.3922
##    Detection Prevalence : 0.3922
##       Balanced Accuracy : 1.0000
##
##        'Positive' Class : fraudulent
##
```

#SVM

```r
set.seed(8819)

model.SVM <- train(
Risk~.,
data = train,
method = "svmRadial",
trControl = control,
metric="ROC",
preProcess = c("center","scale"),
tuneLength = 16
)
```

```
## Warning in preProcess.default(method = c("center", "scale"), x =
## structure(c(3.89, : These variables have zero variances: Detection_Risk
```

```
## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.
```

```
## Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut =
## 10, : These variables have zero variances: Detection_Risk

## Warning in .local(x, ...): Variable(s) `' constant. Cannot scale data.

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## 10, : These variables have zero variances: Detection_Risk

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## 10, : These variables have zero variances: Detection_Risk

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```

```r
pred_y = predict(model.SVM,test)

#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                 Reference
## Prediction       fraudulent not.fraudulent
##   fraudulent             86              4
##   not.fraudulent          5            137
##
##                Accuracy : 0.9612
##                  95% CI : (0.9276, 0.9821)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9185
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9451
##             Specificity : 0.9716
##          Pos Pred Value : 0.9556
##          Neg Pred Value : 0.9648
##              Prevalence : 0.3922
##          Detection Rate : 0.3707
##    Detection Prevalence : 0.3879
##       Balanced Accuracy : 0.9583
##
##        'Positive' Class : fraudulent
##
```

#Naive Bayes

```r
set.seed(8819)
library(naivebayes)
```

```
## naivebayes 1.0.0 loaded
```

```
## For more information please visit:
```

```
## https://majkamichal.github.io/naivebayes/
```

```r
model.Naive_bayes <- train(
Risk~.,
data = train,
method = "naive_bayes",
trControl = control,
metric="ROC",
```

```r
PreProcess = c("center","scale"),
tuneLength = 16
)
```

```
## Warning: In density.default(x, na.rm = TRUE, ...) :
##  extra argument 'PreProcess' will be disregarded
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```r
pred_y = predict(model.Naive_bayes,test)

#create confusion matrix
conf_mat = confusionMatrix(pred_y,test$Risk)
print(conf_mat)
```

```
## Confusion Matrix and Statistics
##
##                  Reference
## Prediction         fraudulent not.fraudulent
##   fraudulent               90              5
##   not.fraudulent            1            136
##
##                Accuracy : 0.9741
##                  95% CI : (0.9446, 0.9905)
##     No Information Rate : 0.6078
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9462
##
##  Mcnemar's Test P-Value : 0.2207
##
##             Sensitivity : 0.9890
##             Specificity : 0.9645
##          Pos Pred Value : 0.9474
##          Neg Pred Value : 0.9927
##              Prevalence : 0.3922
##          Detection Rate : 0.3879
##    Detection Prevalence : 0.4095
##       Balanced Accuracy : 0.9768
##
##        'Positive' Class : fraudulent
##
```