

Credit Card Fraud Detection Capstone Project - Report

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June 12, 2019

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1 Executive Summary

It is important that credit card companies are able to recognize fraudulent credit card transactions so that customers are not charged for items that they did not purchase. The datasets contains transactions made by credit cards in September 2013 by european cardholders.

Due to imbalancing nature of the data, many observations could be predicted as False Negative, in this case Legal Transactions instead of Fraudulent Transaction. For example, a model that predict always **0** (Legal) can achieve an Accuracy of **99.8**. For that reason, the metric used for measuring the score is the **Area Under The Precision-Recall Curve (AUCPR)** instead of the traditional AUC curve. A desirable result is an AUCPR at least greater than **0.85**.

For archieving the task of classifying credit card fraud detection, they are trained several algorithms such as Naive Bayes Classifier, KNN, SVM, Random Forest, GBM, XGBoost and LightGBM.

In this analysis, a XGBoost Model is capable of an AUCPR of **0.8623** and this is great!

2 Exploratory Data Analysis

2.1 The Dataset

This dataset presents transactions that occurred in two days, where we have **492 frauds** out of **284,807 transactions**. The dataset is highly unbalanced, the positive class (frauds) account for 0.172% of all transactions.

The dataset contains only numerical input variables which are the result of a PCA transformation. Unfortunately, due to confidentiality issues, we cannot provide the original features and more background information about the data. Features V1, V2, ... V28 are the principal components obtained with PCA, the only features which have not been transformed with PCA are 'Time' and 'Amount'.

Source [https://www.kaggle.com/mlg-](https://www.kaggle.com/mlg-ulb/creditcardfraud)

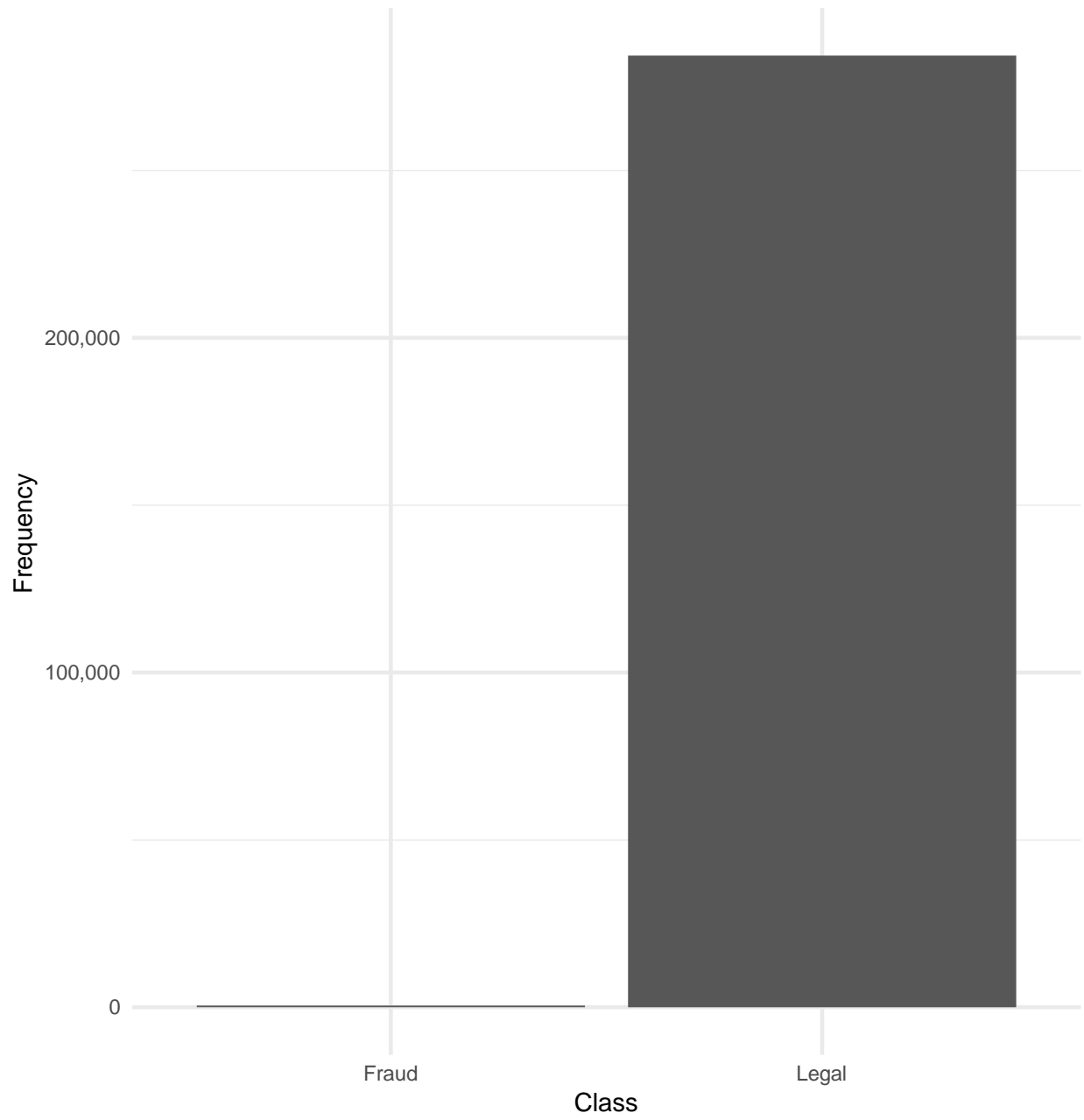
[ulb/creditcardfraud](https://www.kaggle.com/mlg-ulb/creditcardfraud) **Dimensions**

Length	Columns
284807	31

Imbalanced Dataset

This is a very imbalanced dataset. It means that there are few rows that represent a class. In this case, only **492** transactions are frauds, represented by **1** and **284315** are not, represented by **0**.

Proportions between Legal and Frauds Transactions



Class	Count
0	284315
1	492

Missing Values

As the table below suggests, there aren't missing values in this dataframe.

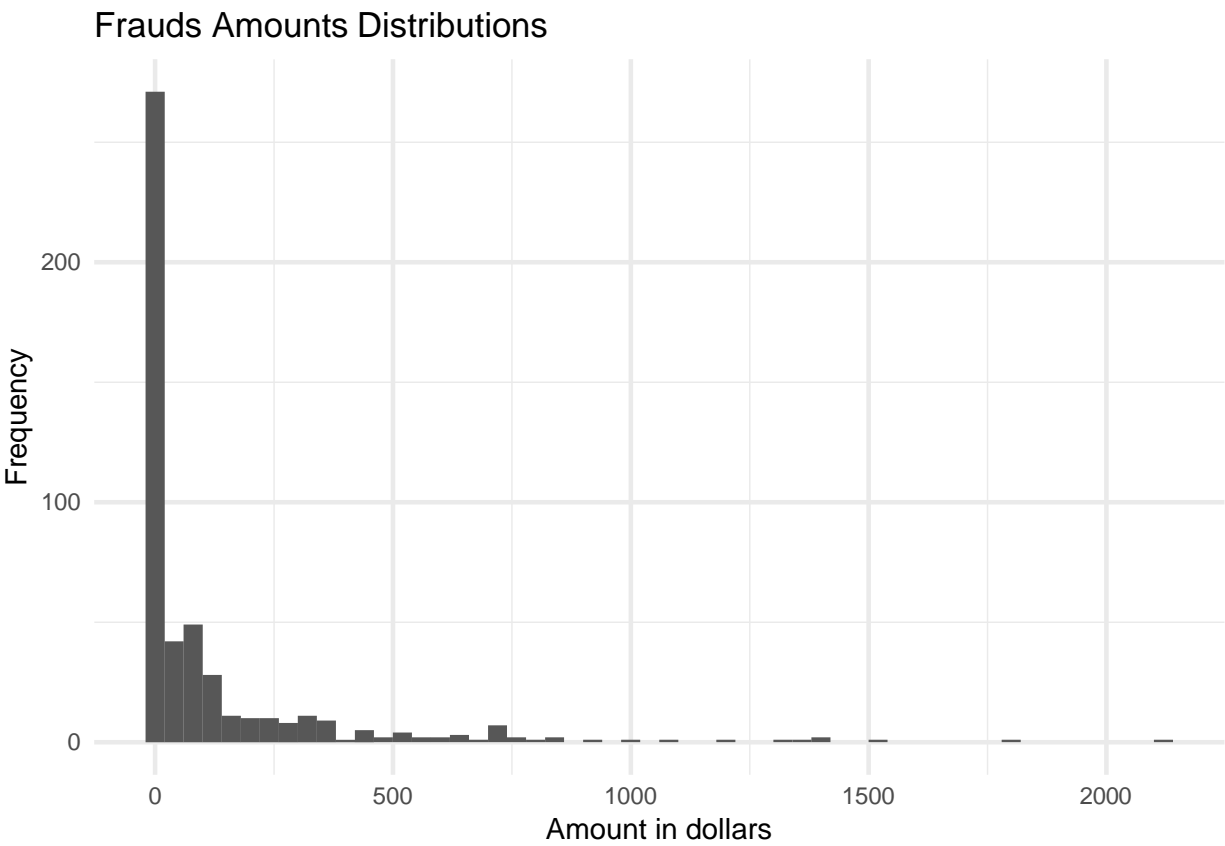
	Missing Values
Time	0
V1	0
V2	0
V3	0
V4	0
V5	0
V6	0
V7	0
V8	0
V9	0
V10	0
V11	0
V12	0
V13	0
V14	0
V15	0
V16	0
V17	0
V18	0
V19	0
V20	0
V21	0
V22	0
V23	0
V24	0
V25	0
V26	0
V27	0
V28	0
Amount	0
Class	0

First 10 Rows of creditcard dataset

Time	V1	V2	V3	V4	V5	V28	Amount	Class
0	-1.3598071	-0.0727812	2.5363467	1.3781552	-0.3383208	-0.0210531	149.62	0
0	1.1918571	0.2661507	0.1664801	0.4481541	0.0600176	0.0147242	2.69	0
1	-1.3583541	-1.3401631	1.7732093	0.3797796	-0.5031981	-0.0597518	378.66	0
1	-0.9662717	-0.1852260	1.7929933	-0.8632913	-0.0103089	0.0614576	123.50	0
2	-1.1582331	0.8777368	1.5487178	0.4030339	-0.4071934	0.2151531	69.99	0
2	-0.4259659	0.9605230	1.1411093	-0.1682521	0.4209869	0.0810803	3.67	0
4	1.2296576	0.1410035	0.0453708	1.2026127	0.1918810	0.0051678	4.99	0
7	-0.6442694	1.4179635	1.0743804	-0.4921990	0.9489341	-1.0853392	40.80	0
7	-0.8942861	0.2861572	-0.1131922	-0.2715261	2.6695987	0.1424043	93.20	0
9	-0.3382618	1.1195934	1.0443666	-0.2221873	0.4993608	0.0830756	3.68	0

Frauds Amount Distributions

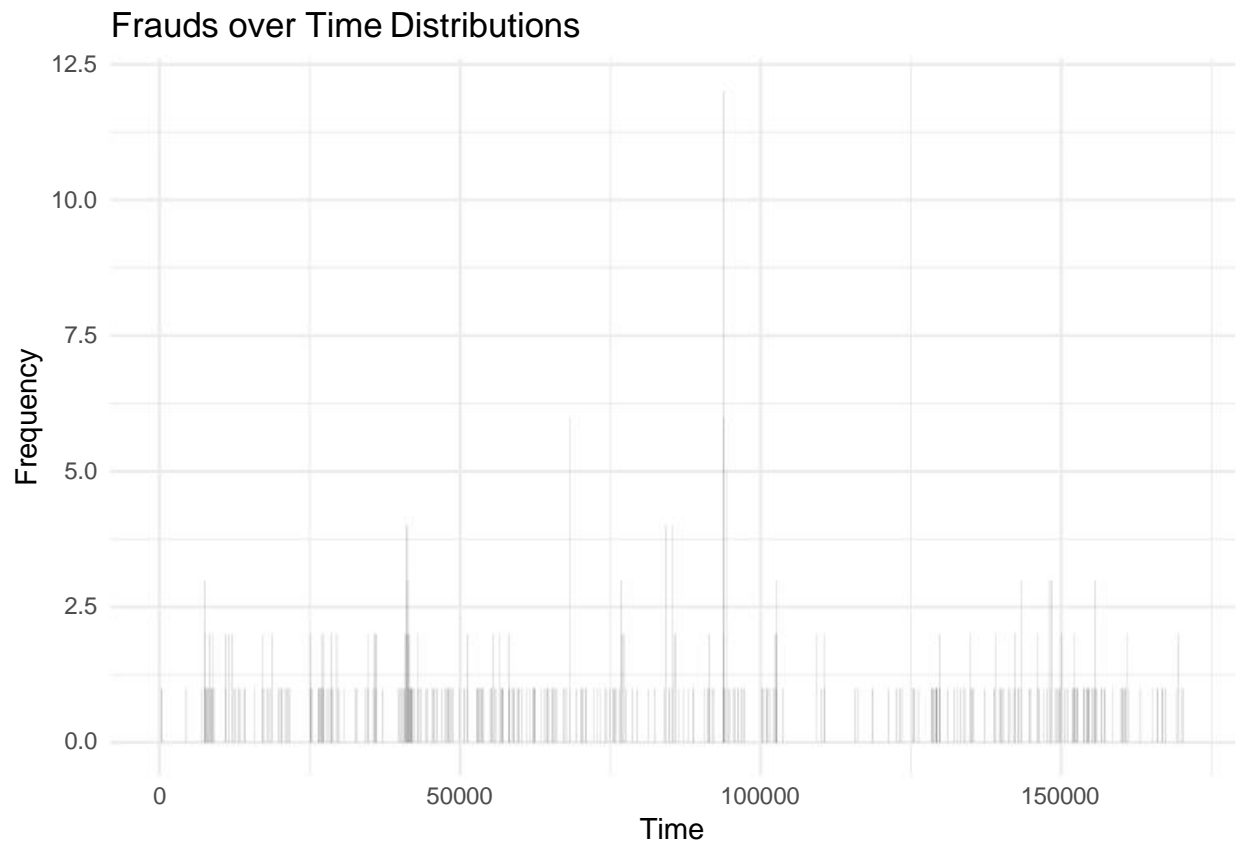
Small amount of money, less or equal of one dollar are scammed more frequently.



Amount	count
1.00	113
0.00	27
99.99	27
0.76	17
0.77	10
0.01	5
2.00	4
3.79	4
0.68	3
1.10	3

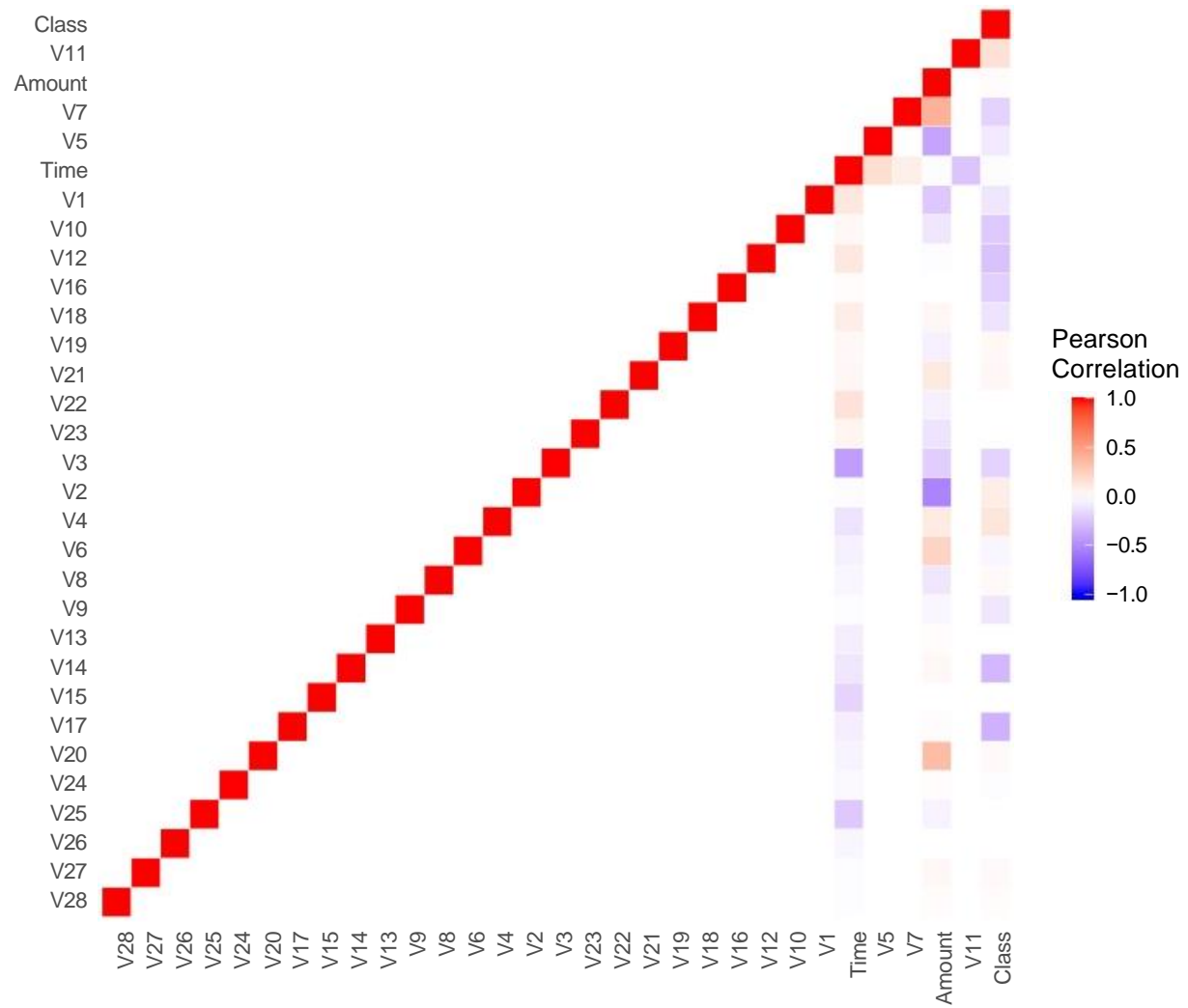
Frauds over Time Distribution

There aren't correlation between time and frauds. A fraud can happen anytime. It seems not particularly useful for the modelling phase. The correlation matrix below, confirms this assumption.



Time	count
68207	6
84204	4
85285	4
93853	4
93860	4
93879	4
94362	4
148053	2
406	1
472	1

Correlations between each variables



3 Data Pre-Processing

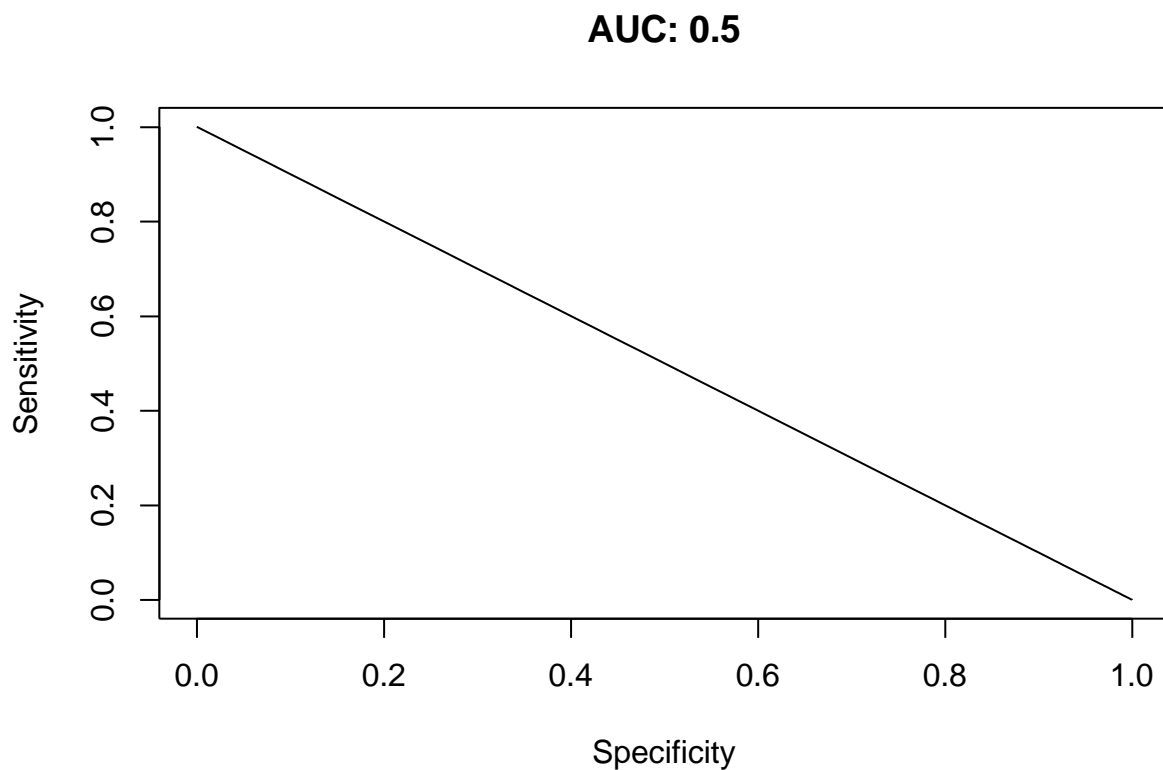
Before continuing to build models, It have to do a little data pre-processing:

1. Remove the “Time” column from the dataset. It isn’t useful.
2. Split the dataset into train, test, cv dataset.

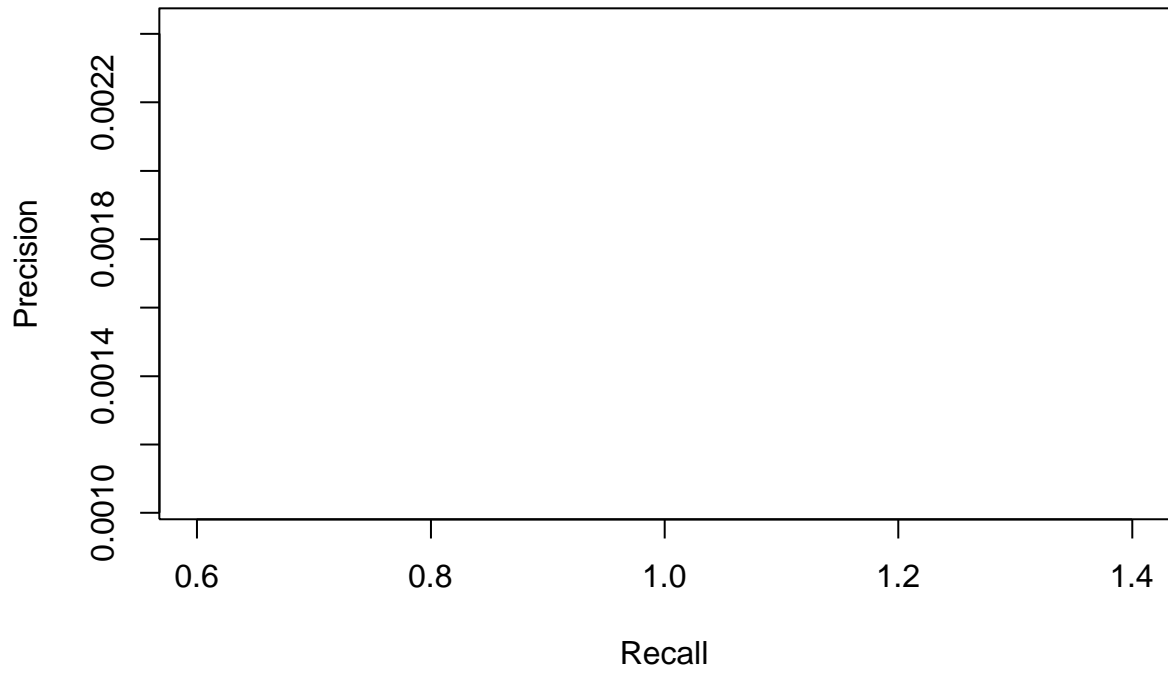
4 Analysis - Models Building and Comparison

4.1 Naive Baseline Algorithm - Predict Always “Legal” Transaction

Predicting always “Legal” transaction can archieve an impressive accuracy of **99.8** and an AUC of **0.92**. Because the recall and precision are **0**, it is impossible to compute the AUCPR, so that is **0**.



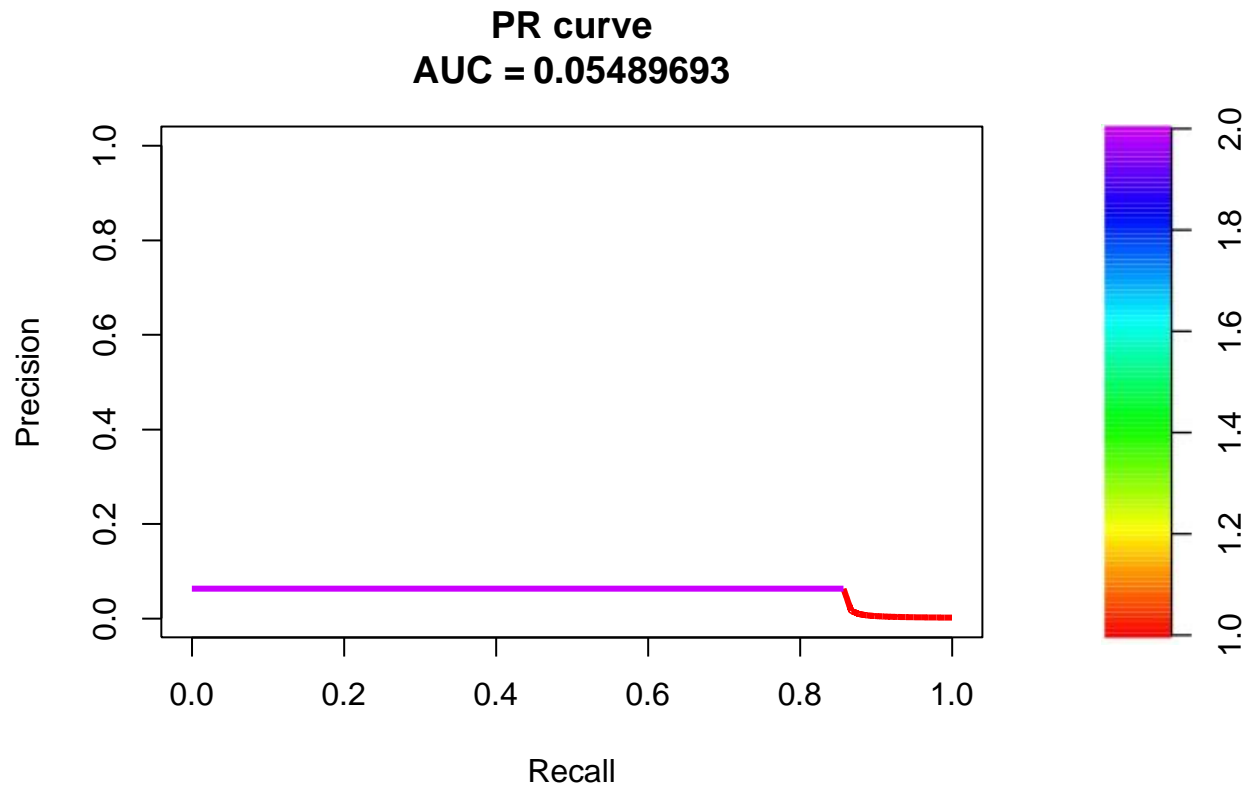
AUCPR: 0



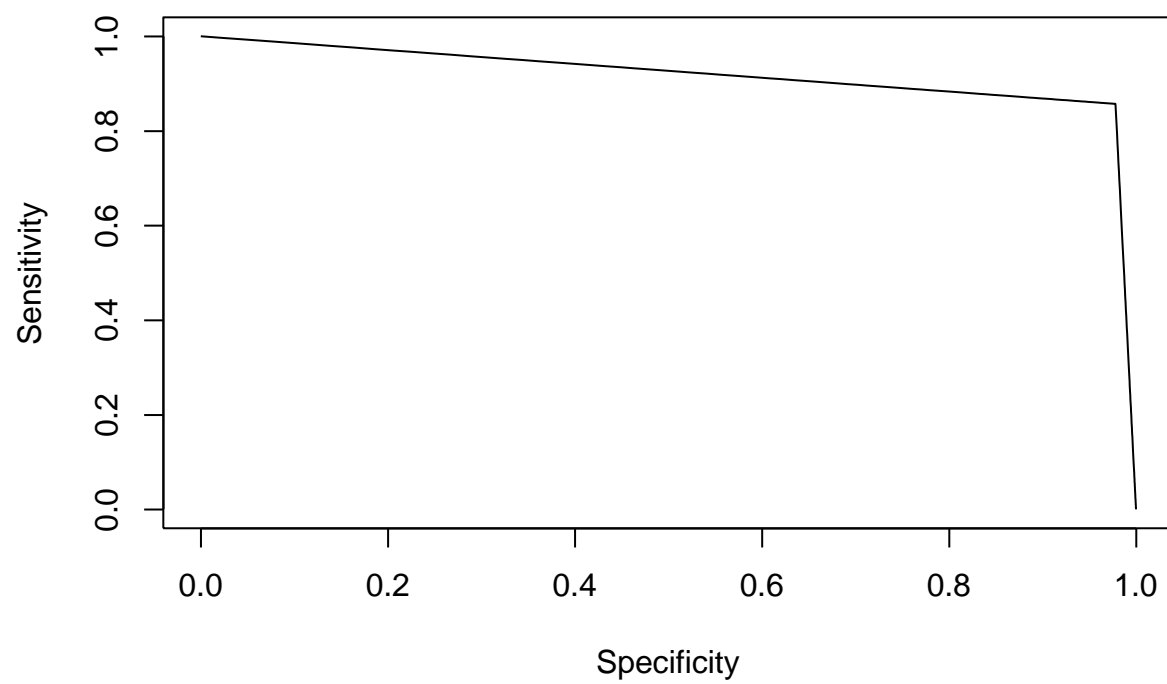
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5	0

4.2 Naive Bayes

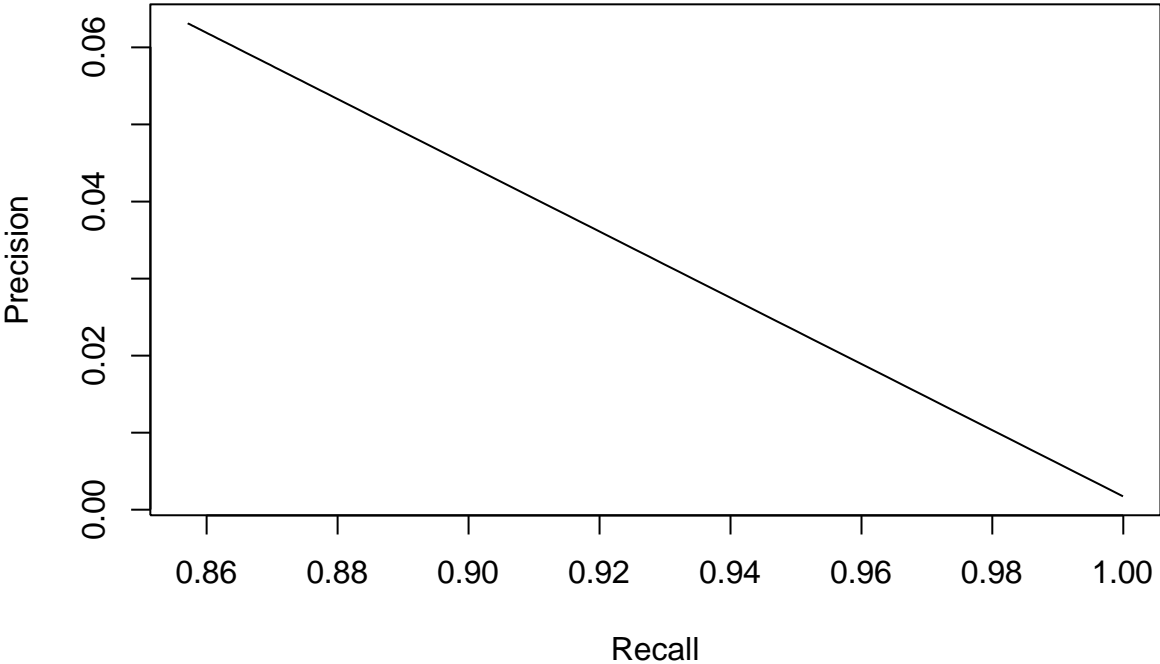
A step forward is building a Naive Bayes Classifier. The performance improve a little bit: AUC is **0.92** and finally the there is an AUCPR of **0.05**. It is a poor result according to the metric of interest and it is easy to improve.



AUC: 0.917597684660626



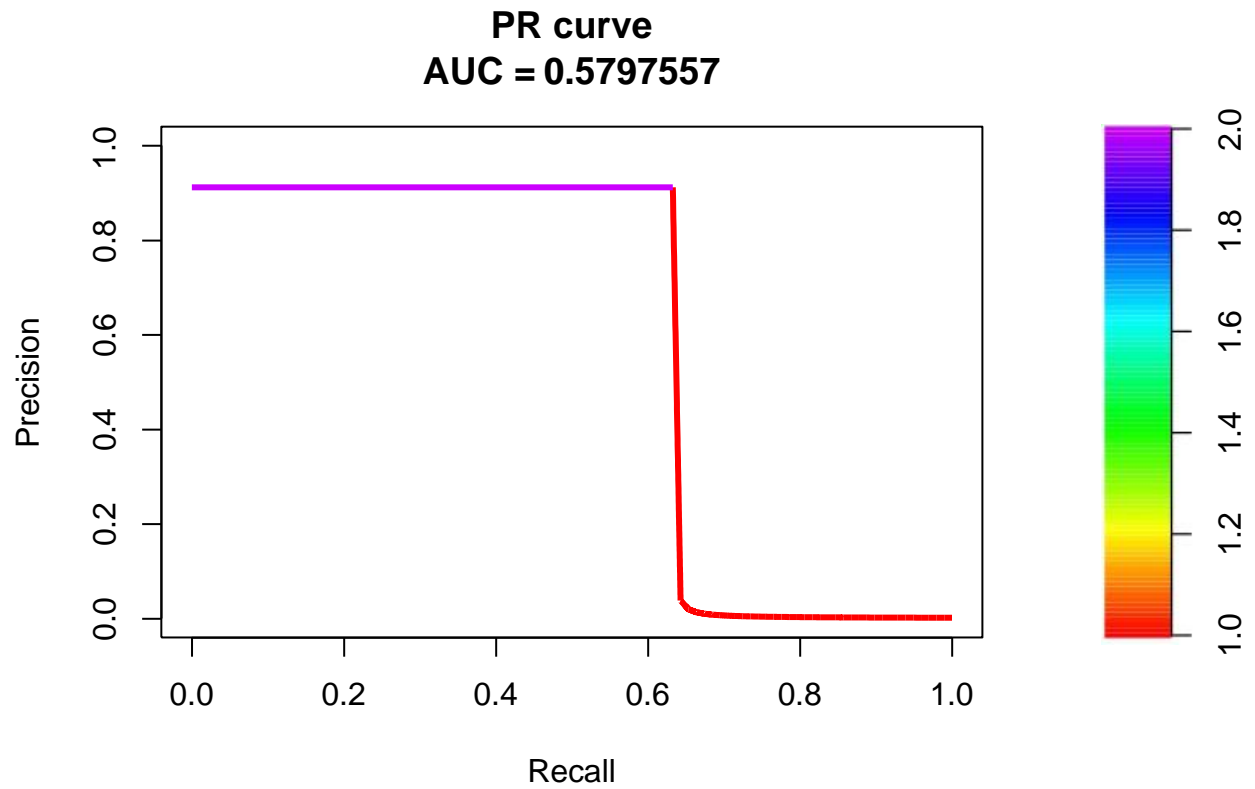
AUCPR: 0.0548969303984264



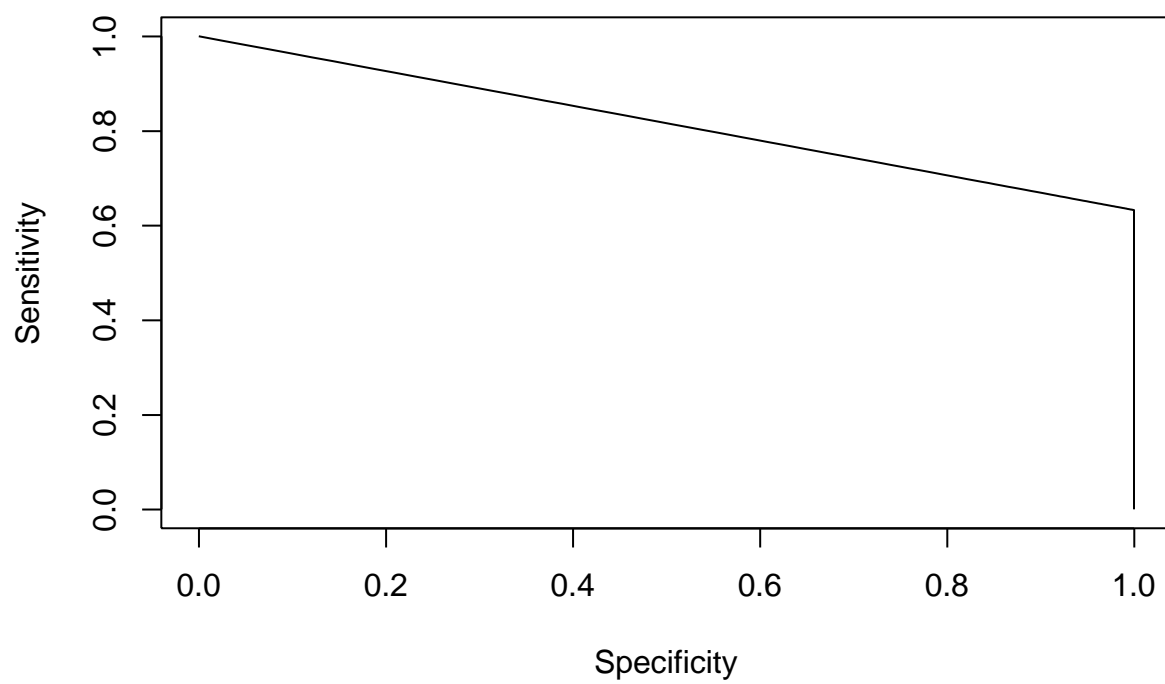
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969

4.3 KNN - K-Nearest Neighbors

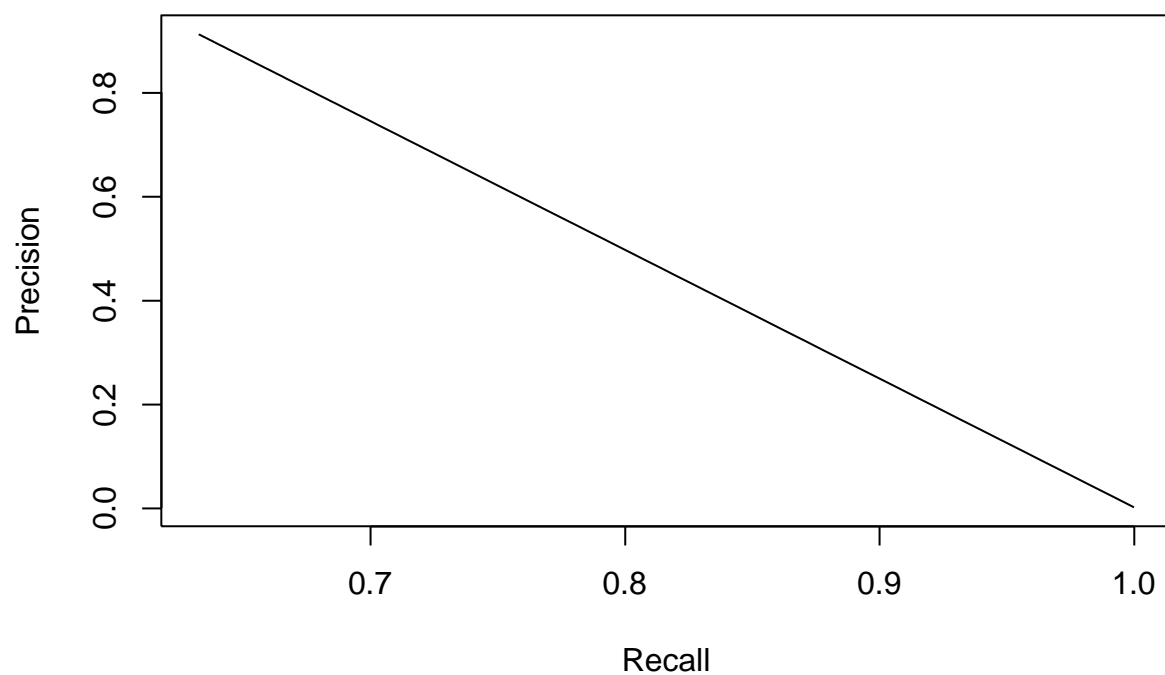
A KNN Model with $k=5$ can achieve a significant improvement in respect to the previous models, as regard AUCPR of **0.58** at the expense of a little drop off AUC, that is **0.81**.



AUC: 0.816273772228058



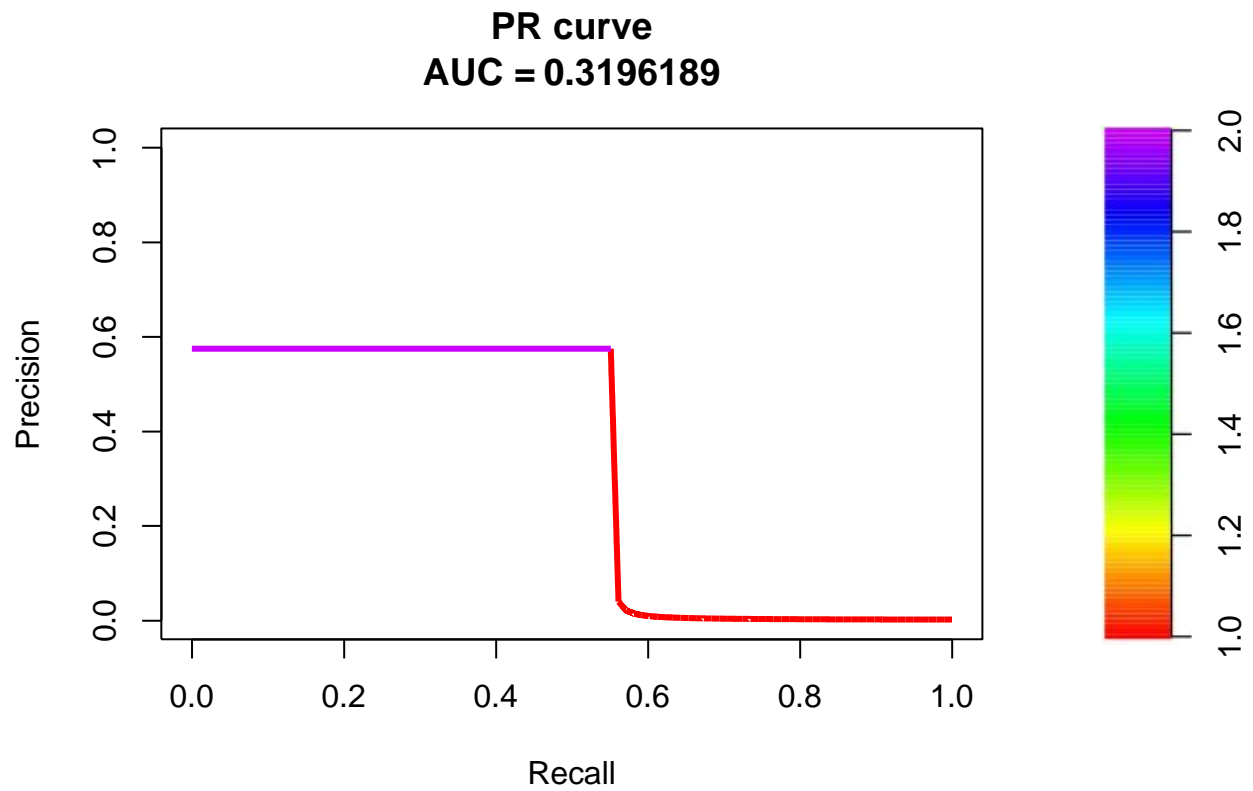
AUCPR: 0.579755719213291



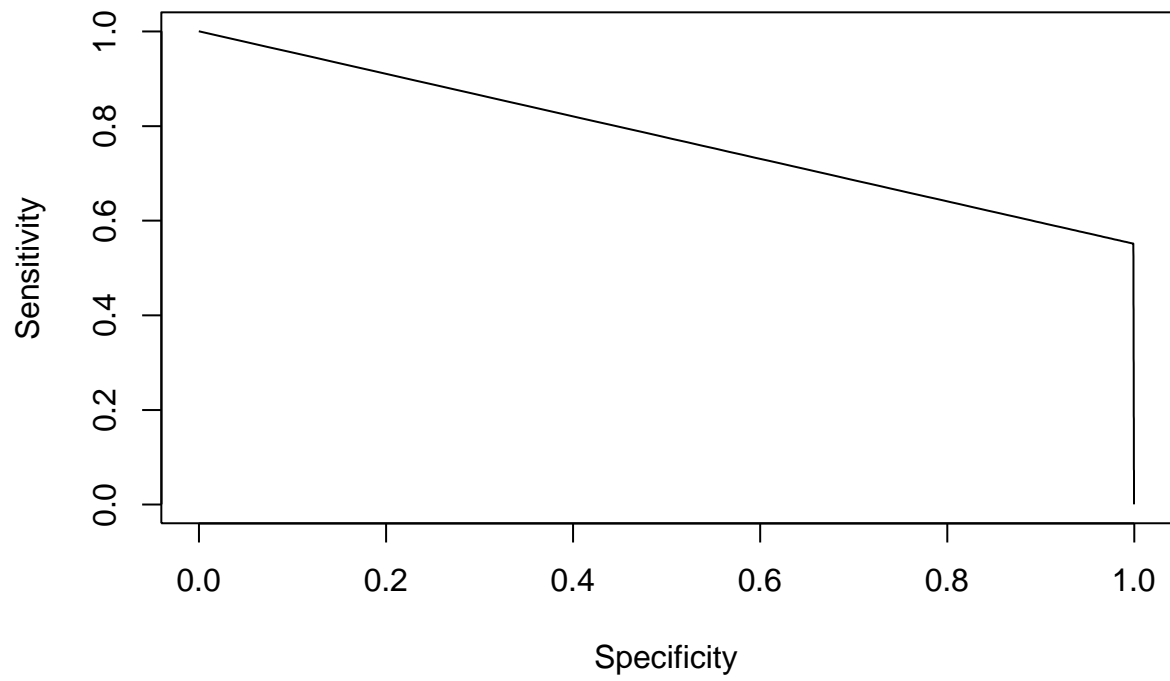
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557

4.4 SVM - Support Vector Machine

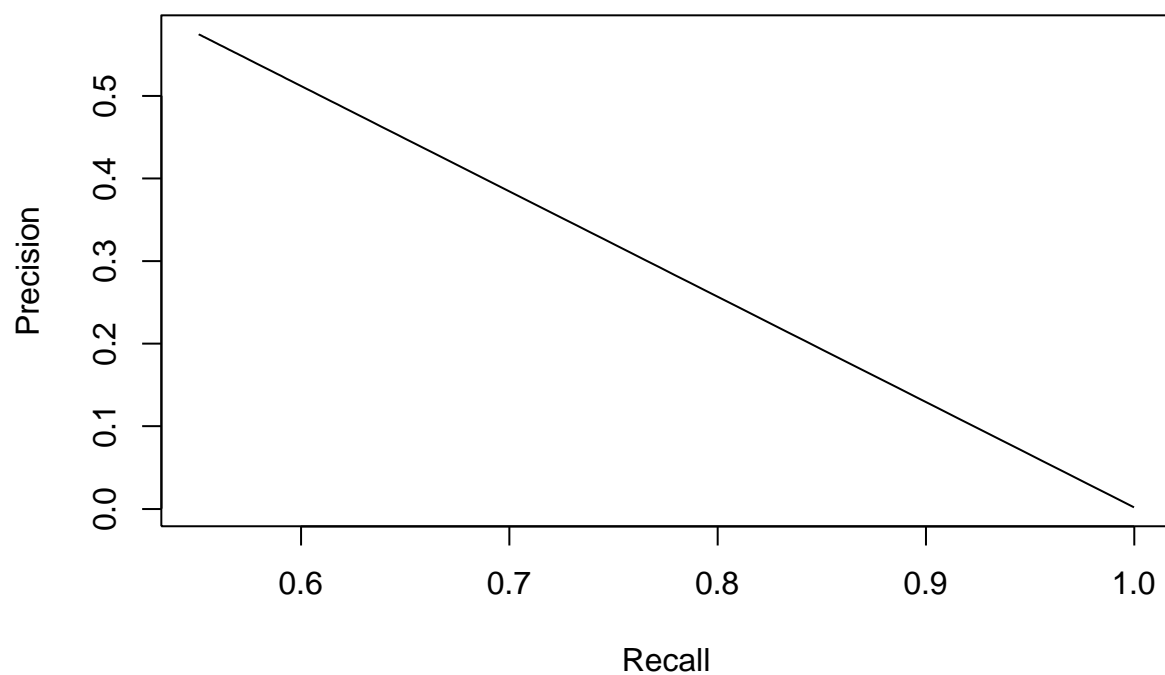
The SVM Model with a Sigmoid Kernel represent a step back on all fronts because the AUCPR is **0.32** and AUC is **0.77**.



AUC: 0.775158481520389



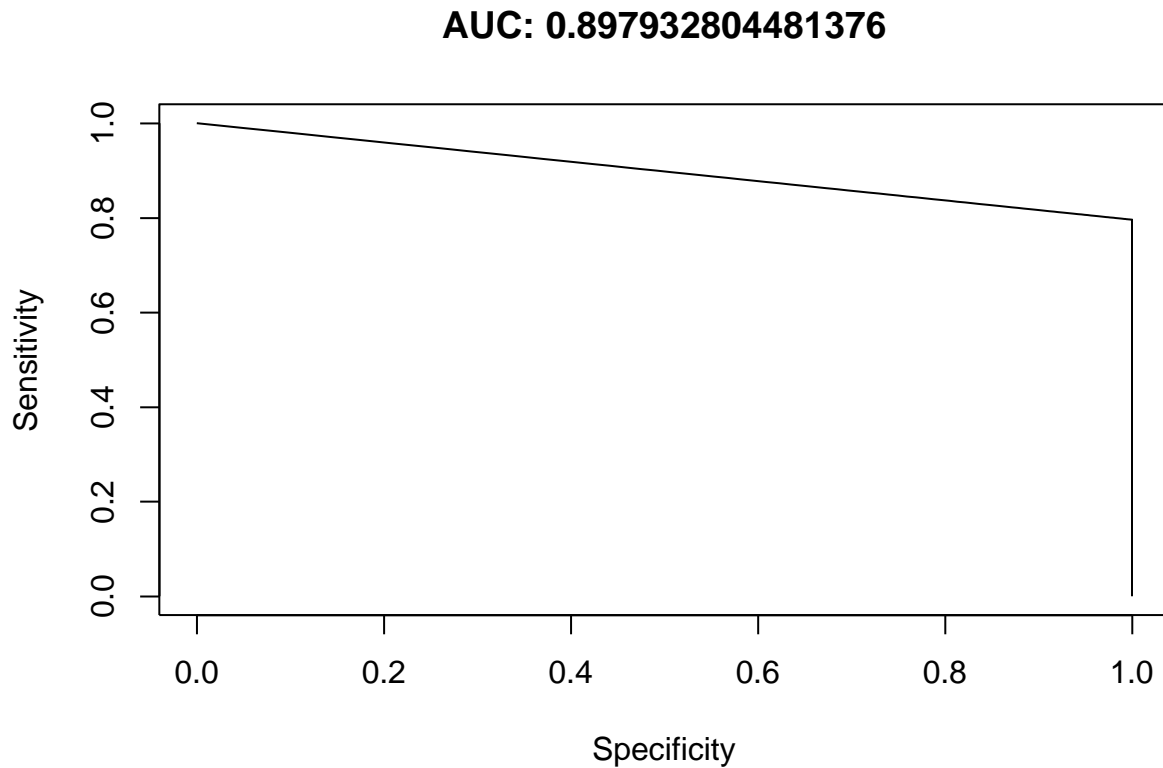
AUCPR: 0.319618862730037



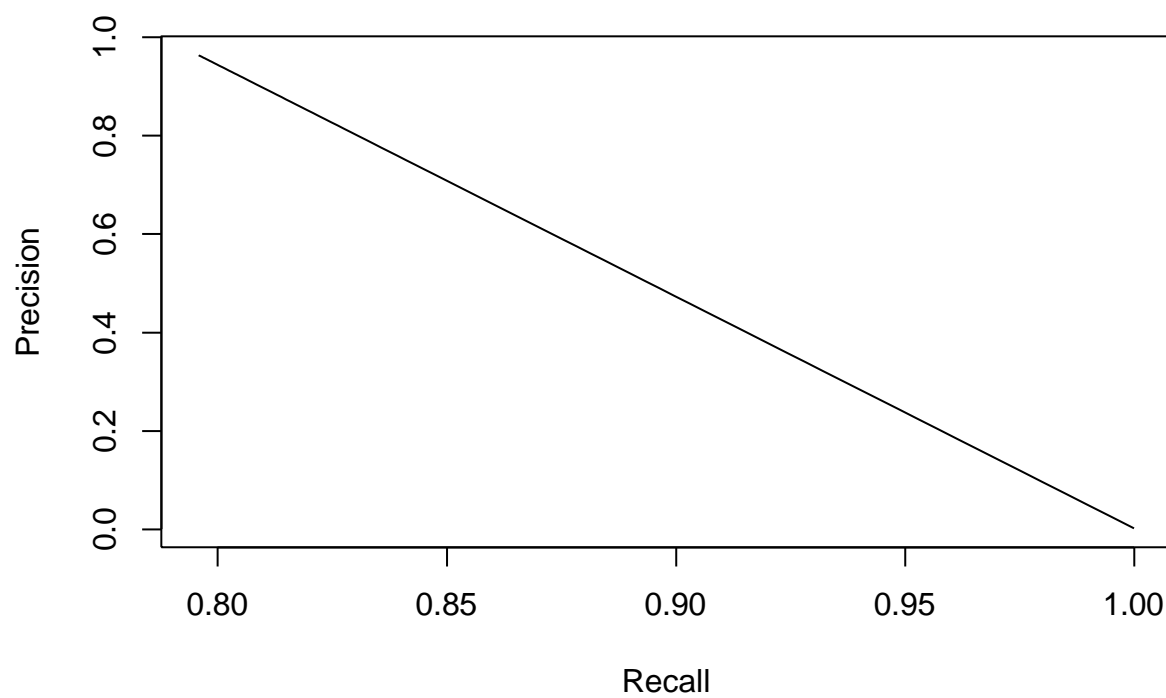
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189

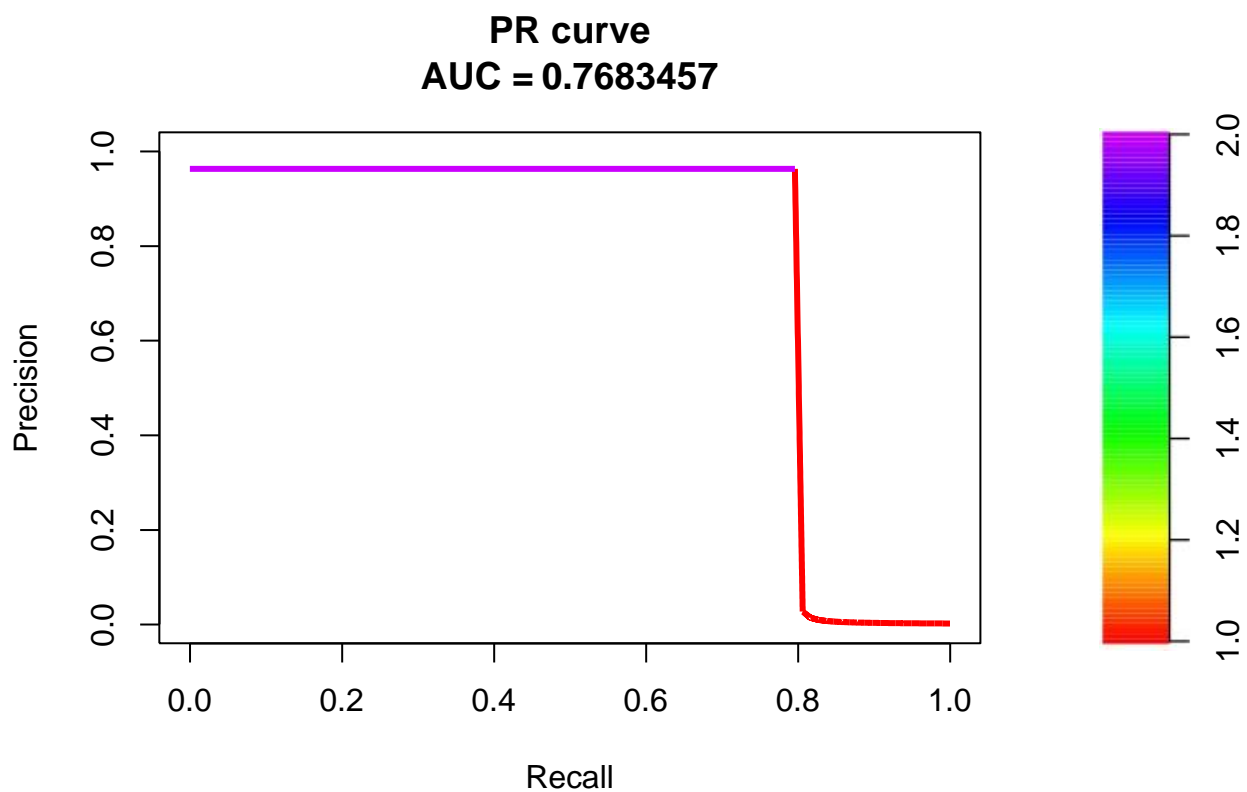
4.5 Random Forest

The ensemble methods are capable of a significant increase in performance. At the expense of another little drop off in terms of AUC (**0.9**) respect to the Naive Bayes model, there is a huge step forward in terms of AUCPR, that is **0.77**. This model doesn't reach the desired performance ($\text{AUCPR} > 0.85$), but it's close to it. As the plot and the table below suggest, there are few predictors like **V17**, **V12** and **V14** that are particularly useful for classifying a fraud.



AUCPR: 0.768345660673728



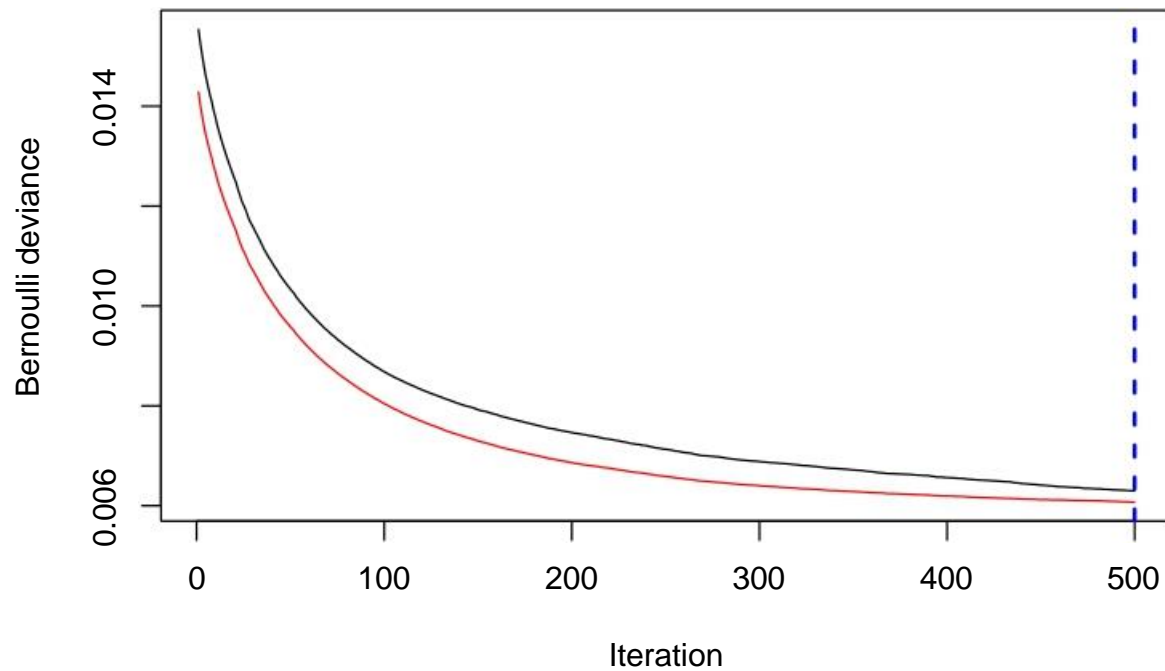


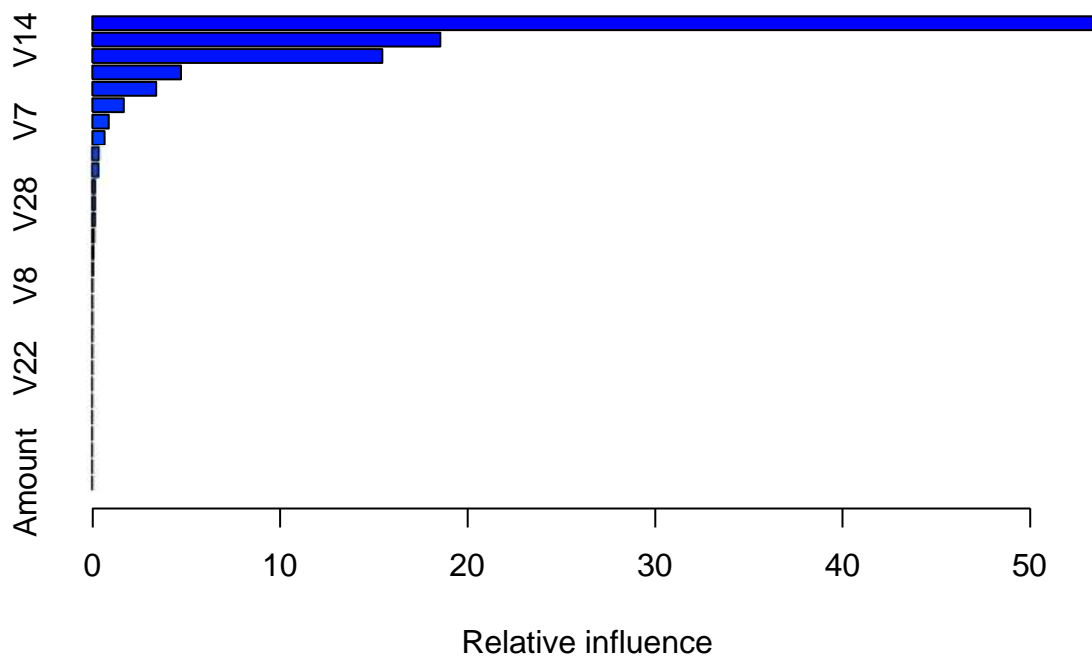
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189
Random Forest	0.8979328	0.7683457

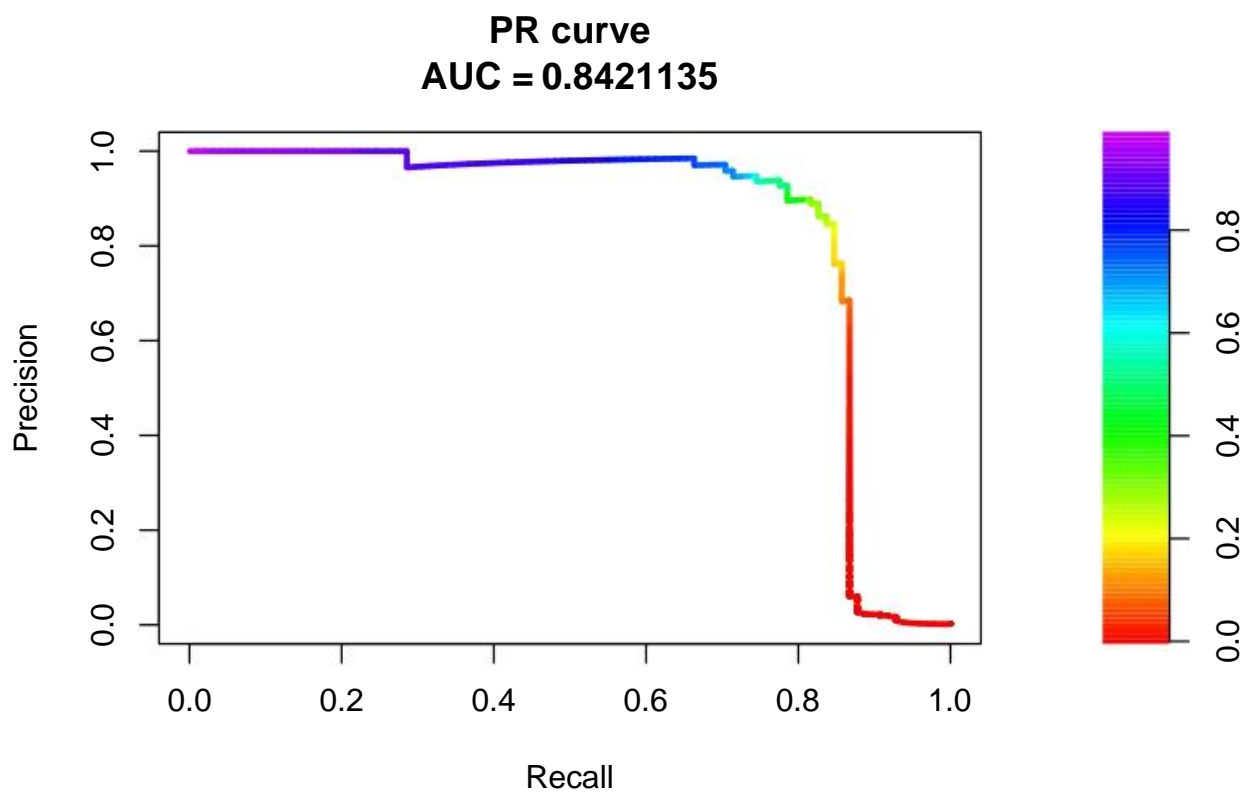
	MeanDecreaseGini
V1	8.708982
V2	7.784292
V3	8.985490
V4	17.257080
V5	7.772203
V6	8.821890
V7	19.072039
V8	7.013489
V9	23.520504
V10	43.772484
V11	44.997607
V12	73.056009
V13	6.829304
V14	63.479173
V15	6.388524
V16	40.124086
V17	105.084852
V18	16.236771
V19	8.041600
V20	8.359602
V21	10.723973
V22	5.886333
V23	4.705090
V24	6.127916
V25	5.290926
V26	10.888757
V27	9.216603
V28	6.266699
Amount	7.974071

4.6 GBM - Generalized Boosted Regression

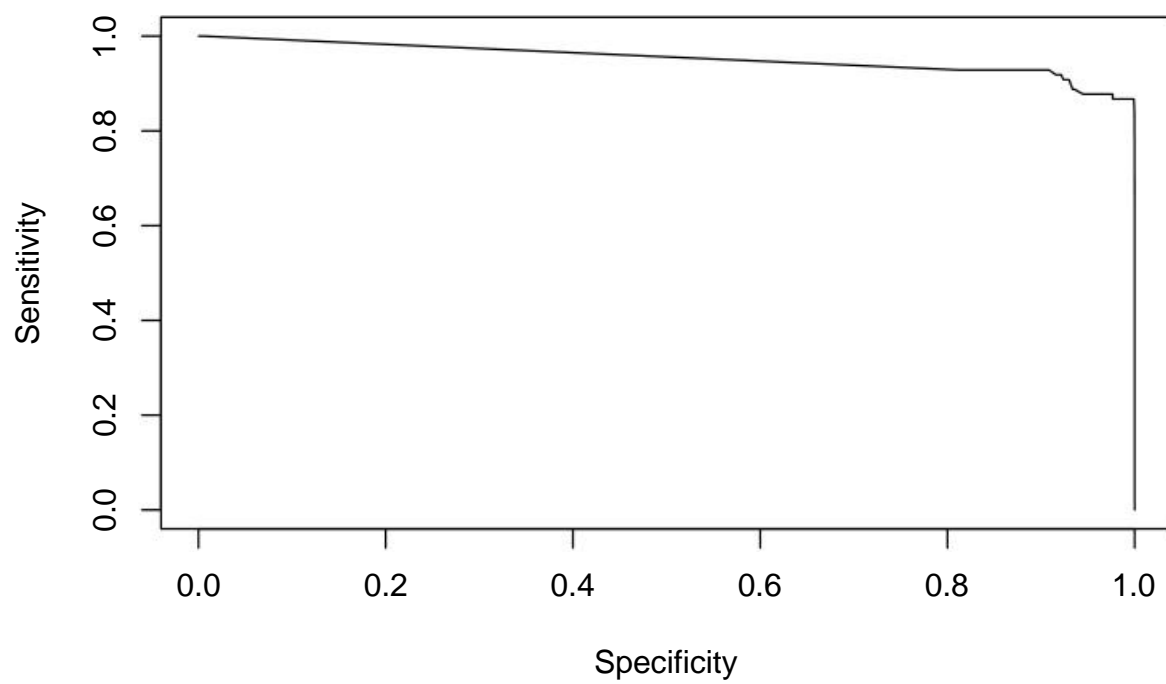
The GBM performance are really good: with an AUC of **0.95** and AUCPR of **0.94**, It doesn't achieve the target for a breath. As the Random Forest model shows, the **V17** and **V14** are still relevant to predict a fraud.



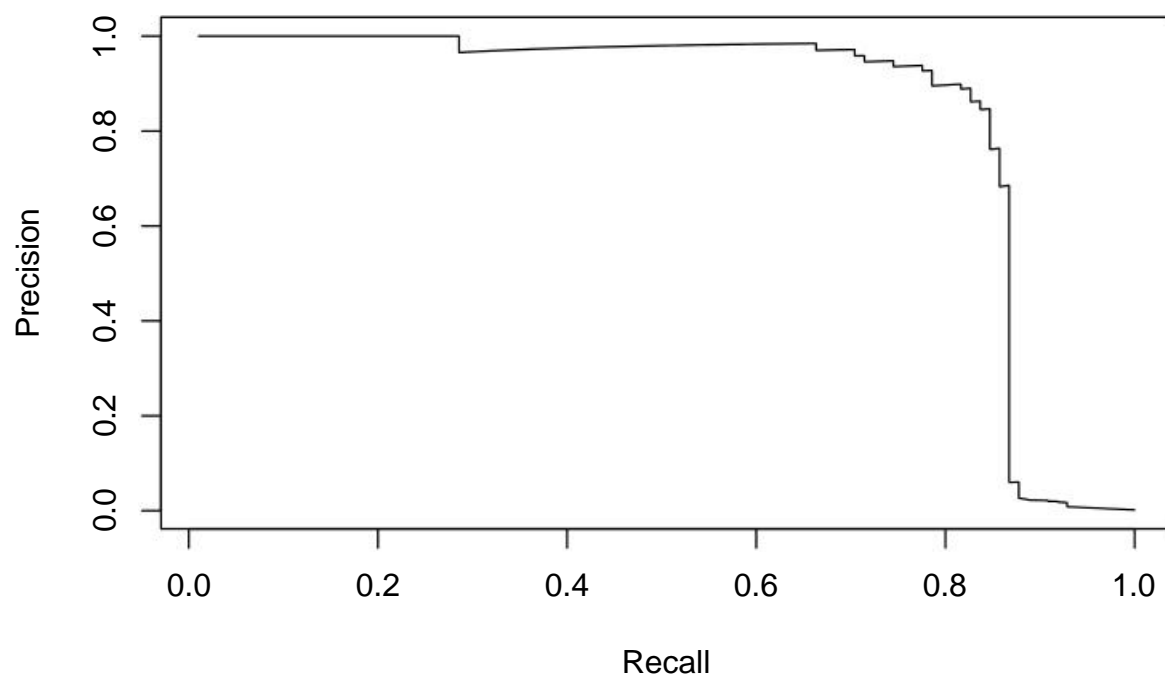




AUC: 0.953857319795125



AUCPR: 0.842113479742729



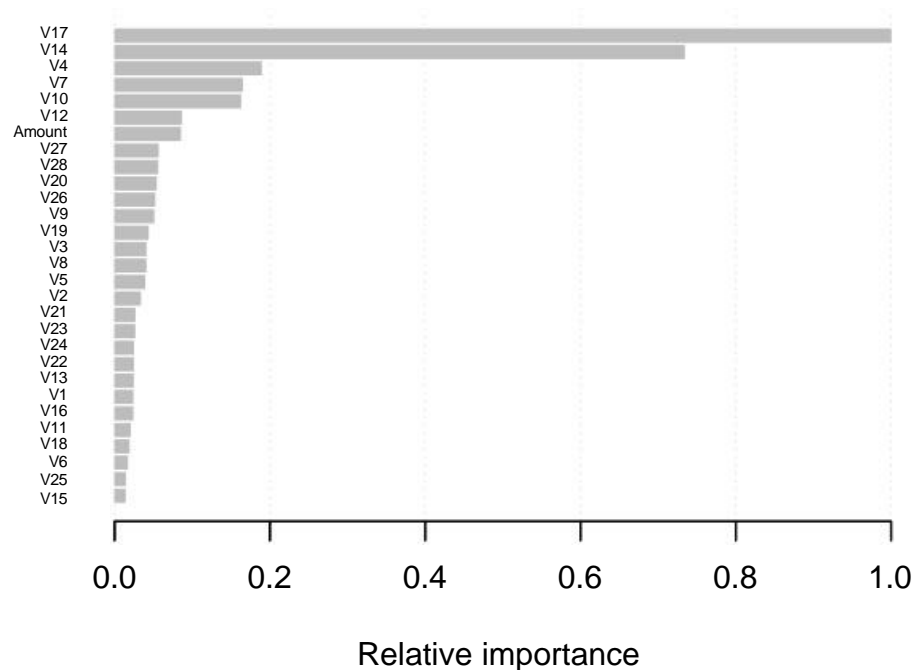
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189
Random Forest	0.8979328	0.7683457
GBM - Generalized Boosted Regression	0.9538573	0.8421135

	var	rel.inf
V17	V17	53.3300209
V14	V14	18.5530357
V12	V12	15.4550412
V10	V10	4.7219307
V20	V20	3.3949817
V11	V11	1.6650329
V7	V7	0.8612551
V9	V9	0.6445507
V4	V4	0.3346926
V26	V26	0.3156347
V3	V3	0.1467431
V28	V28	0.1435442
V18	V18	0.1392624
V16	V16	0.0918682
V27	V27	0.0711635
V25	V25	0.0489084
V8	V8	0.0172958
V5	V5	0.0155866
V6	V6	0.0147381
V15	V15	0.0134430
V21	V21	0.0114564
V22	V22	0.0074806
V19	V19	0.0019186
V1	V1	0.0004148
V2	V2	0.0000000
V13	V13	0.0000000
V23	V23	0.0000000
V24	V24	0.0000000
Amount	Amount	0.0000000

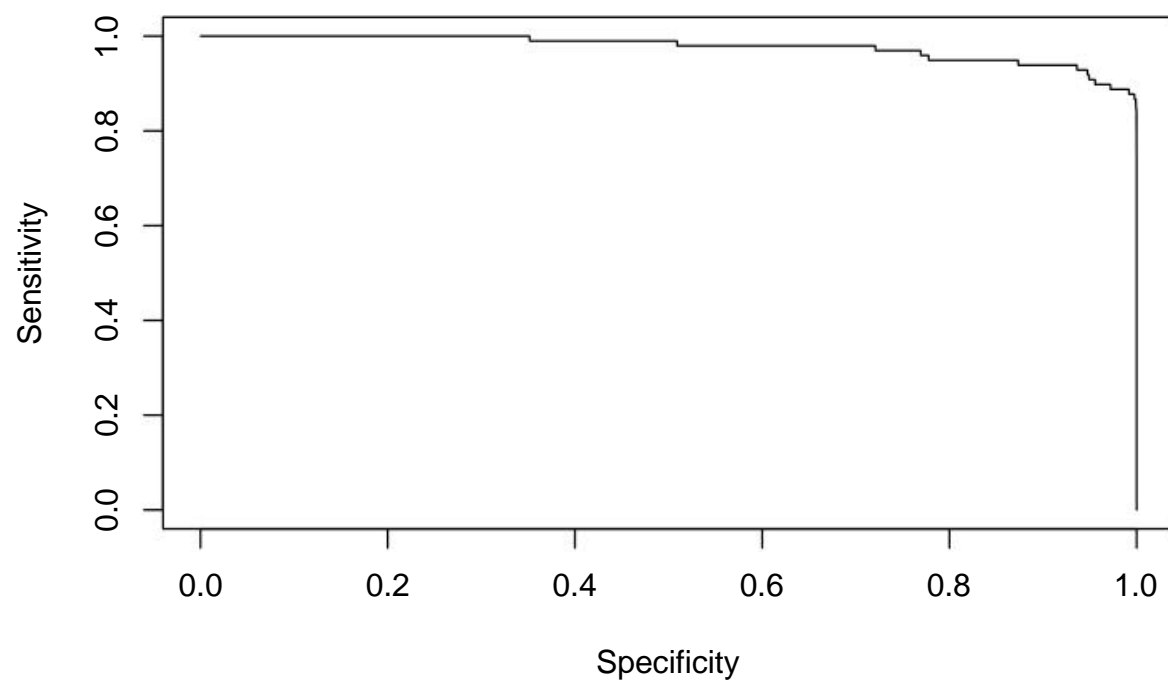
4.7 XGBoost

XGBoost are a top class model. It always stays on TOP5 (or wins them) in every competitions on Kaggle and in this case, its' very fast to train and its performance are awesome. With an AUC of **0.98** and an AUCPR of **0.86** it reach and overtake the desidered performance. As the previous model shown, **V17** and **V14** are still relevant to predict a fraud.

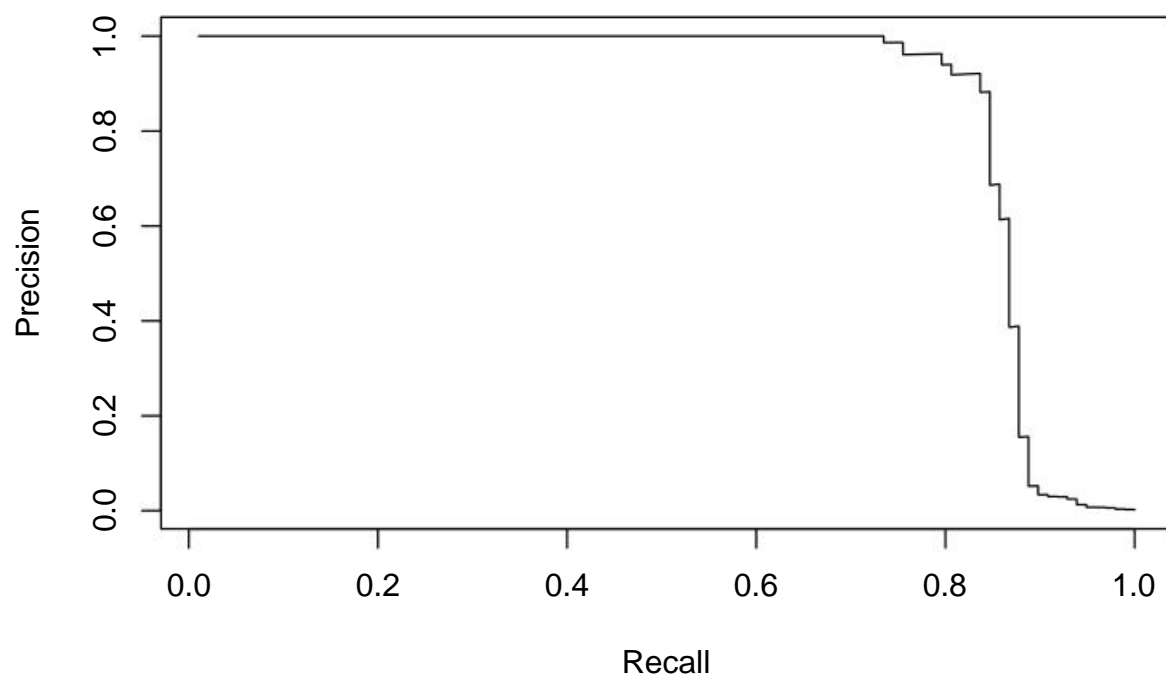
```
## [1] test-aucpr:0.658215 cv-aucpr:0.651097
## Multiple eval metrics are present. Will use cv_aucpr for early stopping.
## Will train until cv_aucpr hasn't improved in 40 rounds.
##
## [101] test-aucpr:0.857385 cv-aucpr:0.877270
## [201] test-aucpr:0.862116 cv-aucpr:0.886406
## Stopping. Best iteration:
## [190] test-aucpr:0.861816 cv-aucpr:0.887686
```

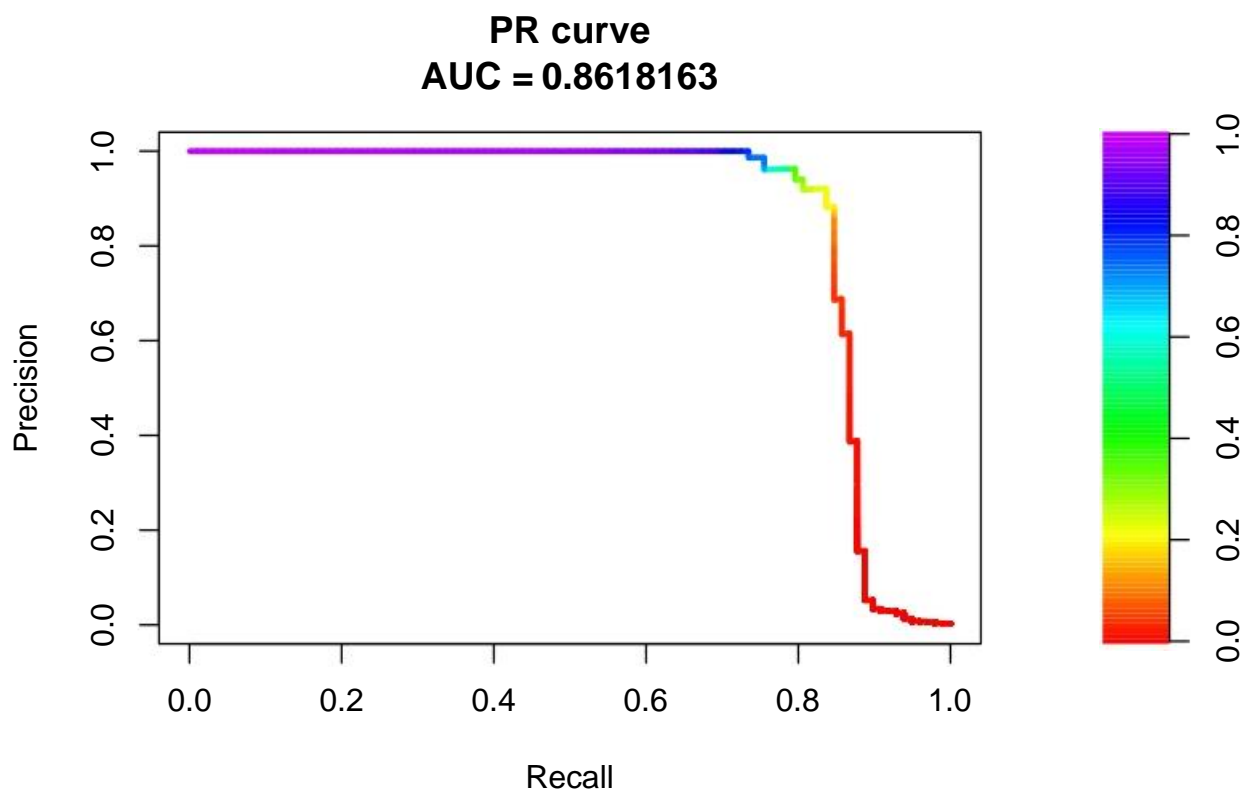


AUC: 0.977038976961337



AUCPR: 0.86181626247754





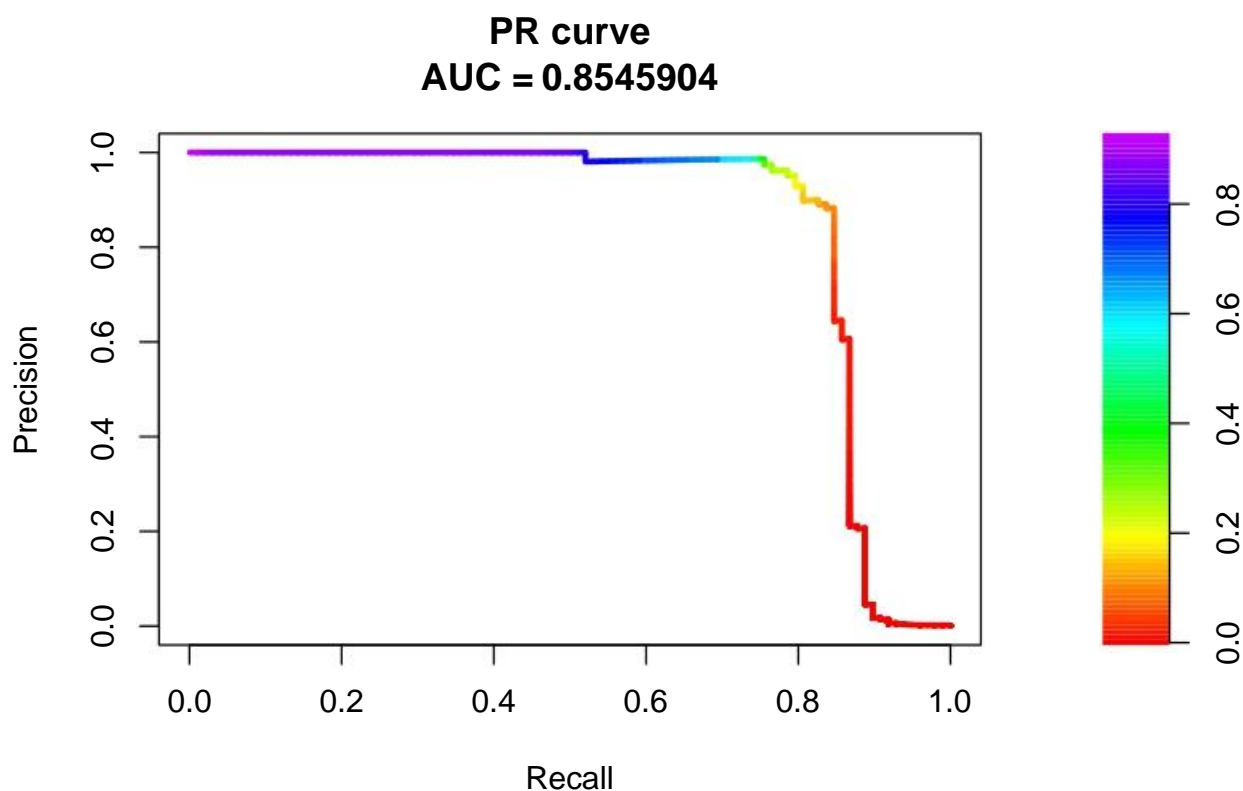
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189
Random Forest	0.8979328	0.7683457
GBM - Generalized Boosted Regression	0.9538573	0.8421135
XGBoost	0.9770390	0.8618163

Feature	Gain	Cover	Frequency	Importance
V17	0.3171657	0.3376839	0.0590406	0.3171657
V14	0.2328285	0.4247761	0.0974170	0.2328285
V4	0.0600361	0.0149544	0.0900369	0.0600361
V7	0.0524206	0.0016778	0.0487085	0.0524206
V10	0.0515966	0.0024414	0.0442804	0.0515966
V12	0.0274032	0.1442810	0.0457565	0.0274032
Amount	0.0270669	0.0014754	0.0568266	0.0270669
V27	0.0179538	0.0006398	0.0265683	0.0179538
V28	0.0178111	0.0008319	0.0324723	0.0178111
V20	0.0171806	0.0008593	0.0250923	0.0171806
V26	0.0166046	0.0006860	0.0332103	0.0166046
V9	0.0161372	0.0059450	0.0265683	0.0161372
V19	0.0139521	0.0008483	0.0346863	0.0139521
V3	0.0129482	0.0014248	0.0391144	0.0129482
V8	0.0128923	0.0008873	0.0280443	0.0128923
V5	0.0125336	0.0188990	0.0324723	0.0125336
V2	0.0106854	0.0006103	0.0228782	0.0106854
V21	0.0084312	0.0007444	0.0191882	0.0084312
V23	0.0083561	0.0280382	0.0265683	0.0083561
V24	0.0079779	0.0005232	0.0250923	0.0079779
V22	0.0079069	0.0011115	0.0228782	0.0079069
V13	0.0077632	0.0008035	0.0243542	0.0077632
V1	0.0076040	0.0006159	0.0295203	0.0076040
V16	0.0076017	0.0069315	0.0258303	0.0076017
V11	0.0066428	0.0006218	0.0177122	0.0066428
V18	0.0060901	0.0004219	0.0199262	0.0060901
V6	0.0054157	0.0004609	0.0169742	0.0054157
V25	0.0045781	0.0004818	0.0169742	0.0045781
V15	0.0044156	0.0003236	0.0118081	0.0044156

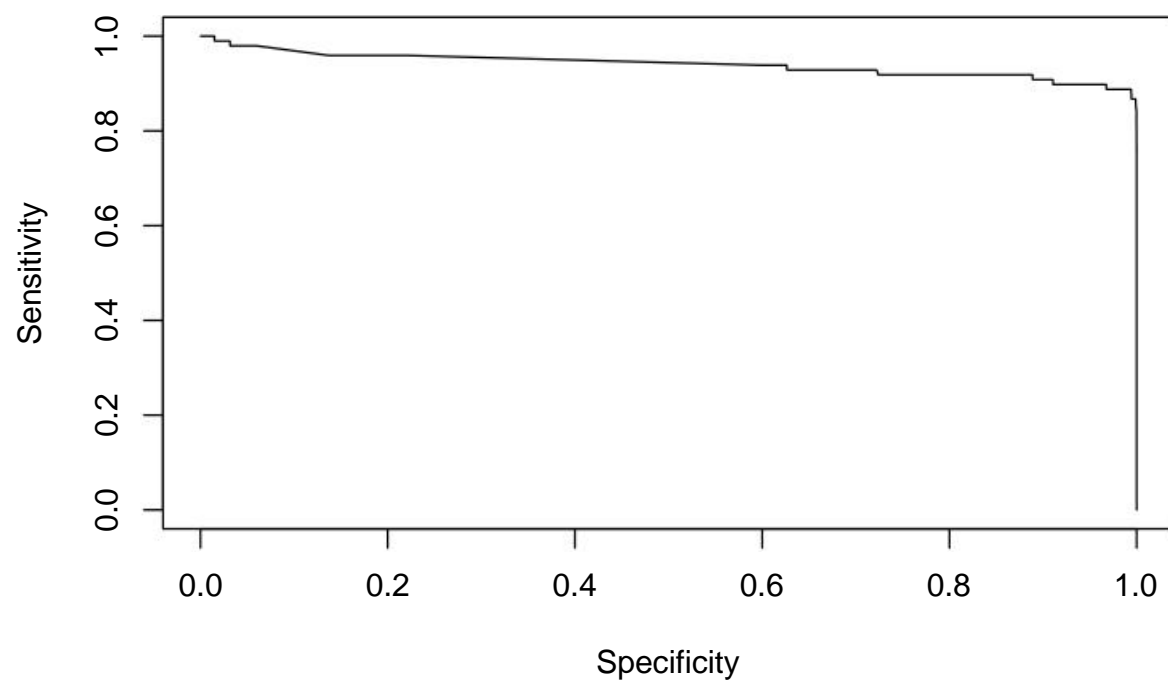
4.8 LightGBM

LightGBM is the fastest and complex implementation of GBM. It has tons of parameters and because of this it has a steep learning curve. With a small change of the parameters, the LightGBM model is able to reach the performance of XGBoost. Because I have more experience with the last one, the performance are a little bit worse: AUC of **0.94** and AUCPR of **0.85**, but they are all good.

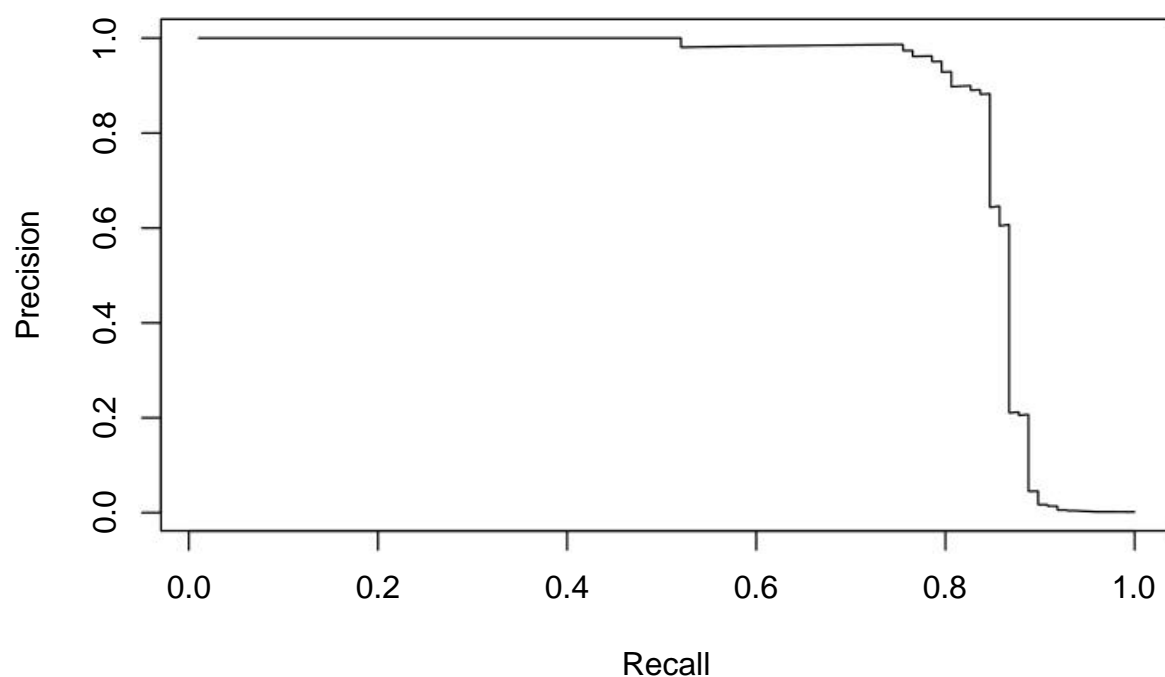
```
## [1]: test's binary_error:0.00172048 cv's binary_error:0.00172048
## [21]: test's binary_error:0.0016327 cv's binary_error:0.00156247
## [41]: test's binary_error:0.000842682 cv's binary_error:0.00080757
## [61]: test's binary_error:0.000842682 cv's binary_error:0.000790014
## [81]: test's binary_error:0.000702235 cv's binary_error:0.000719791
## [101]: test's binary_error:0.000614456 cv's binary_error:0.000667123
## [121]: test's binary_error:0.000544232 cv's binary_error:0.000579344
## [141]: test's binary_error:0.000474009 cv's binary_error:0.000561788
## [161]: test's binary_error:0.000456453 cv's binary_error:0.000526676
## [181]: test's binary_error:0.000456453 cv's binary_error:0.00050912
## [201]: test's binary_error:0.000456453 cv's binary_error:0.00050912
```



AUC: 0.940520305338254



AUCPR: 0.854590406489971



Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189
Random Forest	0.8979328	0.7683457
GBM - Generalized Boosted Regression	0.9538573	0.8421135
XGBoost	0.9770390	0.8618163
LightGBM	0.9405203	0.8545904

Feature	Gain	Cover	Frequency
V14	0.4307962	0.3609848	0.0904762
V7	0.3035386	0.0323388	0.0304348
V12	0.0348256	0.0182142	0.0577640
V26	0.0338785	0.0063473	0.0654244
V10	0.0248953	0.0058810	0.0414079
V4	0.0243032	0.2500562	0.0921325
V20	0.0182291	0.0506729	0.0399586
V1	0.0093899	0.0008671	0.0252588
V18	0.0091918	0.0018870	0.0320911
V2	0.0086183	0.0015763	0.0225673
V16	0.0084501	0.0038963	0.0236025
V13	0.0082319	0.0032468	0.0322981
Amount	0.0071959	0.0159475	0.0465839
V17	0.0068772	0.0408338	0.0225673
V28	0.0068020	0.0016715	0.0337474
V24	0.0062211	0.0023892	0.0293996
V15	0.0061126	0.0019022	0.0289855
V11	0.0050963	0.0335001	0.0260870
V6	0.0048581	0.0029185	0.0188406
V9	0.0048414	0.0010716	0.0287785
V3	0.0048409	0.0020941	0.0273292
V8	0.0047966	0.0138567	0.0207039
V27	0.0047570	0.0344483	0.0395445
V23	0.0046562	0.0377007	0.0333333
V25	0.0046264	0.0002474	0.0113872
V19	0.0043399	0.0126660	0.0182195
V22	0.0037440	0.0587793	0.0213251
V5	0.0032005	0.0024771	0.0229814
V21	0.0026854	0.0015272	0.0167702

5 Results

This is the summary results for all the models built, trained and validated.

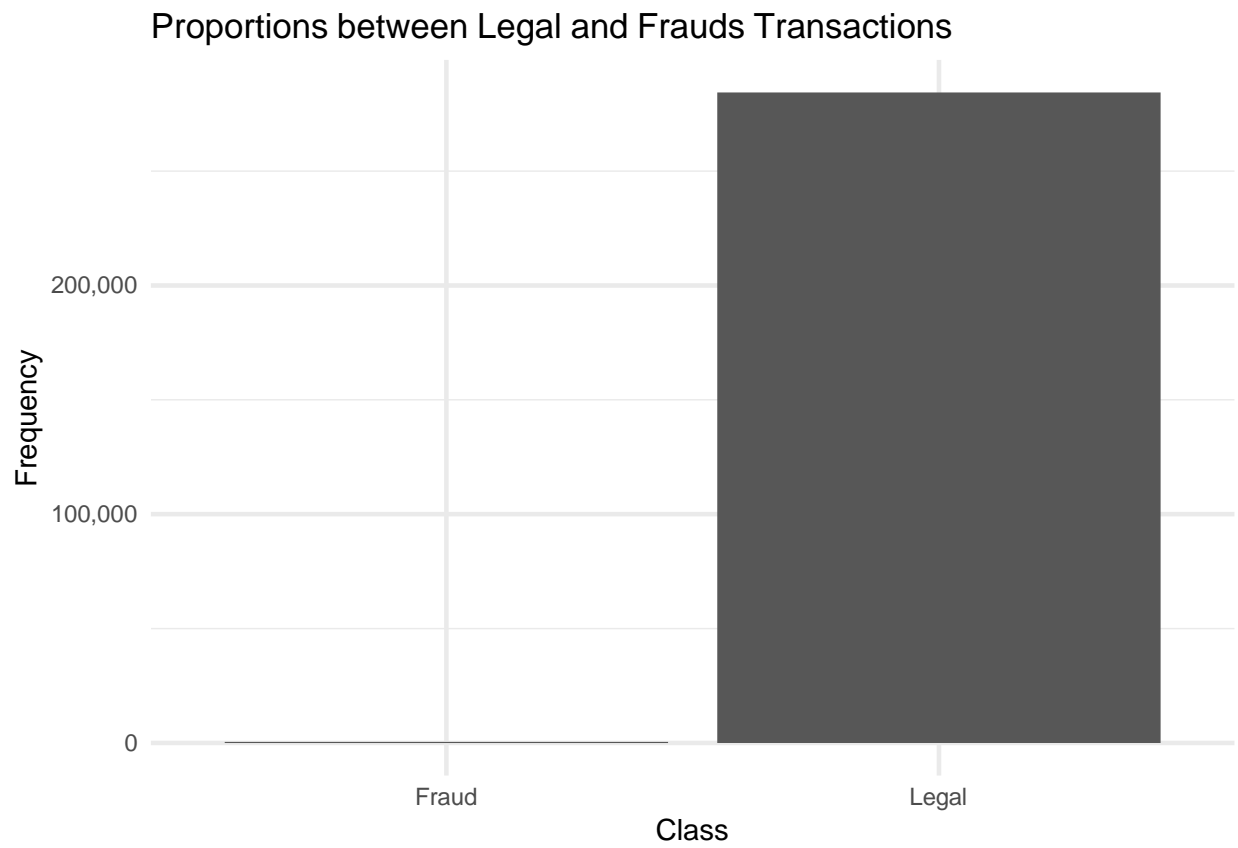
Model	AUC	AUCPR
Naive Baseline - Predict Always Legal	0.5000000	0.0000000
Naive Bayes	0.9175977	0.0548969
K-Nearest Neighbors k=5	0.8162738	0.5797557
SVM - Support Vector Machine	0.7751585	0.3196189
Random Forest	0.8979328	0.7683457
GBM - Generalized Boosted Regression	0.9538573	0.8421135
XGBoost	0.9770390	0.8618163
LightGBM	0.9405203	0.8545904

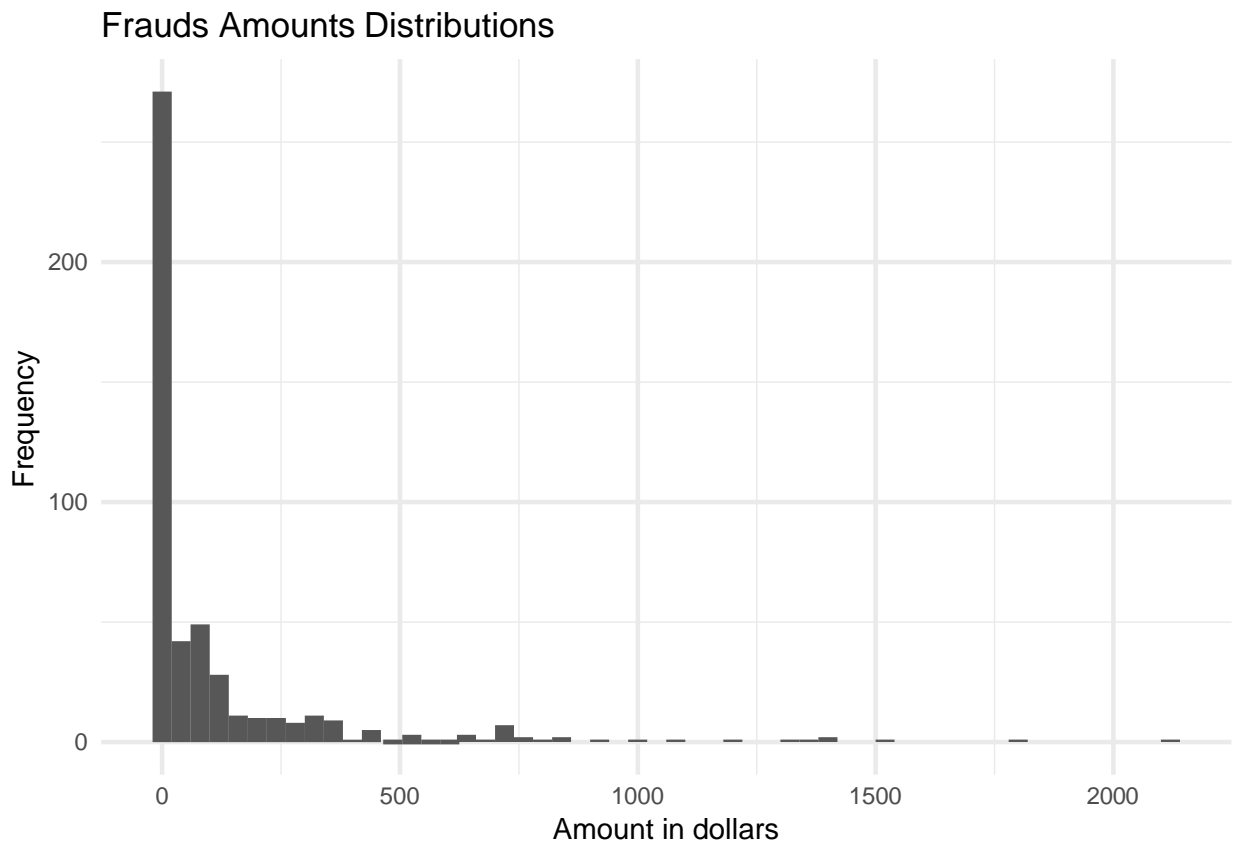
6 Conclusion

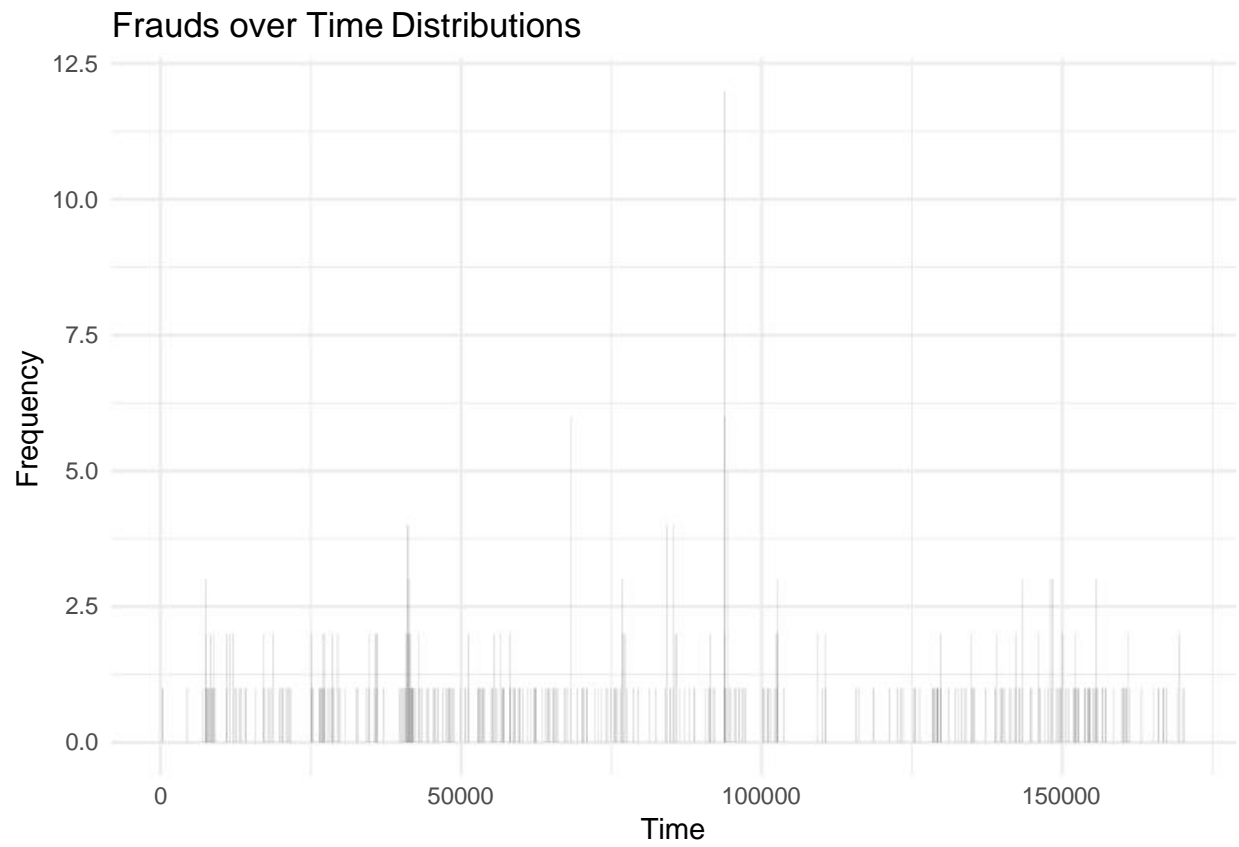
The ensemble methods once again confirm themselves as among the best models out there. It easy to find them as a winners of numerous Kaggle's competitions or on TOP5 of them. In this task, a XGBoost model can achieve a very good AUCPR result of **0.86** and the others ensembe methods are very close to it. As the features importance plots and table show, there are few predictors like **V17** and **V14** that are particularly useful for classifying a fraud. The SMOTE technique (a technique for dealing with imbalanced data) could improve the performance a little bit.

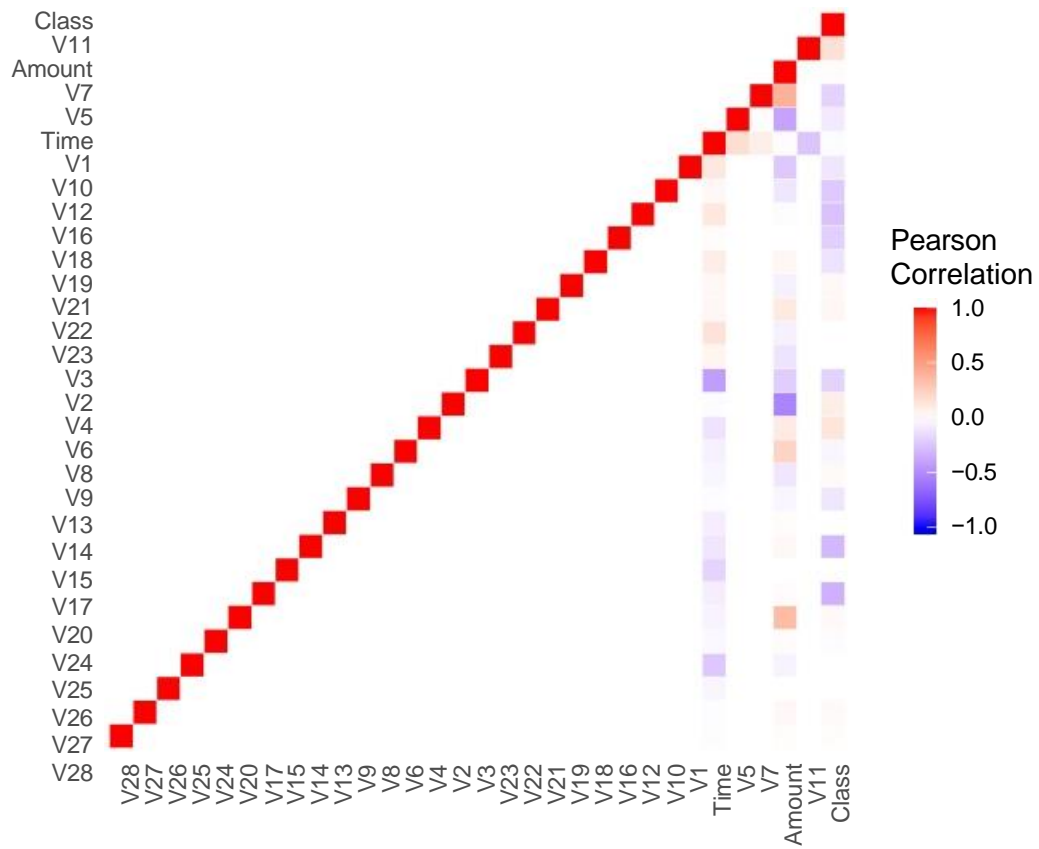
7 Appendix

7.1 1a - All visualization

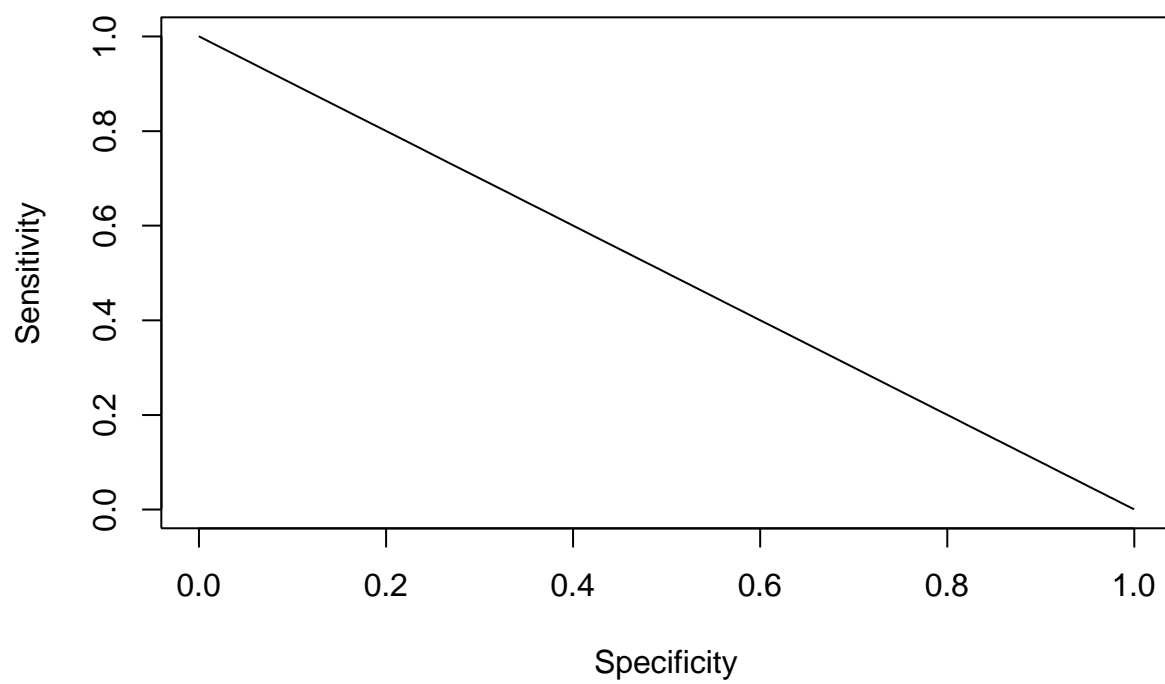




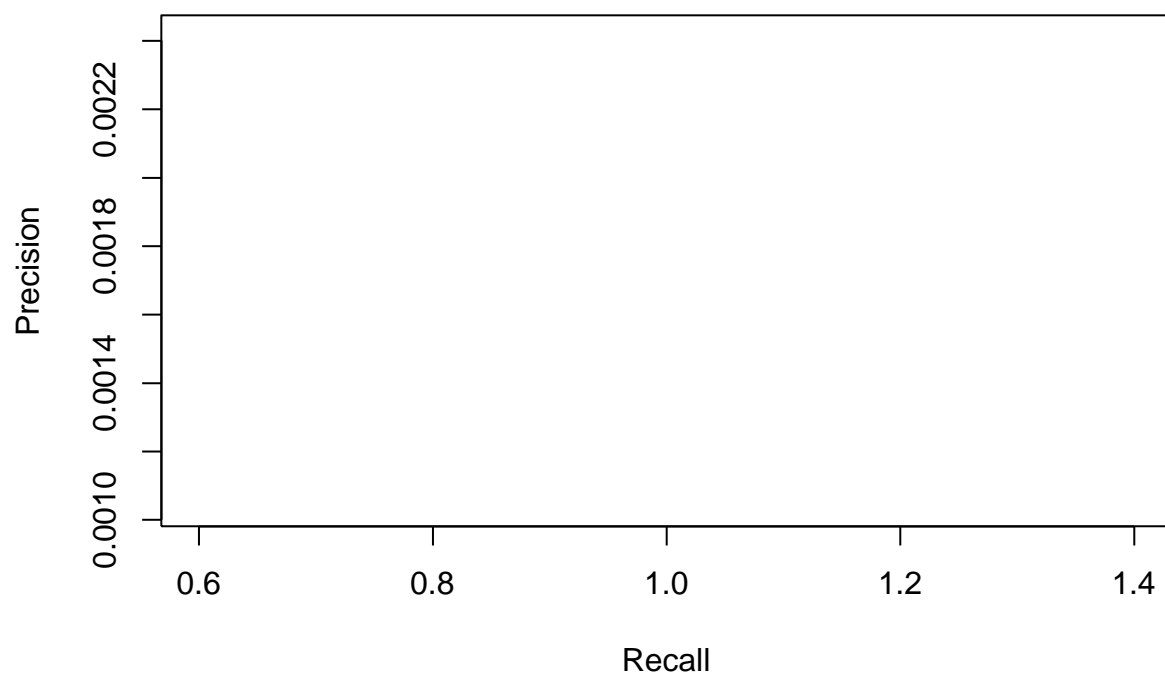


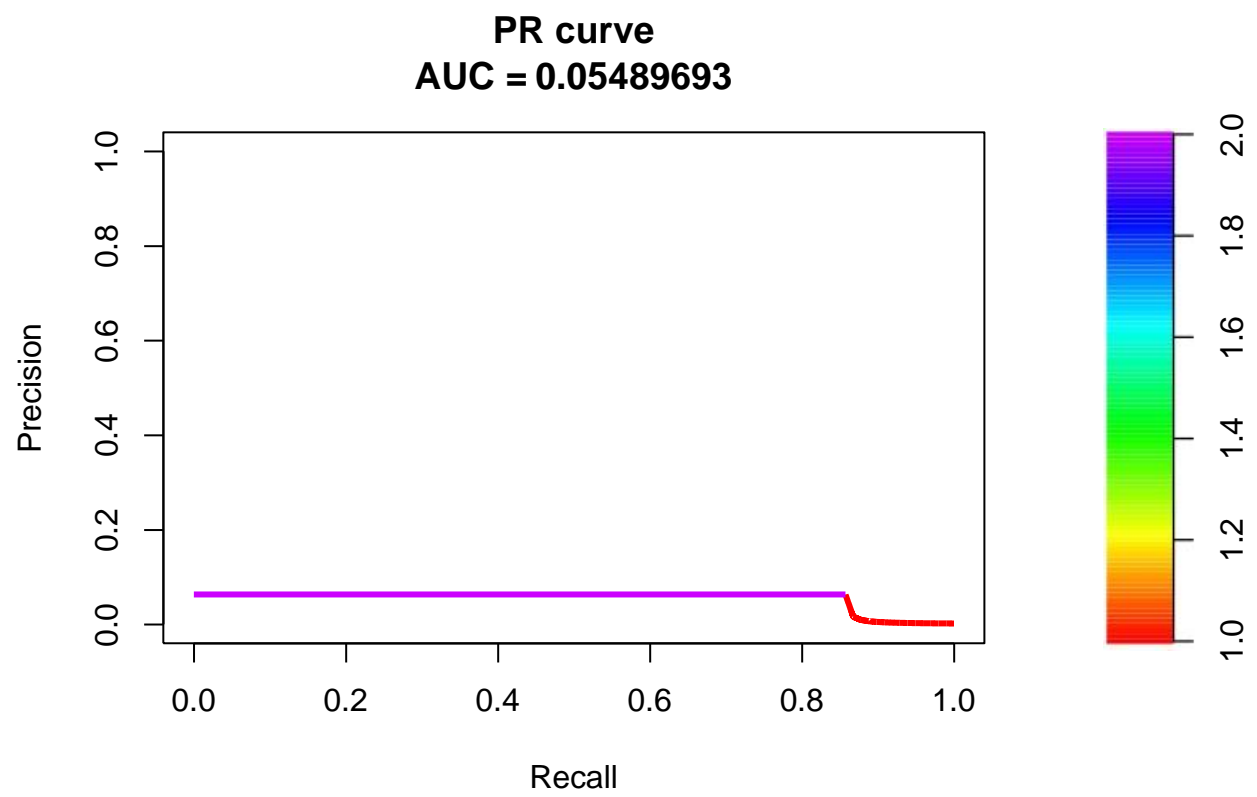


AUC: 0.5

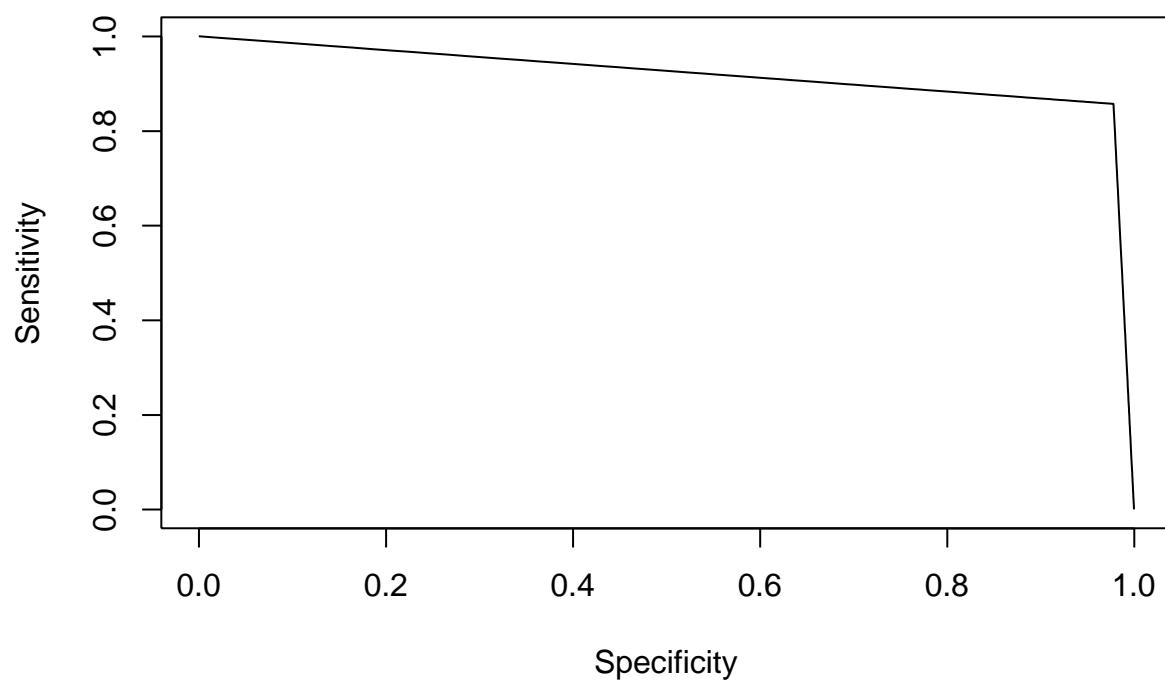


AUCPR: 0

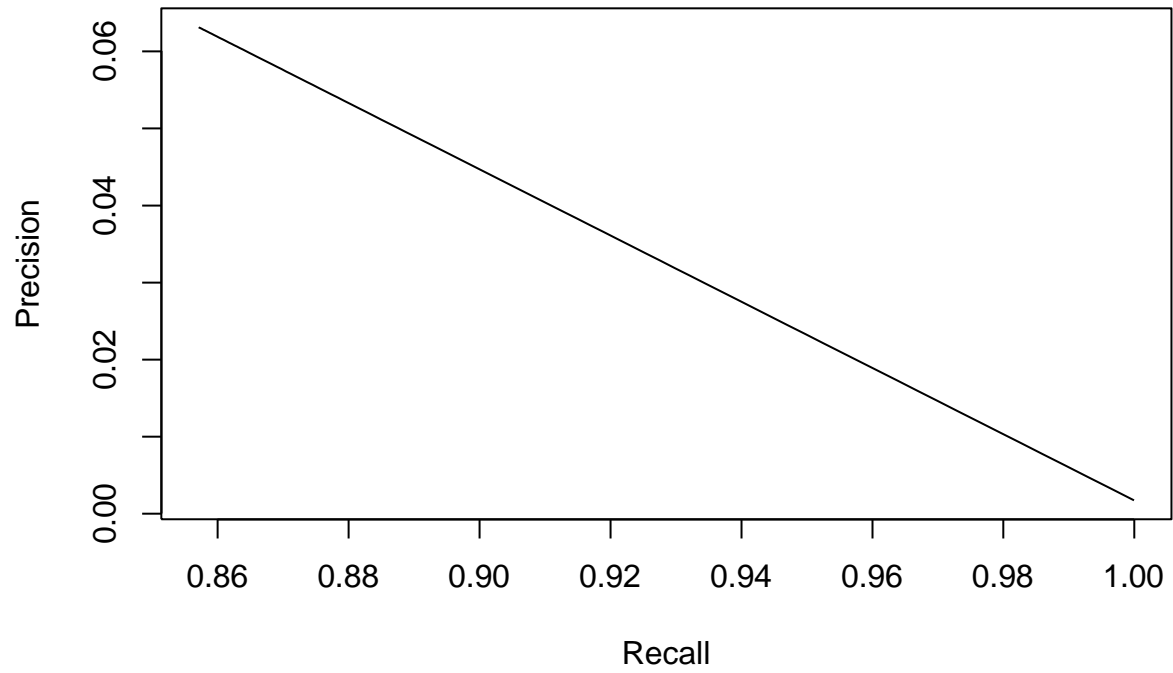




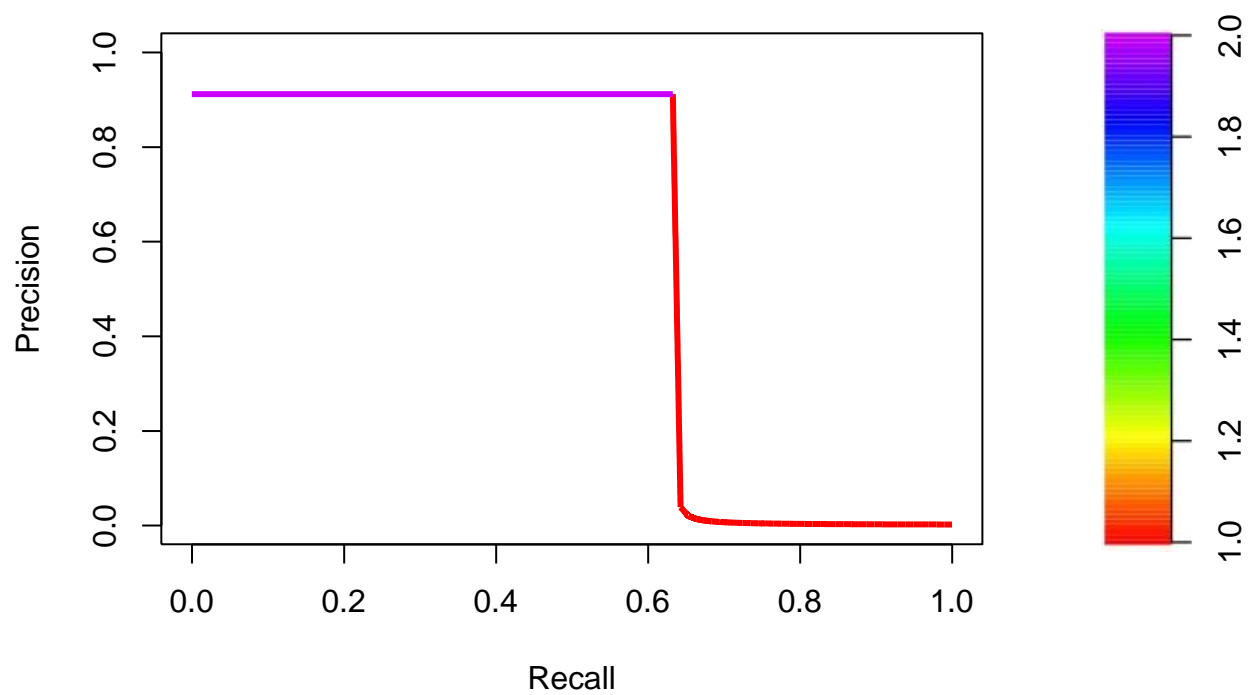
AUC: 0.917597684660626



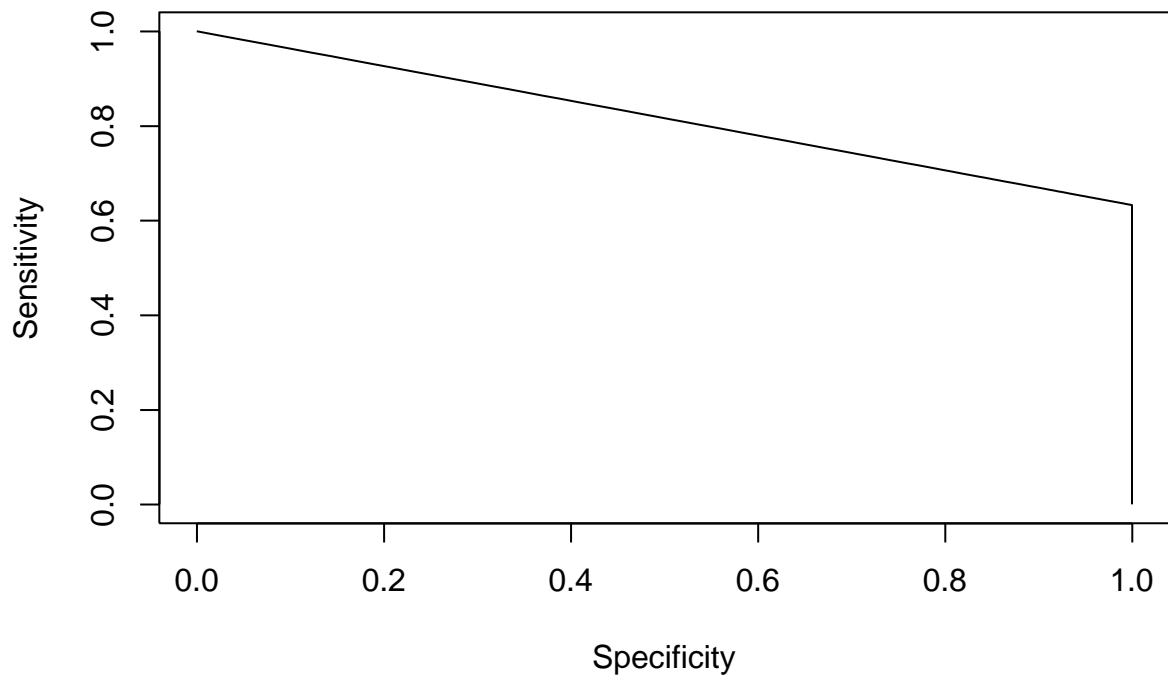
AUCPR: 0.0548969303984264



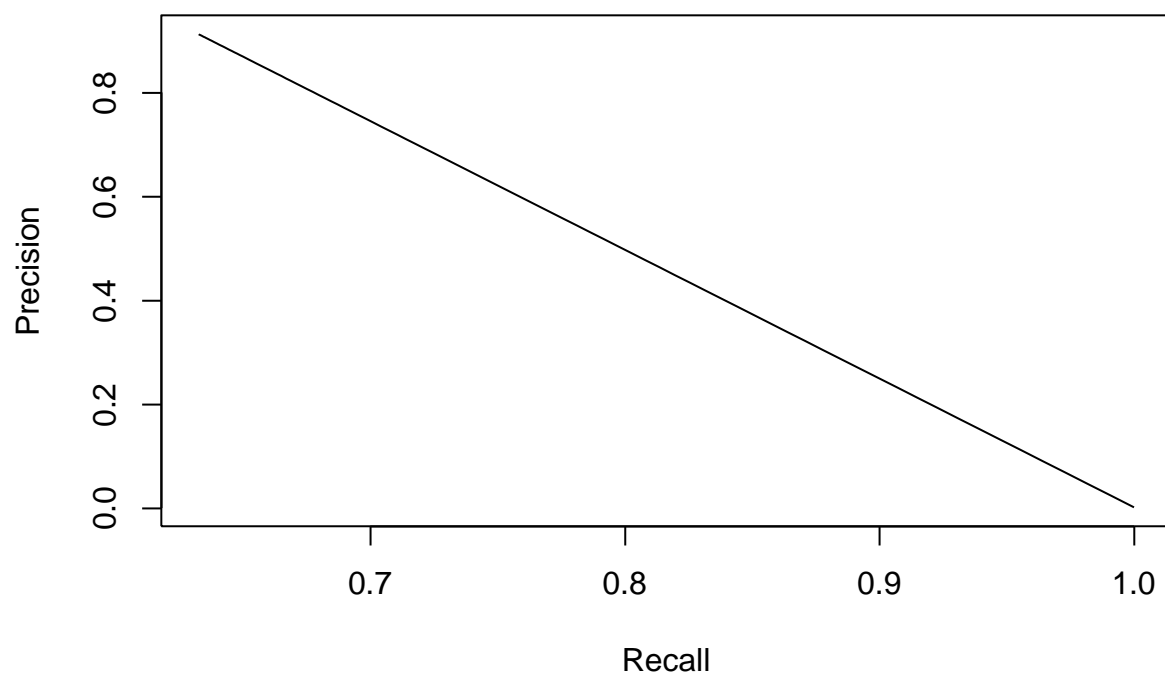
PR curve
AUC = 0.5797557



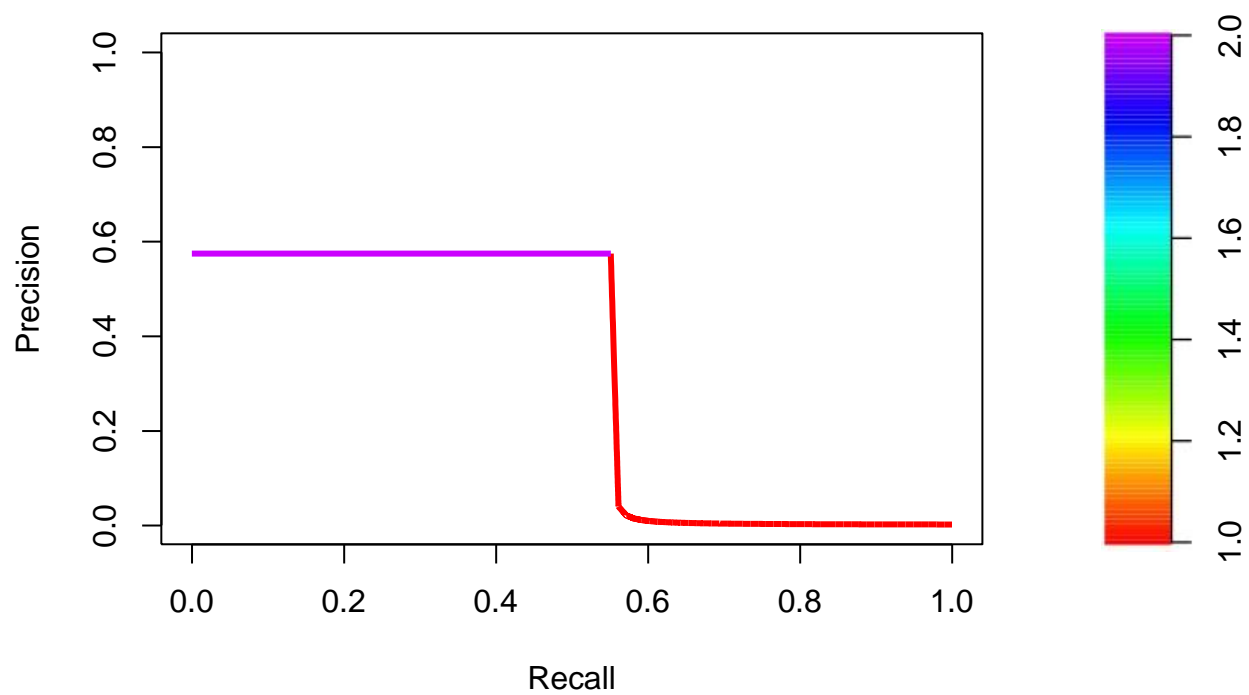
AUC: 0.816273772228058



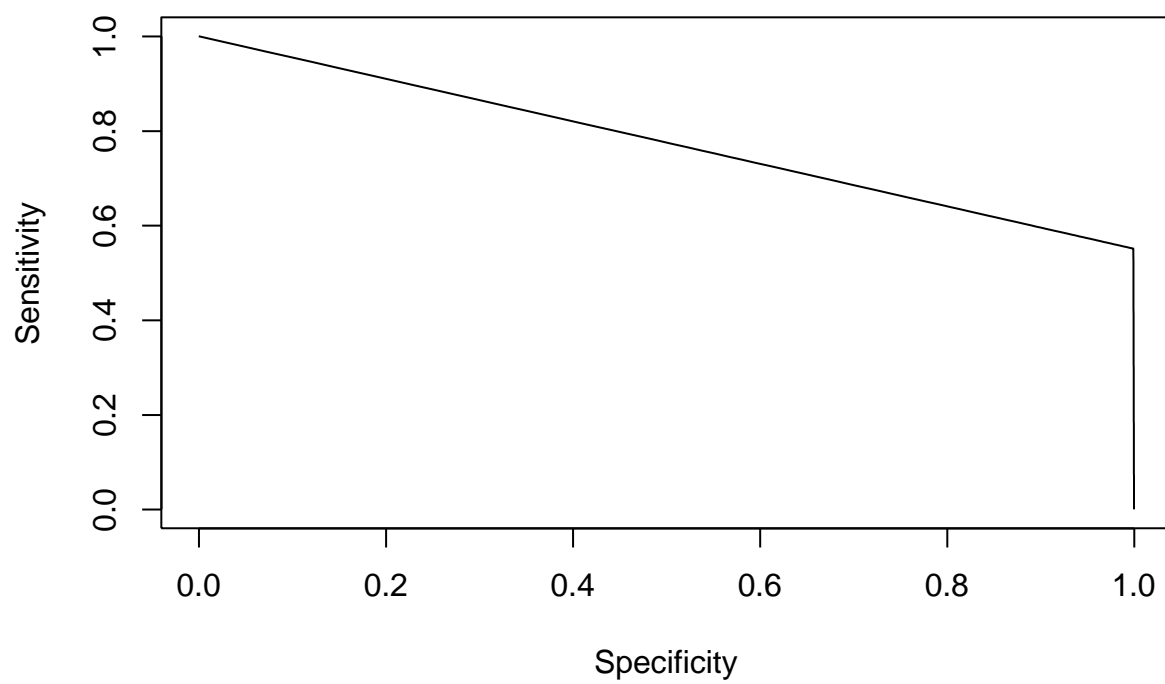
AUCPR: 0.579755719213291



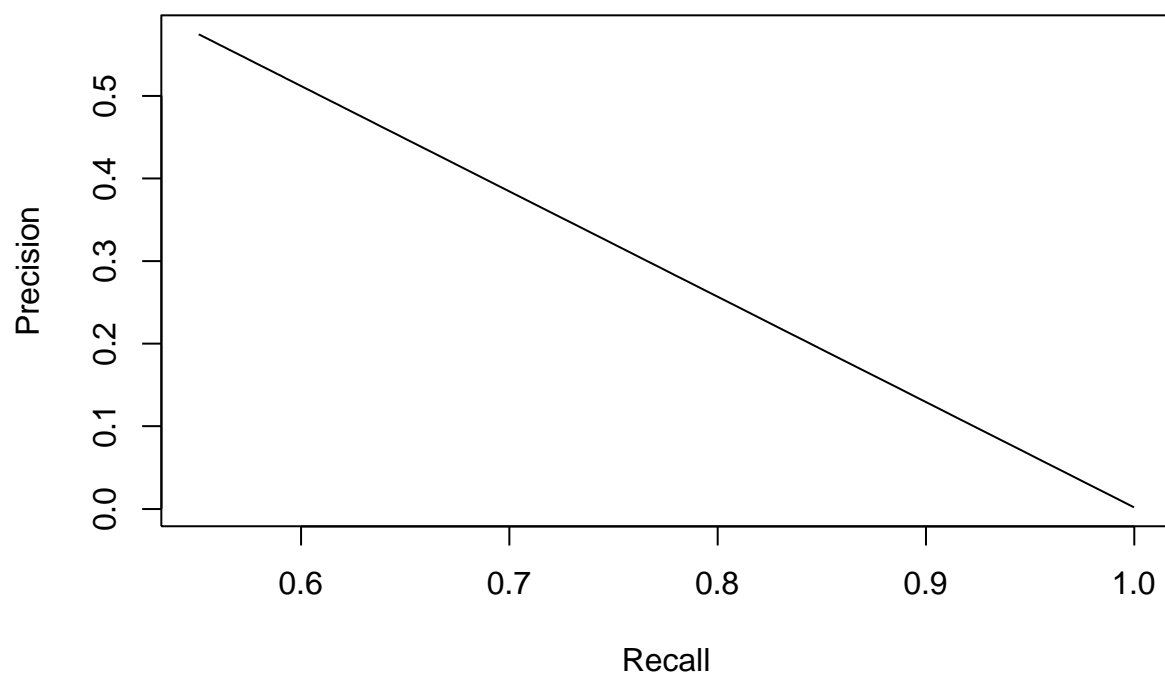
PR curve
AUC = 0.3196189



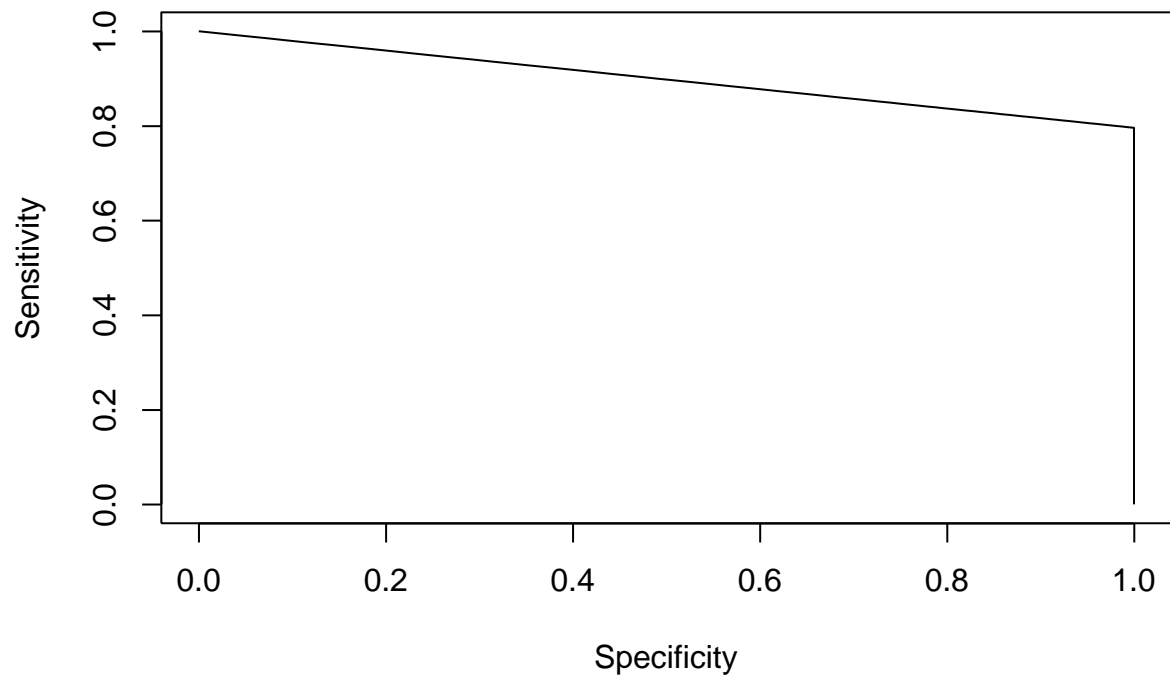
AUC: 0.775158481520389



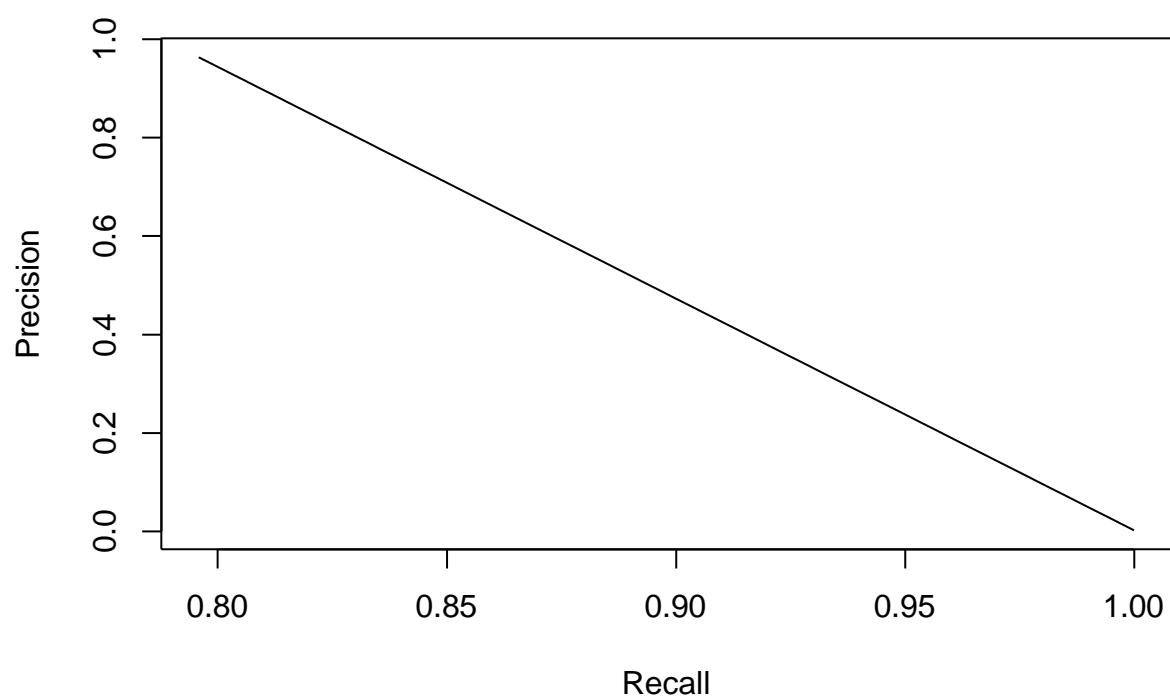
AUCPR: 0.319618862730037



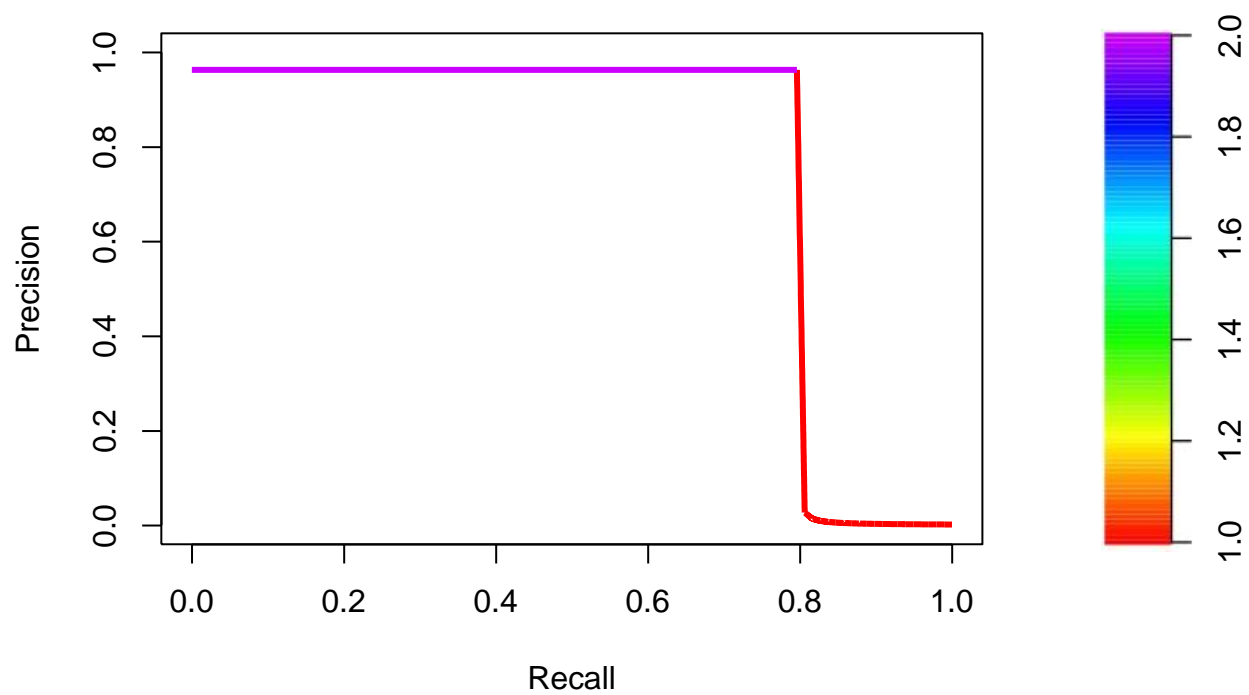
AUC: 0.897932804481376

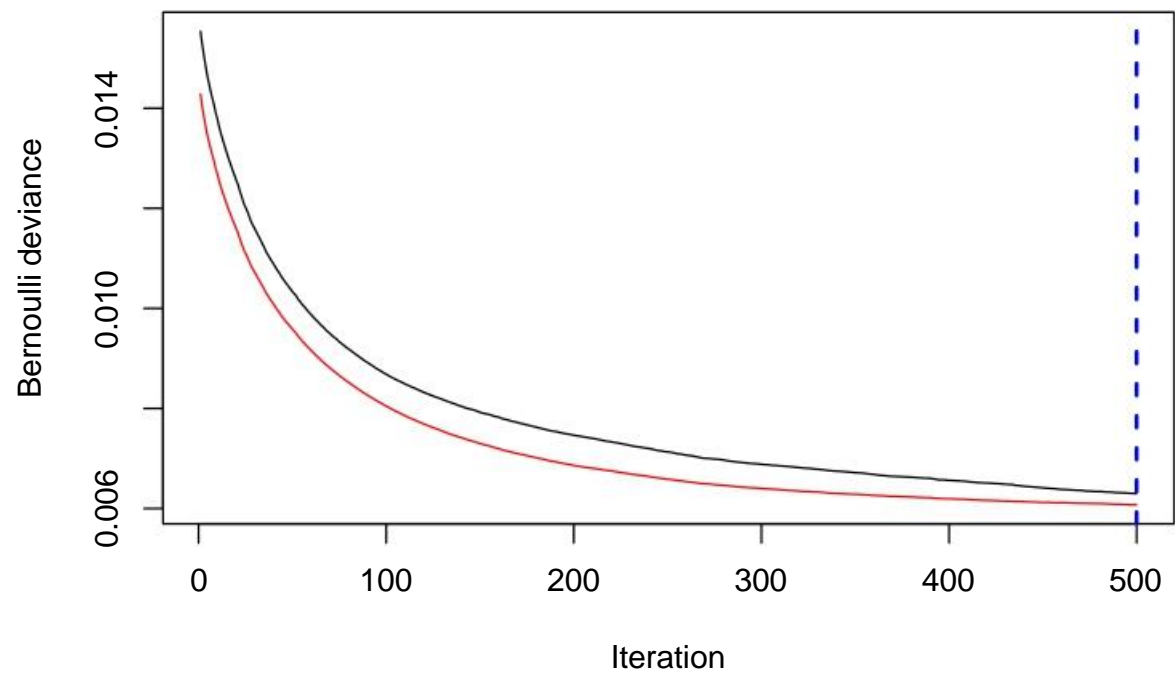


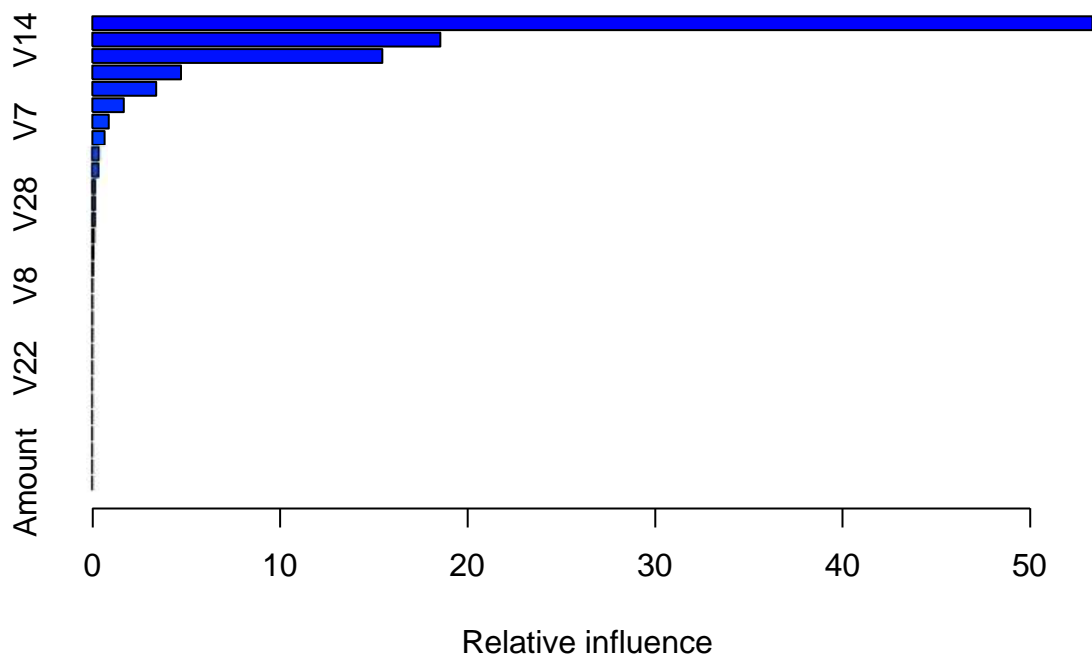
AUCPR: 0.768345660673728



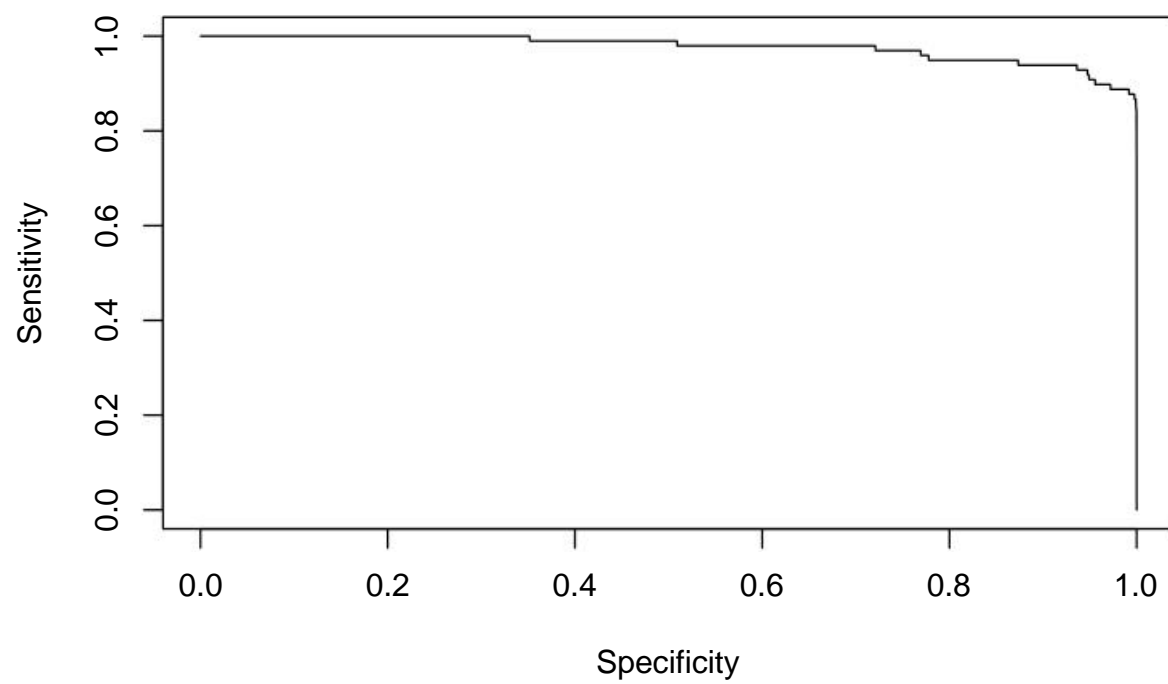
PR curve
AUC = 0.7683457



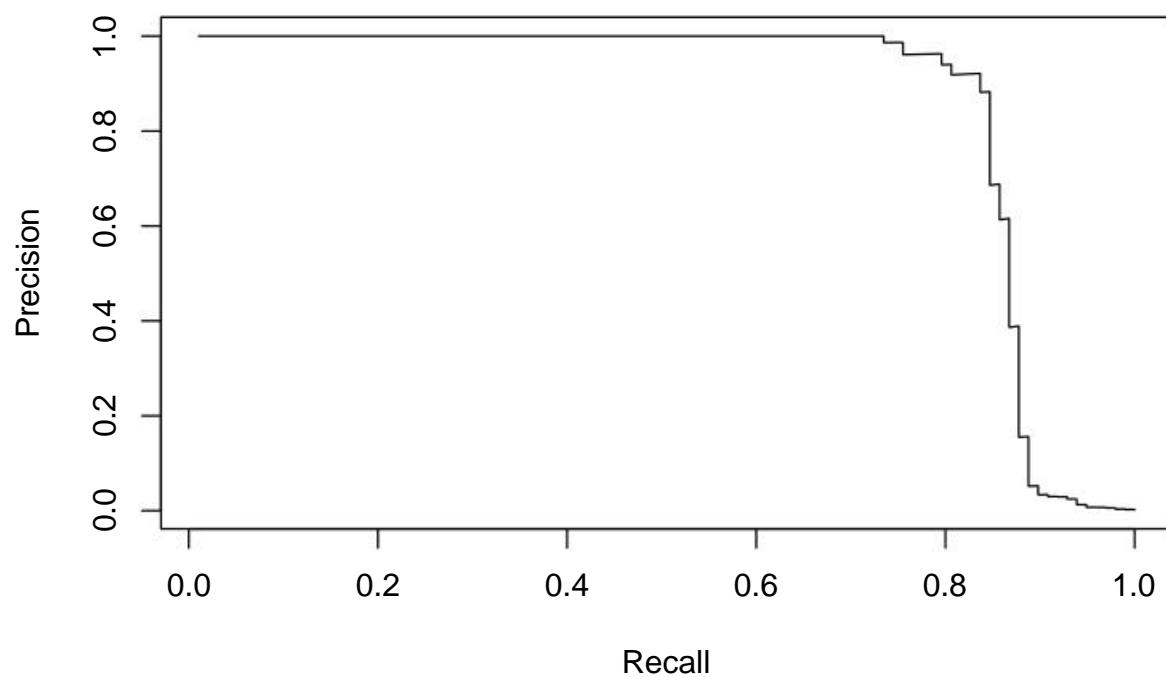


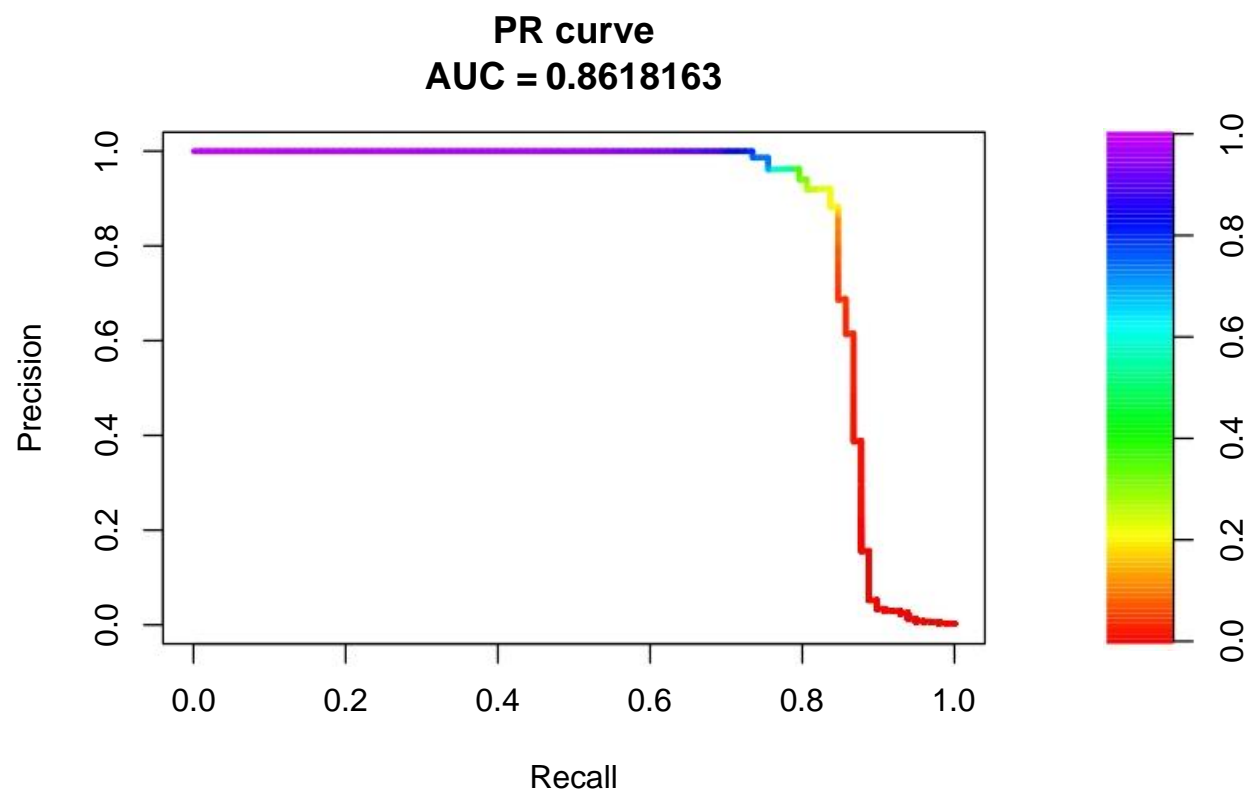


AUC: 0.977038976961337

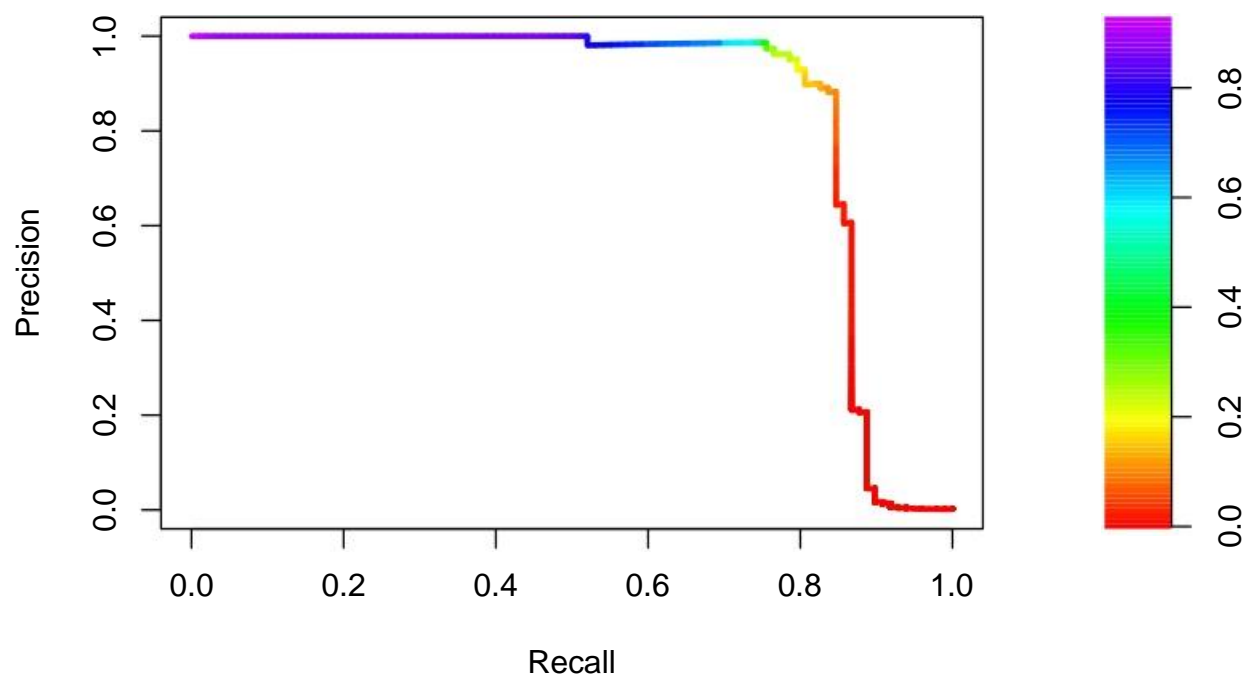


AUCPR: 0.86181626247754

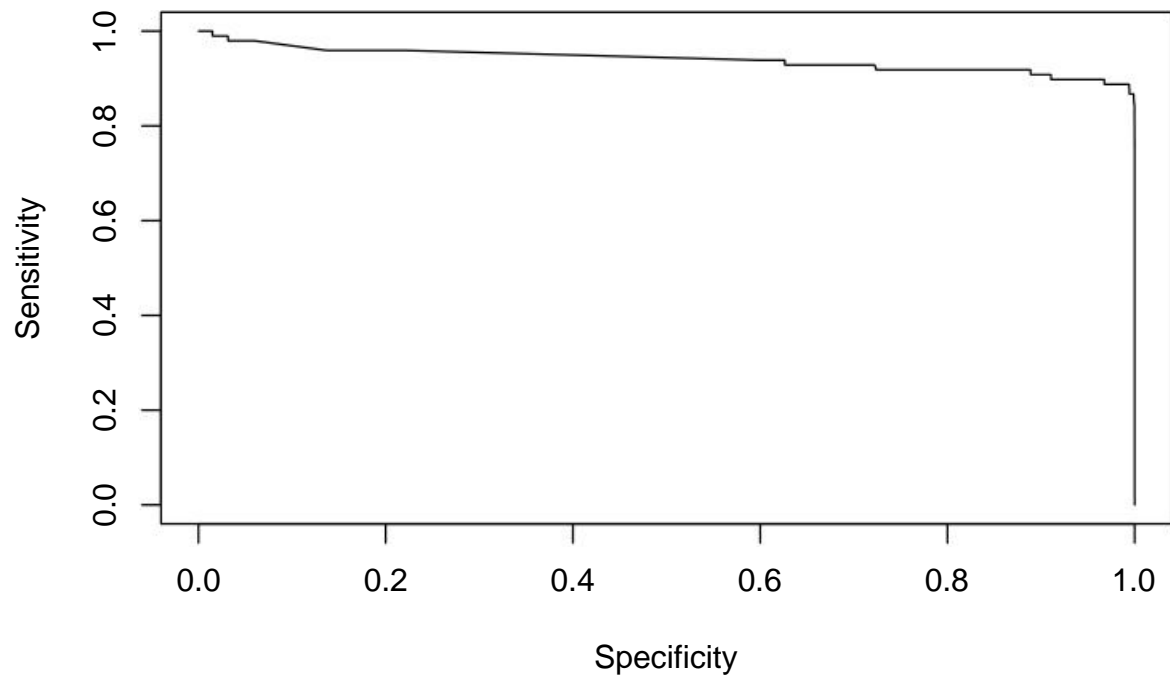




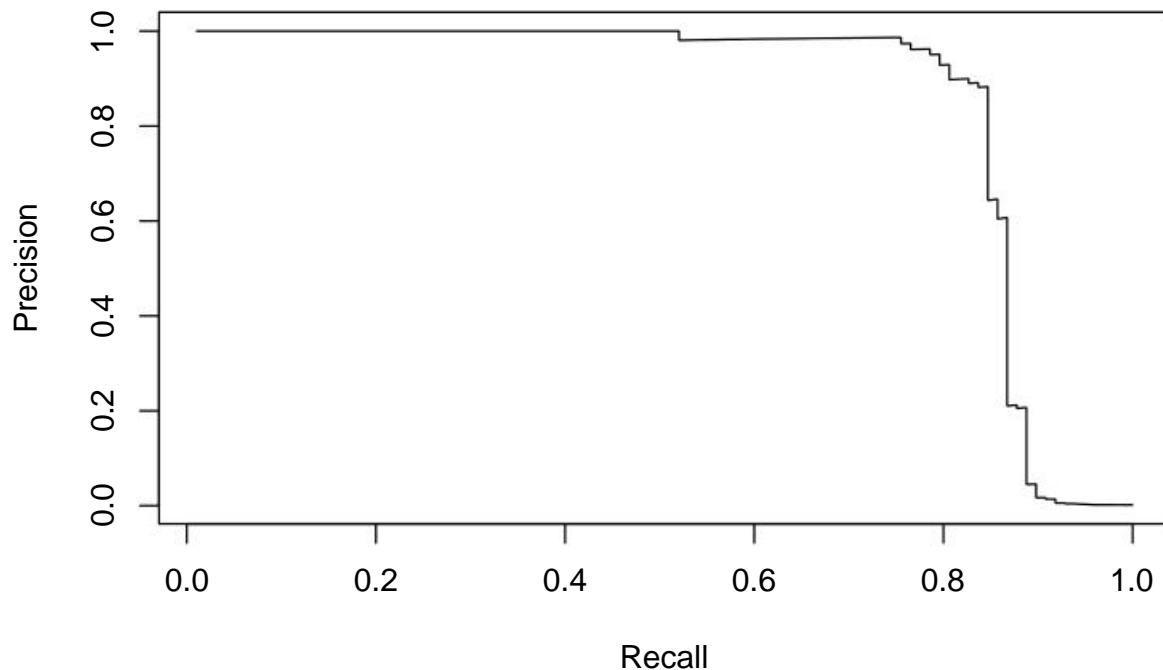
PR curve
AUC = 0.8545904



AUC: 0.940520305338254



AUCPR: 0.854590406489971



7.2 1b - Code used in this report - Credit Card Fraud Detection Project - Code.R

```
# Install all needed libraries if it is not present
```

```
if(!require(tidyverse)) install.packages("tidyverse")
if(!require(kableExtra)) install.packages("kableExtra")
if(!require(tidyr)) install.packages("tidyr")
if(!require(tidyverse)) install.packages("tidyverse")
if(!require(stringr)) install.packages("stringr")
if(!require(ggplot2)) install.packages("ggplot2")
if(!require(gbm)) install.packages("gbm")
if(!require(dplyr)) install.packages("dplyr")
if(!require(caret)) install.packages("caret")
if(!require(xgboost)) install.packages("xgboost")
if(!require(e1071)) install.packages("e1071")
if(!require(class)) install.packages("class")
if(!require(ROCR)) install.packages("ROCR")
if(!require(randomForest)) install.packages("randomForest")
if(!require(PRROC)) install.packages("PRROC")
if(!require(reshape2)) install.packages("reshape2")
```

```
# Loading all needed libraries
```

```
library(dplyr)
library(tidyverse)
```



```

library(kableExtra)
library(tidyr)
library(ggplot2)
library(gbm)
library(caret)
library(xgboost)
library(e1071)
library(class)
library(lightgbm)
library(ROCR)
library(randomForest)
library(PRROC)
library(reshape2)

## Loading the dataset

creditcard <- read.csv("creditcard.csv")

# Check dimensions

data.frame("Length" = nrow(creditcard), "Columns" = ncol(creditcard)) %>%
kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
                position = "center",
                font_size = 10,
                full_width = FALSE)

imbalanced <- data.frame(creditcard)

imbalanced$Class = ifelse(creditcard$Class == 0, 'Legal', 'Fraud') %>% as.factor()

# Visualize the proportion between classes

imbalanced %>%
  ggplot(aes(Class)) +
  theme_minimal() +
  geom_bar() +
  scale_x_discrete() +
  scale_y_continuous(labels = scales::comma) +
  labs(title = "Proportions between Legal and Frauds Transactions",
       x = "Class",
       y = "Frequency")

# Find missing values

sapply(creditcard, function(x) sum(is.na(x))) %>%
kable(col.names = c("Missing Values")) %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
                position = "center",
                font_size = 10,
                full_width = FALSE)

# Frauds Amount

```

```

creditcard[creditcard$Class == 1,] %>%
  ggplot(aes(Amount)) +
  theme_minimal() +
  geom_histogram(binwidth = 40) +
  labs(title = "Frauds Amounts Distributions",
        x = "Amount in dollars",
        y = "Frequency")

creditcard[creditcard$Class == 1,] %>%
  group_by(Amount) %>%
  summarise(count = n()) %>%
  arrange(desc(count)) %>%
  head(n=10) %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
                position = "center",
                font_size = 10,
                full_width = FALSE)

# Frauds over Time

creditcard[creditcard$Class == 1,] %>%
  ggplot(aes(Time)) +
  theme_minimal() +
  geom_histogram(binwidth = 40) +
  labs(title = "Frauds over Time Distributions",
        x = "Time",
        y = "Frequency")

creditcard[creditcard$Class == 1,] %>%
  group_by(Time) %>%
  summarise(count = n()) %>%
  arrange(desc(count)) %>%
  head(n=10) %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
                position = "center",
                font_size = 10,
                full_width = FALSE)

# Get lower triangle of the correlation matrix

get_lower_tri<-function(cormat){
  cormat[upper.tri(cormat)] <- NA
  return(cormat)
}

# Get upper triangle of the correlation matrix

get_upper_tri <- function(cormat){
  cormat[lower.tri(cormat)]<- NA
  return(cormat)
}

```

```

reorder_cormat <- function(cormat){
  # Use correlation between variables as distance
  dd <- as.dist((1-cormat)/2)
  hc <- hclust(dd)
  cormat <-cormat[hc$order, hc$order]
}

corr_matrix <- round(cor(creditcard),2)
corr_matrix <- reorder_cormat(corr_matrix)

upper_tri <- get_upper_tri(corr_matrix)

melted_corr_matrix <- melt(upper_tri, na.rm = TRUE)

ggplot(melted_corr_matrix, aes(Var2, Var1, fill = value)) +
  geom_tile(color = "white") +
  scale_fill_gradient2(low = "blue", high = "red", mid = "white",
    midpoint = 0, limit = c(-1,1), space = "Lab",
    name="Pearson\nCorrelation") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 90, vjust = 1,
    size = 9, hjust = 1), axis.text.y = element_text(size = 9),
    axis.title.y = element_blank(),
    panel.grid.major = element_blank(),
    panel.border = element_blank(),
    panel.background = element_blank(),
    axis.ticks = element_blank()) +
  coord_fixed()

# Set seed for reproducibility

set.seed(1234)

# Remove the "Time" column from the dataset

creditcard$Class <- as.factor(creditcard$Class)
creditcard <- creditcard %>% select(-Time)

# Split the dataset into train, test dataset and cv

train_index <- createDataPartition(
  y = creditcard$Class,
  p = .6,
  list = F
)

train <- creditcard[train_index,]
test_cv <- creditcard[-train_index,]
test_index <- createDataPartition(
  y = test_cv$Class,
  p = .5,
  list = F)

```

```

test <- test_cv[test_index,]
cv <- test_cv[-test_index,]

rm(train_index, test_index, test_cv)

# Create a baseline model that predict always "legal"
# (aka "0") transactions and compute all metrics

# Clone the creditcard dataframe

baseline_model <- data.frame(creditcard)

# Set Class al to Legal (0)

baseline_model$Class = factor(0, c(0,1))

# Make predictions

pred <- prediction(
  as.numeric(as.character(baseline_model$Class)),
  as.numeric(as.character(credit

# Compute the AUC and AUCPR

auc_val_baseline <- performance(pred, "auc")
auc_plot_baseline <- performance(pred, 'sens', 'spec')
aucpr_plot_baseline <- performance(pred, "prec", "rec")

# Make the relative plot

plot(auc_plot_baseline,
     main=paste("AUC:",
     auc_val_baseline@y.values[[1]])
)

plot(aucpr_plot_baseline, main="AUCPR: 0")

# Create a dataframe 'results' that contains all metrics
# obtained by the trained models

results <- data.frame(
  Model = "Naive Baseline - Predict Always Legal",
  AUC = auc_val_baseline@y.values[[1]],
  AUCPR = 0
)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(
    bootstrap_options =
      c("striped", "hover", "condensed", "responsive"),

```

```

    position = "center",
    font_size = 10,
    full_width = FALSE
)

# Create a Naive Bayes Model, it will improve a little bit the
# results in AUC and AUCPR

# Set seed 1234 for reproducibility

set.seed(1234)

# Build the model with Class as target and all other variables
# as predictors

naive_model <- naiveBayes(Class ~ ., data = train, laplace=1)

# Predict

predictions <- predict(naive_model, newdata=test)

# Compute the AUC and AUCPR for the Naive Model

pred <- prediction(as.numeric(predictions) , test$Class)

auc_val_naive <- performance(pred, "auc")

auc_plot_naive <- performance(pred, 'sens', 'spec')

aucpr_plot_naive <- performance(pred, "prec", "rec")

aucpr_val_naive <- pr.curve(
  scores.class0 = predictions[test$Class == 1],
  scores.class1 = predictions[test$Class == 0],
  curve = T,
  dg.compute = T
)

# Make the relative plot

plot(aucpr_val_naive)
plot(auc_plot_naive, main=paste("AUC:", auc_val_naive@y.values[[1]]))
plot(aucpr_plot_naive, main=paste("AUCPR:", aucpr_val_naive$auc.integral))

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "Naive Bayes",
  AUC = auc_val_naive@y.values[[1]],
  AUCPR = aucpr_val_naive$auc.integral
)

# Show results on a table

results %>%

```

```

kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Set seed 1234 for reproducibility

set.seed(1234)

# Build a KNN Model with Class as Target and all other
# variables as predictors. k is set to 5

knn_model <- knn(train[,-30], test[,-30], train$Class, k=5, prob = TRUE)

# Compute the AUC and AUCPR for the KNN Model

pred <- prediction(
  as.numeric(as.character(knn_model)),
  as.numeric(as.character(test$C
))

auc_val_knn <- performance(pred, "auc")

auc_plot_knn <- performance(pred, 'sens', 'spec')
aucpr_plot_knn <- performance(pred, "prec", "rec")

aucpr_val_knn <- pr.curve(
  scores.class0 = knn_model[test$Class == 1],
  scores.class1 = knn_model[test$Class == 0],
  curve = T,
  dg.compute = T
)

# Make the relative plot

plot(aucpr_val_knn)
plot(auc_plot_knn, main=paste("AUC:", auc_val_knn@y.values[[1]]))
plot(aucpr_plot_knn, main=paste("AUCPR:", aucpr_val_knn$auc.integral))

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "K-Nearest Neighbors k=5",
  AUC = auc_val_knn@y.values[[1]],
  AUCPR = aucpr_val_knn$auc.integral
)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,

```

```

    full_width = FALSE)

# Set seed 1234 for reproducibility

set.seed(1234)

# Build a SVM Model with Class as Target and all other
# variables as predictors. The kernel is set to sigmoid

svm_model <- svm(Class ~ ., data = train, kernel='sigmoid')

# Make predictions based on this model

predictions <- predict(svm_model, newdata=test)

# Compute AUC and AUCPR

pred <- prediction(
  as.numeric(as.character(predictions)),
  as.numeric(as.character(test$C
))

auc_val_svm <- performance(pred, "auc")

auc_plot_svm <- performance(pred, 'sens', 'spec')
aucpr_plot_svm <- performance(pred, "prec", "rec")

aucpr_val_svm <- pr.curve(
  scores.class0 = predictions[test$Class == 1],
  scores.class1 = predictions[test$Class == 0],
  curve = T,
  dg.compute = T
)

# Make the relative plot

plot(aucpr_val_svm)
plot(auc_plot_svm, main=paste("AUC:", auc_val_svm@y.values[[1]]))
plot(aucpr_plot_svm, main=paste("AUCPR:", aucpr_val_svm$auc.integral))

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "SVM - Support Vector Machine",
  AUC = auc_val_svm@y.values[[1]],
  AUCPR = aucpr_val_svm$auc.integral)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

```

```

# Set seed 1234 for reproducibility

set.seed(1234)

# Build a Random Forest Model with Class as Target and all other
# variables as predictors. The number of trees is set to 500

rf_model <- randomForest(Class ~ ., data = train, ntree = 500)

# Get the feature importance

feature_imp_rf <- data.frame(importance(rf_model))

# Make predictions based on this model

predictions <- predict(rf_model, newdata=test)

# Compute the AUC and AUPCR

pred <- prediction(
  as.numeric(as.character(predictions)),
  as.numeric(as.character(test$C
)

auc_val_rf <- performance(pred, "auc")

auc_plot_rf <- performance(pred, 'sens', 'spec')

aucpr_plot_rf <- performance(pred, "prec", "rec", curve = T, dg.compute = T)

aucpr_val_rf <- pr.curve(scores.class0 = predictions[test$Class == 1], scores.class1 = predictions[test

# make the relative plot

plot(auc_plot_rf, main=paste("AUC:", auc_val_rf@y.values[[1]]))
plot(aucpr_plot_rf, main=paste("AUCPR:", aucpr_val_rf$auc.integral))
plot(aucpr_val_rf)

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "Random Forest",
  AUC = auc_val_rf@y.values[[1]],
  AUCPR = aucpr_val_rf$auc.integral)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

```



```

# Show feature importance on a table

feature_imp_rf %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Set seed 1234 for reproducibility

set.seed(1234)

# Build a GBM Model with Class as Target and all other
# variables as predictors. Distribution is bernoulli,
# number of tree is 500

gbm_model <- gbm(as.character(Class) ~ .,
  distribution = "bernoulli",
  data = rbind(train, test),
  n.trees = 500,
  interaction.depth = 3,
  n.minobsinnode = 100,
  shrinkage = 0.01,
  train.fraction = 0.7,
)

# Determine the best iteration based on test data

best_iter = gbm.perf(gbm_model, method = "test")

# Make predictions based on this model

predictions = predict.gbm(
  gbm_model,
  newdata = test,
  n.trees = best_iter,
  type="response"
)

# Get feature importance

feature_imp_gbm = summary(gbm_model, n.trees = best_iter)

# Compute the AUC and AUPCR

pred <- prediction(
  as.numeric(as.character(predictions)),
  as.numeric(as.character(test$C
)

auc_val_gbm <- performance(pred, "auc")

auc_plot_gbm <- performance(pred, 'sens', 'spec')
aucpr_plot_gbm <- performance(pred, "prec", "rec")

```

```

aucpr_val_gbm <- pr.curve(
  scores.class0 = predictions[test$Class == 1],
  scores.class1 = predictions[test$Class == 0],
  curve = T,
  dg.compute = T
)

# Make the relative plot

plot(aucpr_val_gbm)
plot(auc_plot_gbm, main=paste("AUC:", auc_val_gbm@y.values[[1]]))
plot(aucpr_plot_gbm, main=paste("AUCPR:", aucpr_val_gbm$auc.integral))

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "GBM - Generalized Boosted Regression",
  AUC = auc_val_gbm@y.values[[1]],
  AUCPR = aucpr_val_gbm$auc.integral)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Show feature importance on a table

feature_imp_gbm %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Set seed 1234 for reproducibility

set.seed(1234)

# Prepare the training dataset

xgb_train <- xgb.DMatrix(
  as.matrix(train[, colnames(train) != "Class"]),
  label = as.numeric(as.character(train$Class))
)

# Prepare the test dataset

xgb_test <- xgb.DMatrix(
  as.matrix(test[, colnames(test) != "Class"]),

```

```

) label = as.numeric(as.character(test$Class))

# Prepare the cv dataset

xgb_cv <- xgb.DMatrix(
  as.matrix(cv[, colnames(cv) != "Class"]),
  label = as.numeric(as.character(cv$Class))
)

# Prepare the parameters list.

xgb_params <- list(
  objective = "binary:logistic",
  eta = 0.1,
  max.depth = 3,
  nthread = 6,
  eval_metric = "aucpr"
)

# Train the XGBoost Model

xgb_model <- xgb.train(
  data = xgb_train,
  params = xgb_params,
  watchlist = list(test = xgb_test, cv = xgb_cv),
  nrounds = 500,
  early_stopping_rounds = 40,
  print_every_n = 20
)

# Get feature importance

feature_imp_xgb <- xgb.importance(colnames(train), model = xgb_model)

xgb.plot.importance(feature_imp_xgb, rel_to_first = TRUE, xlab = "Relative importance")

# Make predictions based on this model

predictions = predict(
  xgb_model,
  newdata = as.matrix(test[, colnames(test) != "Class"]),
  ntreetlimit = xgb_model$bestInd
)

# Compute the AUC and AUPCR

pred <- prediction(
  as.numeric(as.character(predictions)),
  as.numeric(as.character(test$C
)

auc_val_xgb <- performance(pred, "auc")

auc_plot_xgb <- performance(pred, 'sens', 'spec')

```

```

aucpr_plot_xgb <- performance(pred, "prec", "rec")

aucpr_val_xgb <- pr.curve(
  scores.class0 = predictions[test$Class == 1],
  scores.class1 = predictions[test$Class == 0],
  curve = T,
  dg.compute = T
)

# Make the relative plot

plot(auc_plot_xgb, main=paste("AUC:", auc_val_xgb@y.values[[1]]))
plot(aucpr_plot_xgb, main=paste("AUCPR:", aucpr_val_xgb$auc.integral))
plot(aucpr_val_xgb)

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "XGBoost",
  AUC = auc_val_xgb@y.values[[1]],
  AUCPR = aucpr_val_xgb$auc.integral)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Show feature importance on a table

feature_imp_xgb %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

# Set seed 1234 for reproducibility

set.seed(1234)

# Prepare the training dataset

lgb_train <- lgb.Dataset(
  as.matrix(train[, colnames(train) != "Class"]),
  label = as.numeric(as.character(train$Class))
)

# Prepare the test dataset

lgb_test <- lgb.Dataset(

```

```

    as.matrix(test[, colnames(test) != "Class"]),
    label = as.numeric(as.character(test$Class))
  )

# Prepare the cvtaset

lgb_cv <- lgb.Dataset(
  as.matrix(cv[, colnames(cv) != "Class"]),
  label = as.numeric(as.character(cv$Class))
)

# Prepare the parameters list

lgb_params = list(
  objective = "binary",
  metric = "binary_error"
)

# Train the LightGBM Model

lgb_model <- lgb.train(
  params = lgb_params,
  data = lgb_train,
  valid = list(test = lgb_test, cv = lgb_cv),
  learning_rate = 0.01,
  nrounds = 500,
  early_stopping_rounds = 40,
  eval_freq = 20
)

# Get feature importance

feature_imp_lgb = lgb.importance(lgb_model, percentage = TRUE)

# Make predictions based on this model

predictions = predict(
  lgb_model,
  data = as.matrix(test[, colnames(test) != "Class"]),
  n = lgb_model$best_iter)

# Compute the AUC and AUPCR

pred <- prediction(
  predictions,
  as.numeric(as.character(test$Class))
)

auc_val_lgb <- performance(pred, "auc")

auc_plot_lgb <- performance(pred, 'sens', 'spec')
aucpr_plot_lgb <- performance(pred, "prec", "rec")

aucpr_val_lgb <- pr.curve(

```

```

scores.class0 = predictions[test$Class == 1],
scores.class1 = predictions[test$Class == 0],
curve = T,
dg.compute = T
)

# Make the relative plot

plot(aucpr_val_lgb)
plot(auc_plot_lgb, main=paste("AUC:", auc_val_lgb@y.values[[1]]))
plot(aucpr_plot_lgb, main=paste("AUCPR:", aucpr_val_lgb$auc.integral))

# Adding the respective metrics to the results dataset

results <- results %>% add_row(
  Model = "LightGBM",
  AUC = auc_val_lgb@y.values[[1]],
  AUCPR = aucpr_val_lgb$auc.integral
)

# Show results on a table

results %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

feature_imp_lgb %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center",
    font_size = 10,
    full_width = FALSE)

```

7.3 1c - Enviroment

```

## [1] "Operating System:"

##
## platform      _
## arch          x86_64-w64-mingw32
## os            mingw32
## system        x86_64,mingw32
## status
## major         3
## minor         6.0
## year          2019
## month         04
## day           26
## svn rev       76424
## language      R
## version.string R version 3.6.0 (2019-04-26)
##nickname       Planting of a Tree

```

```
## [1] "All installed packages"
```

```
##          Package
## abind      "abind"
## askpass    "askpass"
## assertthat "assertthat"
## backports  "backports"
## base64enc  "base64enc"
## BH         "BH"
## bitops     "bitops"
## broom      "broom"
## callr      "callr"
## caret      "caret"
## caTools    "caTools"
## cellranger "cellranger"
## Ckmeans.1d.dp "Ckmeans.1d.dp"
## class      "class"
## cli        "cli"
## clipr      "clipr"
## colorspace "colorspace"
## crayon     "crayon"
## curl       "curl"
## data.table "data.table"
## DBI        "DBI"
## dbplyr     "dbplyr"
## digest     "digest"
## DMwR       "DMwR"
## DMwR2      "DMwR2"
## doParallel "doParallel"
## dplyr      "dplyr"
## dslabs     "dslabs"
## e1071      "e1071"
## ellipsis   "ellipsis"
## evaluate   "evaluate"
## fansi      "fansi"
## forcats    "forcats"
## foreach    "foreach"
## fs         "fs"
## gbm        "gbm"
## gdata      "gdata"
## generics   "generics"
## ggplot2    "ggplot2"
## glue       "glue"
## gower      "gower"
## gplots     "gplots"
## gridExtra  "gridExtra"
## gtable     "gtable"
## gtools     "gtools"
## haven      "haven"
## highr      "highr"
## hms        "hms"
## htmltools  "htmltools"
## httr       "httr"
## ipred      "ipred"
```

## iterators	"iterators"
## jsonlite	"jsonlite"
## kableExtra	"kableExtra"
## knitr	"knitr"
## labeling	"labeling"
## lattice	"lattice"
## lava	"lava"
## lazyeval	"lazyeval"
## lightgbm	"lightgbm"
## lubridate	"lubridate"
## magrittr	"magrittr"
## markdown	"markdown"
## mime	"mime"
## ModelMetrics	"ModelMetrics"
## modelr	"modelr"
## munsell	"munsell"
## numDeriv	"numDeriv"
## openssl	"openssl"
## PerfMeas	"PerfMeas"
## pillar	"pillar"
## pkgconfig	"pkgconfig"
## plogr	"plogr"
## plyr	"plyr"
## precrec	"precrec"
## prettyunits	"prettyunits"
## pROC	"pROC"
## processx	"processx"
## prodlim	"prodlim"
## progress	"progress"
## PRROC	"PRROC"
## ps	"ps"
## purrr	"purrr"
## quantmod	"quantmod"
## R6	"R6"
## randomForest	"randomForest"
## RColorBrewer	"RColorBrewer"
## Rcpp	"Rcpp"
## RcppRoll	"RcppRoll"
## readr	"readr"
## readxl	"readxl"
## recipes	"recipes"
## rematch	"rematch"
## reprex	"reprex"
## reshape2	"reshape2"
## rlang	"rlang"
## rmarkdown	"rmarkdown"
## ROCR	"ROCR"
## rprojroot	"rprojroot"
## rstudioapi	"rstudioapi"
## rvest	"rvest"
## scales	"scales"
## selectr	"selectr"
## SQUAREM	"SQUAREM"
## stringi	"stringi"

## stringr	"stringr"
## sys	"sys"
## tibble	"tibble"
## tidyr	"tidyr"
## tidyselect	"tidyselect"
## tidyverse	"tidyverse"
## timeDate	"timeDate"
## tinytex	"tinytex"
## TTR	"TTR"
## utf8	"utf8"
## vctrs	"vctrs"
## viridisLite	"viridisLite"
## webshot	"webshot"
## whisker	"whisker"
## withr	"withr"
## xfun	"xfun"
## xgboost	"xgboost"
## xml2	"xml2"
## xts	"xts"
## yaml	"yaml"
## zeallot	"zeallot"
## zoo	"zoo"
## base	"base"
## boot	"boot"
## class	"class"
## cluster	"cluster"
## codetools	"codetools"
## compiler	"compiler"
## datasets	"datasets"
## foreign	"foreign"
## graphics	"graphics"
## grDevices	"grDevices"
## grid	"grid"
## KernSmooth	"KernSmooth"
## lattice	"lattice"
## MASS	"MASS"
## Matrix	"Matrix"
## methods	"methods"
## mgcv	"mgcv"
## nlme	"nlme"
## nnet	"nnet"
## parallel	"parallel"
## rpart	"rpart"
## spatial	"spatial"
## splines	"splines"
## stats	"stats"
## stats4	"stats4"
## survival	"survival"
## tcltk	"tcltk"
## tools	"tools"
## translations	"translations"
## utils	"utils"
##	LibPath
## abind	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"

```

## askpass "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## assertthat "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## backports "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## base64enc "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## BH "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## bitops "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## broom "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## callr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## caret "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## caTools "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## cellranger "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## Ckmeans.1d.dp "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## class "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## cli "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## clipr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## colorspace "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## crayon "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## curl "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## data.table "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## DBI "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## dbplyr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## digest "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## DMwR "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## DMwR2 "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## doParallel "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## dplyr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## dslabs "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## e1071 "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ellipsis "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## evaluate "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## fansi "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## forcats "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## foreach "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## fs "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gbm "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gdata "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## generics "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ggplot2 "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## glue "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gower "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gplots "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gridExtra "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gtable "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## gtools "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## haven "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## highr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## hms "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## htmltools "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## http "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ipred "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## iterators "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## jsonlite "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## kableExtra "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## knitr "C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"

```

## labeling	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## lattice	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## lava	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## lazyeval	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## lightgbm	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## lubridate	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## magrittr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## markdown	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## mime	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ModelMetrics	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## modelr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## munsell	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## numDeriv	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## openssl	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## PerfMeas	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## pillar	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## pkgconfig	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## plogr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## plyr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## precrec	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## prettyunits	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## pROC	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## processx	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## prodlim	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## progress	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## PRROC	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ps	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## purrr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## quantmod	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## R6	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## randomForest	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## RColorBrewer	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## Rcpp	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## RcppRoll	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## readr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## readxl	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## recipes	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rematch	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## repress	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## reshape2	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rlang	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rmarkdown	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## ROCR	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rprojroot	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rstudioapi	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## rvest	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## scales	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## selectr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## SQUAREM	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## stringi	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## stringr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## sys	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## tibble	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## tidyr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"

## tidyselect	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## tidyverse	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## timeDate	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## tinytex	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## TTR	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## utf8	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## vctr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## viridisLite	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## webshot	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## whisker	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## withr	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## xfun	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## xgboost	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## xml2	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## xts	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## yaml	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## zeallot	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## zoo	"C:/Users/aless/OneDrive/Documenti/R/win-library/3.6"
## base	"C:/Program Files/R/R-3.6.0/library"
## boot	"C:/Program Files/R/R-3.6.0/library"
## class	"C:/Program Files/R/R-3.6.0/library"
## cluster	"C:/Program Files/R/R-3.6.0/library"
## codetools	"C:/Program Files/R/R-3.6.0/library"
## compiler	"C:/Program Files/R/R-3.6.0/library"
## datasets	"C:/Program Files/R/R-3.6.0/library"
## foreign	"C:/Program Files/R/R-3.6.0/library"
## graphics	"C:/Program Files/R/R-3.6.0/library"
## grDevices	"C:/Program Files/R/R-3.6.0/library"
## grid	"C:/Program Files/R/R-3.6.0/library"
## KernSmooth	"C:/Program Files/R/R-3.6.0/library"
## lattice	"C:/Program Files/R/R-3.6.0/library"
## MASS	"C:/Program Files/R/R-3.6.0/library"
## Matrix	"C:/Program Files/R/R-3.6.0/library"
## methods	"C:/Program Files/R/R-3.6.0/library"
## mgcv	"C:/Program Files/R/R-3.6.0/library"
## nlme	"C:/Program Files/R/R-3.6.0/library"
## nnet	"C:/Program Files/R/R-3.6.0/library"
## parallel	"C:/Program Files/R/R-3.6.0/library"
## rpart	"C:/Program Files/R/R-3.6.0/library"
## spatial	"C:/Program Files/R/R-3.6.0/library"
## splines	"C:/Program Files/R/R-3.6.0/library"
## stats	"C:/Program Files/R/R-3.6.0/library"
## stats4	"C:/Program Files/R/R-3.6.0/library"
## survival	"C:/Program Files/R/R-3.6.0/library"
## tcltk	"C:/Program Files/R/R-3.6.0/library"
## tools	"C:/Program Files/R/R-3.6.0/library"
## translations	"C:/Program Files/R/R-3.6.0/library"
## utils	"C:/Program Files/R/R-3.6.0/library"
##	Version Priority
## abind	"1.4-5" NA
## askpass	"1.1" NA
## assertthat	"0.2.1" NA
## backports	"1.1.4" NA
## base64enc	"0.1-3" NA

## BH	"1.69.0-1"	NA
## bitops	"1.0-6"	NA
## broom	"0.5.2"	NA
## callr	"3.2.0"	NA
## caret	"6.0-84"	NA
## caTools	"1.17.1.2"	NA
## cellranger	"1.1.0"	NA
## Ckmeans.1d.dp	"4.2.2"	NA
## class	"7.3-15"	"recommended"
## cli	"1.1.0"	NA
## clipr	"0.6.0"	NA
## colorspace	"1.4-1"	NA
## crayon	"1.3.4"	NA
## curl	"3.3"	NA
## data.table	"1.12.2"	NA
## DBI	"1.0.0"	NA
## dbplyr	"1.4.0"	NA
## digest	"0.6.19"	NA
## DMwR	"0.4.1"	NA
## DMwR2	"0.0.2"	NA
## doParallel	"1.0.14"	NA
## dplyr	"0.8.1"	NA
## dslabs	"0.6.0"	NA
## e1071	"1.7-1"	NA
## ellipsis	"0.1.0"	NA
## evaluate	"0.13"	NA
## fansi	"0.4.0"	NA
## forcats	"0.4.0"	NA
## foreach	"1.4.4"	NA
## fs	"1.3.1"	NA
## gbm	"2.1.5"	NA
## gdata	"2.18.0"	NA
## generics	"0.0.2"	NA
## ggplot2	"3.1.1"	NA
## glue	"1.3.1"	NA
## gower	"0.2.1"	NA
## gplots	"3.0.1.1"	NA
## gridExtra	"2.3"	NA
## gtable	"0.3.0"	NA
## gtools	"3.8.1"	NA
## haven	"2.1.0"	NA
## highr	"0.8"	NA
## hms	"0.4.2"	NA
## htmltools	"0.3.6"	NA
## httr	"1.4.0"	NA
## ipred	"0.9-9"	NA
## iterators	"1.0.10"	NA
## jsonlite	"1.6"	NA
## kableExtra	"1.1.0"	NA
## knitr	"1.23"	NA
## labeling	"0.3"	NA
## lattice	"0.20-38"	"recommended"
## lava	"1.6.5"	NA
## lazyeval	"0.2.2"	NA

## lightgbm	"2.2.4"	NA
## lubridate	"1.7.4"	NA
## magrittr	"1.5"	NA
## markdown	"0.9"	NA
## mime	"0.6"	NA
## ModelMetrics	"1.2.2"	NA
## modelr	"0.1.4"	NA
## munsell	"0.5.0"	NA
## numDeriv	"2016.8-1"	NA
## openssl	"1.3"	NA
## PerfMeas	"1.2.1"	NA
## pillar	"1.4.0"	NA
## pkgconfig	"2.0.2"	NA
## plogr	"0.2.0"	NA
## plyr	"1.8.4"	NA
## precrec	"0.10.1"	NA
## prettyunits	"1.0.2"	NA
## pROC	"1.14.0"	NA
## processx	"3.3.1"	NA
## prodlim	"2018.04.18"	NA
## progress	"1.2.2"	NA
## PRROC	"1.3.1"	NA
## ps	"1.3.0"	NA
## purrr	"0.3.2"	NA
## quantmod	"0.4-14"	NA
## R6	"2.4.0"	NA
## randomForest	"4.6-14"	NA
## RColorBrewer	"1.1-2"	NA
## Rcpp	"1.0.1"	NA
## RcppRoll	"0.3.0"	NA
## readr	"1.3.1"	NA
## readxl	"1.3.1"	NA
## recipes	"0.1.5"	NA
## rematch	"1.0.1"	NA
## reprex	"0.3.0"	NA
## reshape2	"1.4.3"	NA
## rlang	"0.3.4"	NA
## rmarkdown	"1.13"	NA
## ROCR	"1.0-7"	NA
## rprojroot	"1.3-2"	NA
## rstudioapi	"0.10"	NA
## rvest	"0.3.4"	NA
## scales	"1.0.0"	NA
## selectr	"0.4-1"	NA
## SQUAREM	"2017.10-1"	NA
## stringi	"1.4.3"	NA
## stringr	"1.4.0"	NA
## sys	"3.2"	NA
## tibble	"2.1.1"	NA
## tidyr	"0.8.3"	NA
## tidyselect	"0.2.5"	NA
## tidyverse	"1.2.1"	NA
## timeDate	"3043.102"	NA
## tinytex	"0.13"	NA

## TTR	"0.23-4"	NA
## utf8	"1.1.4"	NA
## vctrs	"0.1.0"	NA
## viridisLite	"0.3.0"	NA
## webshot	"0.5.1"	NA
## whisker	"0.3-2"	NA
## withr	"2.1.2"	NA
## xfun	"0.7"	NA
## xgboost	"0.82.1"	NA
## xml2	"1.2.0"	NA
## xts	"0.11-2"	NA
## yaml	"2.2.0"	NA
## zeallot	"0.1.0"	NA
## zoo	"1.8-5"	NA
## base	"3.6.0"	"base"
## boot	"1.3-22"	"recommended"
## class	"7.3-15"	"recommended"
## cluster	"2.0.8"	"recommended"
## codetools	"0.2-16"	"recommended"
## compiler	"3.6.0"	"base"
## datasets	"3.6.0"	"base"
## foreign	"0.8-71"	"recommended"
## graphics	"3.6.0"	"base"
## grDevices	"3.6.0"	"base"
## grid	"3.6.0"	"base"
## KernSmooth	"2.23-15"	"recommended"
## lattice	"0.20-38"	"recommended"
## MASS	"7.3-51.4"	"recommended"
## Matrix	"1.2-17"	"recommended"
## methods	"3.6.0"	"base"
## mgcv	"1.8-28"	"recommended"
## nlme	"3.1-139"	"recommended"
## nnet	"7.3-12"	"recommended"
## parallel	"3.6.0"	"base"
## rpart	"4.1-15"	"recommended"
## spatial	"7.3-11"	"recommended"
## splines	"3.6.0"	"base"
## stats	"3.6.0"	"base"
## stats4	"3.6.0"	"base"
## survival	"2.44-1.1"	"recommended"
## tcltk	"3.6.0"	"base"
## tools	"3.6.0"	"base"
## translations	"3.6.0"	NA
## utils	"3.6.0"	"base"
##	Depends	
## abind	"R (>= 1.5.0)"	
## askpass	NA	
## assertthat	NA	
## backports	"R (>= 3.0.0)"	
## base64enc	"R (>= 2.9.0)"	
## BH	NA	
## bitops	NA	
## broom	"R (>= 3.1)"	
## callr	NA	

```

## caret                "R (>= 3.2.0), lattice (>= 0.20), ggplot2"
## caTools              "R (>= 2.2.0)"
## cellranger           "R (>= 3.0.0)"
## Ckmeans.1d.dp        NA
## class                "R (>= 3.0.0), stats, utils"
## cli                  "R (>= 2.10)"
## clipr                NA
## colorspace           "R (>= 3.0.0), methods"
## crayon               NA
## curl                 "R (>= 3.0.0)"
## data.table           "R (>= 3.1.0)"
## DBI                  "R (>= 3.0.0), methods"
## dbplyr               "R (>= 3.1)"
## digest               "R (>= 3.1.0)"
## DMwR                 "R(>= 2.10), methods, graphics, lattice (>= 0.18-3), grid (>= 2.10.1)"
## DMwR2                "R(>= 3.0), methods"
## doParallel           "R (>= 2.14.0), foreach(>= 1.2.0), iterators(>= 1.0.0), nparallel, utils"
## dplyr                "R (>= 3.2.0)"
## dslabs               "R (>= 3.1.2)"
## e1071                NA
## ellipsis             "R (>= 3.1)"
## evaluate             "R (>= 3.0.2)"
## fansi                "R (>= 3.1.0)"
## forcats              "R (>= 3.1)"
## foreach              "R (>= 2.5.0)"
## fs                   "R (>= 3.1)"
## gbm                  "R (>= 2.9.0)"
## gdata                "R (>= 2.3.0)"
## generics             "R (>= 3.1)"
## ggplot2              "R (>= 3.1)"
## glue                 "R (>= 3.1)"
## gower                NA
## gplots               "R (>= 3.0)"
## gridExtra            NA
## gtable               "R (>= 3.0)"
## gtools               "methods, stats, utils"
## haven                "R (>= 3.1)"
## highr                "R (>= 3.2.3)"
## hms                  NA
## htmltools            "R (>= 2.14.1)"
## httr                 "R (>= 3.1)"
## ipred                "R (>= 2.10)"
## iterators            "R (>= 2.5.0), utils"
## jsonlite             "methods"
## kableExtra           "R (>= 3.1.0)"
## knitr                "R (>= 3.2.3)"
## labeling             NA
## lattice              "R (>= 3.0.0)"
## lava                 "R (>= 3.0)"
## lazyeval             "R (>= 3.1.0)"
## lightgbm             "R (>= 3.4), R6 (>= 2.0)"
## lubridate            "methods, R (>= 3.0.0)"
## magrittr             NA
## markdown             "R (>= 2.11.1)"

```



```

## mime NA
## ModelMetrics "R (>= 3.2.2)"
## modelr "R (>= 3.1)"
## munsell NA
## numDeriv "R (>= 2.11.1)"
## openssl NA
## PerfMeas "limma, graph, RBGL"
## pillar NA
## pkgconfig NA
## plogr NA
## plyr "R (>= 3.1.0)"
## precrec "R (>= 3.2.1)"
## prettyunits NA
## pROC "R (>= 2.14)"
## processx NA
## prodlim "R (>= 2.9.0)"
## progress NA
## PRROC NA
## ps "R (>= 3.1)"
## purrr "R (>= 3.1)"
## quantmod "R (>= 3.2.0), xts(>= 0.9-0), zoo, TTR(>= 0.2), methods"
## R6 "R (>= 3.0)"
## randomForest "R (>= 3.2.2), stats"
## RColorBrewer "R (>= 2.0.0)"
## Rcpp "R (>= 3.0.0)"
## RcppRoll "R (>= 2.15.1)"
## readr "R (>= 3.1)"
## readxl NA
## recipes "R (>= 3.1), dplyr"
## rematch NA
## reprex "R (>= 3.1)"
## reshape2 "R (>= 3.1)"
## rlang "R (>= 3.1.0)"
## rmarkdown "R (>= 3.0)"
## ROCR "gplots, methods"
## rprojroot "R (>= 3.0.0)"
## rstudioapi NA
## rvest "R (>= 3.2), xml2"
## scales "R (>= 3.1)"
## selectr "R (>= 3.0)"
## SQUAREM "R (>= 3.0)"
## stringi "R (>= 2.14)"
## stringr "R (>= 3.1)"
## sys NA
## tibble "R (>= 3.1.0)"
## tidyr "R (>= 3.1)"
## tidyselect "R (>= 3.1)"
## tidyverse NA
## timeDate "R (>= 2.15.1), graphics, utils, stats, methods"
## tinytex NA
## TTR NA
## utf8 "R (>= 2.10)"
## vctrs "R (>= 3.1)"
## viridisLite "R (>= 2.10)"

```

```

##webshot      "R (>= 3.0)"
## whisker     NA
## withr       "R (>= 3.0.2)"
## xfun         NA
##xgboost      "R (>= 3.3.0)"
##xml2         "R (>= 3.1.0)"
## xts         "zoo (>= 1.7-12)"
## yaml        NA
## zeallot      NA
##zoo          "R (>= 3.1.0), stats"
## base        NA
##boot         "R (>= 3.0.0), graphics, stats"
##class        "R (>= 3.0.0), stats, utils"
## cluster     "R (>= 3.3.0)"
## codetools    "R (>= 2.1)"
## compiler    NA
## datasets     NA
## foreign      "R (>= 3.0.0)"
## graphics     NA
## grDevices    NA
## grid         NA
##KernSmooth   "R (>= 2.5.0), stats"
## lattice      "R (>= 3.0.0)"
##MASS          "R (>= 3.1.0), grDevices, graphics, stats, utils"
##Matrix        "R (>= 3.2.0)"
## methods     NA
##mgcv          "R (>= 2.14.0), nlme (>= 3.1-64)"
##nlme          "R (>= 3.4.0)"
##nnet          "R (>= 2.14.0), stats, utils"
## parallel    NA
## rpart        "R (>= 2.15.0), graphics, stats, grDevices"
## spatial      "R (>= 3.0.0), graphics, stats, utils"
## splines      NA
## stats        NA
## stats4       NA
## survival     "R (>= 2.13.0)"
## tcltk        NA
## tools        NA
## translations NA
## utils        NA
##             Imports
##abind          "methods, utils"
##askpass        "sys (>= 2.1)"
## assertthat    "tools"
##backports      "utils"
## base64enc     NA
## BH            NA
## bitops        NA
##broom          "backports, dplyr, generics (>= 0.0.2), methods, nlme, purrr,\nreshape2, stringr, tibble"
## callr         "processx (>= 3.3.0), R6, utils"
## caret         "foreach, methods, plyr, ModelMetrics (>= 1.1.0), nlme,\nreshape2, stats, stats4, utils"
##caTools        "bitops"
## cellranger    "rematch, tibble"
## Ckmeans.1d.dp "Rcpp (>= 0.12.18)"

```

```

## class "MASS"
## cli "assertthat, crayon (>= 1.3.4), methods, utils"
## clipr "utils"
## colorspace "graphics, grDevices, stats"
## crayon "grDevices, methods, utils"
## curl NA
## data.table "methods"
## DBI NA
## dbplyr "assertthat (>= 0.2.0), DBI (>= 1.0.0), dplyr (>= 0.8.0), glue\n(>= 1.2.0), methods, p
## digest NA
## DMwR "xts (>= 0.6-7), quantmod (>= 0.3-8), zoo (>= 1.6-4), abind (>=\n1.1-0), rpart (>= 3.1
## DMwR2 "xts (>= 0.9-7), zoo (>= 1.7-10), class (>= 7.3-14), rpart (>=\n4.1-10), quantmod (>=
## doParallel NA
## dplyr "assertthat (>= 0.2.1), glue (>= 1.3.1), magrittr (>= 1.5),\nmethods, pkgconfig (>= 2.
## dslabs "ggplot2"
## e1071 "graphics, grDevices, class, stats, methods, utils"
## ellipsis NA
## evaluate "methods"
## fansi NA
## forcats "ellipsis, magrittr, rlang, tibble"
## foreach "codetools, utils, iterators"
## fs "methods,Rcpp"
## gbm "gridExtra, lattice, parallel, survival"
## gdata "gtools, stats, methods, utils"
## generics "methods"
## ggplot2 "digest, grid, gtable (>= 0.1.1), lazyeval, MASS, mgcv, plyr\n(>= 1.7.1), reshape2, r
## glue "methods"
## gower NA
## gplots "gtools, gdata, stats, caTools, KernSmooth"
## gridExtra "gtable, grid, grDevices, graphics, utils"
## gtable "grid"
## gtools NA
## haven "forcats (>= 0.2.0), hms, Rcpp (>= 0.11.4), readr (>= 0.1.0),\ntibble"
## highr NA
## hms "methods, pkgconfig, rlang"
## htmltools "utils, digest, Rcpp"
## http "curl (>= 0.9.1), jsonlite, mime, openssl (>= 0.8), R6"
## ipred "rpart (>= 3.1-8), MASS, survival, nnet, class, prodlim"
## iterators NA
## jsonlite NA
## kableExtra "knitr (>= 1.16), magrittr, stringr (>= 1.0), xml2 (>= 1.1.1),\nrvest, rmarkdown (>= 1
## knitr "evaluate (>= 0.10), highr, markdown, stringr (>= 0.6), yaml\n(>= 2.1.19), methods, xf
## labeling NA
## lattice "grid, grDevices, graphics, stats, utils"
## lava "grDevices, graphics, methods, numDeriv, stats, survival,\nSQUAREM, utils"
## lazyeval NA
## lightgbm "data.table (>= 1.9.6), graphics, jsonlite (>= 1.0), magrittr\n(>= 1.5), Matrix (>= 1.
## lubridate "stringr, Rcpp (>= 0.12.13),"
## magrittr NA
## markdown "utils, mime (>= 0.3)"
## mime "tools"
## ModelMetrics "Rcpp, data.table"
## modelr "broom, dplyr, magrittr, purrr (>= 0.2.2), rlang (>= 0.2.0),\ntibble, tidyr (>= 0.8.0)
## munsell "colorspace, methods"

```

```

## numDeriv      NA
## openssl      "askpass"
## PerfMeas     NA
## pillar       "cli (>= 1.1.0), crayon (>= 1.3.4), fansi (>= 0.4.0), methods,\nrlang (>= 0.3.4), utf8
## pkgconfig    "utils"
## plogr        NA
## plyr         "Rcpp (>= 0.11.0)"
## precrec      "Rcpp (>= 0.12.2), ggplot2 (>= 2.1.0), assertthat (>= 0.1),\ngrid, gridExtra (>= 2.0.0
## prettyunits  "magrittr, assertthat, methods"
## pROC         "methods, plyr, Rcpp (>= 0.11.1)"
## processx     "ps (>= 1.2.0), R6, utils"
## prodlim      "Rcpp (>= 0.11.5), stats, graphics, survival, KernSmooth, lava"
## progress     "hms, prettyunits, R6, crayon"
## PRROC        NA
## ps           "utils"
## purrr        "magrittr (>= 1.5), rlang (>= 0.3.1)"
## quantmod     "curl"
## R6           NA
## randomForest NA
## RColorBrewer NA
## Rcpp         "methods, utils"
## RcppRoll     "Rcpp"
## readr        "Rcpp (>= 0.12.0.5), tibble, hms (>= 0.4.1), R6, clipr, crayon,\nmethods"
## readxl       "cellranger, Rcpp (>= 0.12.18), tibble (>= 1.3.1), utils"
## recipes      "generics, glue, gower, ipred, lubridate, magrittr, Matrix,\nnpurrr (>= 0.2.3), RcppRol
## rematch     NA
## reprex       "callr (>= 2.0.0), clipr (>= 0.4.0), fs, rlang, rmarkdown,\nutils, whisker, withr"
## reshape2     "plyr (>= 1.8.1), Rcpp, stringr"
## rlang        NA
## rmarkdown    "tools, utils, knitr (>= 1.22), yaml (>= 2.1.19), htmltools (>=\n0.3.5), evaluate (>=
## ROCR         NA
## rprojroot    "backports"
## rstudioapi   NA
## rvest        "httr (>= 0.5), magrittr, selectr"
## scales       "labeling, munsell (>= 0.5), R6, RColorBrewer, Rcpp,\nviridisLite"
## selectr      "methods, stringr, R6"
## SQUAREM      NA
## stringi      "tools, utils, stats"
## stringr      "glue (>= 1.2.0), magrittr, stringi (>= 1.1.7)"
## sys          NA
## tibble       "cli (>= 1.0.1), crayon (>= 1.3.4), fansi (>= 0.4.0), methods,\npillar (>= 1.3.1), pkg
## tidyr        "dplyr (>= 0.7.0), glue, magrittr, purrr, Rcpp, rlang, stringi,\ntibble, tidyselect (>
## tidyselect   "glue (>= 1.3.0), purrr, rlang (>= 0.2.2), Rcpp (>= 0.12.0)"
## tidyverse    "broom (>= 0.4.2), cli (>= 1.0.0), crayon (>= 1.3.4), dplyr (>=\n0.7.4), dbplyr (>= 1.
## timeDate     NA
## tinytex      "xfun (>= 0.5)"
## TTR          "xts (>= 0.10-0), zoo, curl"
## utf8         NA
## vctr         "backports, digest, glue, rlang, zeallot"
## viridisLite  NA
## webshot      "magrittr, jsonlite, callr"
## whisker      NA
## withr        "stats, graphics, grDevices"
## xfun         "tools"

```

```

##xgboost      "Matrix (>= 1.1-0), methods, data.table (>= 1.9.6), magrittr\n(>= 1.5), stringi (>= 0.
## xml2        "Rcpp"
## xts         "methods"
## yaml       NA
## zeallot     NA
##zoo          "utils, graphics, grDevices, lattice (>= 0.20-27)"
## base       NA
## boot       NA
## class      "MASS"
## cluster    "graphics, grDevices, stats, utils"
## codetools  NA
## compiler   NA
## datasets   NA
##foreign     "methods, utils, stats"
## graphics   "grDevices"
## grDevices  NA
## grid        "grDevices, utils"
## KernSmooth NA
## lattice    "grid, grDevices, graphics, stats, utils"
## MASS       "methods"
##Matrix      "methods, graphics, grid, stats, utils, lattice"
##methods     "utils, stats"
##mgcv        "methods, stats, graphics, Matrix, splines, utils"
##nlme        "graphics, stats, utils, lattice"
## nnet       NA
## parallel   "tools, compiler"
## rpart      NA
## spatial    NA
##splines     "graphics, stats"
## stats      "utils, grDevices, graphics"
## stats4     "graphics, methods, stats"
##survival    "graphics, Matrix, methods, splines, stats, utils"
## tcltk      "utils"
## tools      NA
## translations NA
## utils      NA
##           LinkingTo
## abind      NA
## askpass    NA
## assertthat NA
## backports  NA
## base64enc  NA
## BH         NA
## bitops     NA
## broom      NA
## callr      NA
## caret      NA
## caTools    NA
## cellranger NA
## Ckmeans.1d.dp "Rcpp"
## class      NA
## cli        NA
## clipr      NA
## colorspace NA

```

```

## crayon      NA
## curl        NA
## data.table  NA
## DBI          NA
## dbplyr      NA
## digest      NA
## DMwR        NA
## DMwR2       NA
## doParallel  NA
## dplyr       "BH (>= 1.69.0-1), plogr (>= 0.2.0), Rcpp (>= 1.0.1)"
## dslabs      NA
## e1071       NA
## ellipsis    NA
## evaluate    NA
## fansi       NA
## forcats     NA
## foreach     NA
## fs          "Rcpp"
## gbm         NA
## gdata       NA
## generics    NA
## ggplot2     NA
## glue        NA
## gower       NA
## gplots      NA
## gridExtra   NA
## gtable      NA
## gtools      NA
## haven       "Rcpp"
## highr       NA
## hms         NA
## htmltools   "Rcpp"
## httr        NA
## ipred       NA
## iterators   NA
## jsonlite    NA
## kableExtra  NA
## knitr       NA
## labeling    NA
## lattice     NA
## lava        NA
## lazyeval    NA
## lightgbm    NA
## lubridate   "Rcpp,"
## magrittr    NA
## markdown    NA
## mime        NA
## ModelMetrics "Rcpp"
## modelr      NA
## munsell     NA
## numDeriv    NA
## openssl     NA
## PerfMeas    NA
## pillar      NA

```

```

## pkgconfig      NA
## plogr          NA
## plyr           "Rcpp"
## precrec        "Rcpp"
## prettyunits    NA
## pROC           "Rcpp"
## processx       NA
## prodlim        "Rcpp"
## progress       NA
## PRROC          NA
## ps             NA
## purrr          NA
## quantmod       NA
## R6             NA
## randomForest   NA
## RColorBrewer   NA
## Rcpp           NA
## RcppRoll       "Rcpp"
## readr          "Rcpp, BH"
## readxl        "progress, Rcpp"
## recipes        NA
## rematch        NA
## reprex         NA
## reshape2       "Rcpp"
## rlang          NA
## rmarkdown      NA
## ROCR           NA
## rprojroot      NA
## rstudioapi     NA
## rvest          NA
## scales         "Rcpp"
## selectr        NA
## SQUAREM        NA
## stringi        NA
## stringr        NA
## sys            NA
## tibble         NA
## tidyr          "Rcpp"
## tidyselect     "Rcpp (>= 0.12.0),"
## tidyverse      NA
## timeDate       NA
## tinytex        NA
## TTR            "xts"
## utf8           NA
## vctrs          NA
## viridisLite    NA
## webshot        NA
## whisker        NA
## withr          NA
## xfun           NA
## xgboost        NA
## xml2           "Rcpp (>= 0.12.12)"
## xts            "zoo"
## yaml          NA

```

```

## zeallot      NA
## zoo          NA
## base         NA
## boot         NA
## class        NA
## cluster      NA
## codetools    NA
## compiler     NA
## datasets     NA
## foreign      NA
## graphics     NA
## grDevices    NA
## grid         NA
## KernSmooth   NA
## lattice      NA
## MASS         NA
## Matrix       NA
## methods      NA
## mgcv         NA
## nlme         NA
## nnet         NA
## parallel     NA
## rpart        NA
## spatial      NA
## splines      NA
## stats        NA
## stats4       NA
## survival     NA
## tcltk        NA
## tools        NA
## translations NA
## utils        NA
##              Suggests
## abind        NA
## askpass      "testthat"
## assertthat   "testthat, covr"
## backports    NA
## base64enc    NA
## BH           NA
## bitops       NA
## broom        "AER, akima, AUC, bbmle, betareg, biglm, binGroup, boot, brms,\nbtergm, car, caret, co
## callr        "cliapp, covr, crayon, pingr, ps, testthat, withr"
## caret        "BradleyTerry2, e1071, earth (>= 2.2-3), fastICA, gam (>=\n1.15), ipred, kernlab, kni
## caTools      "MASS, rpart"
## cellranger    "covr, testthat (>= 1.0.0), knitr, rmarkdown"
## Ckmeans.1d.dp "testthat, knitr, rmarkdown"
## class        NA
## cli          "covr, fansi, mockery, testthat, webshot, withr"
## clipr        "covr, knitr, rmarkdown, rstudioapi (>= 0.5), testthat (>=\n2.0.0)"
## colorspace    "datasets, utils, KernSmooth, MASS, kernlab, mvtnorm, vcd,\nntcltk, shiny, shinyjs, ggp
## crayon        "mockery, rstudioapi, testthat, withr"
## curl         "spelling, testthat (>= 1.0.0), knitr, jsonlite, rmarkdown,\nmagrittr, httpuv (>= 1.4.
## data.table    "bit64, curl, R.utils, knitr, xts, nanotime, zoo"
## DBI          "blob, covr, hms, knitr, magrittr, rprojroot, rmarkdown,\nRSQLite (>= 1.1-2), testthat

```



```

## dbplyr "bit64, covr, knitr, Lahman, nycflights13, RMariaDB (>=1.0.2), rmarkdown, RMySQL (>=
## digest "knitr,rmarkdown"
## DMwR NA
## DMwR2 NA
## doParallel "caret, mlbench, rpart, RUnit"
##dplyr "bit64 (>= 0.9-7), callr (>= 3.2.0), covr (>= 3.2.1), DBI (>=1.0.0), dbplyr (>= 1.4.
## dslabs NA
##e1071 "cluster, mlbench, nnet, randomForest, rpart, SparseM, xtable,\nMatrix, MASS, slam"
## ellipsis "covr, testthat"
##evaluate "testthat, lattice, ggplot2"
## fansi "unitizer, knitr, rmarkdown"
## forcats "covr, ggplot2, testthat, readr, knitr, rmarkdown, dplyr"
## foreach "randomForest"
## fs "testthat, covr, pillar (>= 1.0.0), crayon, rmarkdown, knitr,\nwithr, spelling"
##gbm "knitr, pdp, RUnit, splines, viridis"
## gdata "RUnit"
##generics "covr, pkgload, testthat, tibble"
##ggplot2 "covr, dplyr, ggplot2movies, hexbin, Hmisc, lattice, mapproj,\nmaps, maptools, multcom
##glue "testthat, covr, magrittr, crayon, knitr, rmarkdown, DBI,\nRSQLite, R.utils, forcats,
##gower "tinytest (>= 0.9.3),"
## gplots "grid,MASS"
##gridExtra "ggplot2, egg, lattice, knitr, testthat"
##gtable "covr, testthat, knitr, rmarkdown, ggplot2, profvis"
## gtools NA
##haven "covr, fs, knitr, rmarkdown, testthat, pillar (>= 1.1.1), cli,\nncrayon"
##highr "knitr, testit"
##hms "crayon, lubridate, pillar (>= 1.1.0), testthat"
## htmltools "markdown, testthat"
## httr "covr, httpuv, jpeg, knitr, png, readr, rmarkdown, testthat\n(>= 0.8.0), xml2"
## ipred "mvtnorm, mlbench, TH.data"
## iterators "RUnit,foreach"
## jsonlite "httr, curl, plyr, testthat, knitr, rmarkdown, R.rsp, sp"
##kableExtra "testthat, magick, formattable, dplyr"
## knitr "formatR, testit, digest, rgl (>= 0.95.1201), codetools,\nrmardown, htmlwidgets (>= 0
## labeling NA
## lattice "KernSmooth,MASS,latticeExtra"
## lava "KernSmooth, Matrix, Rgraphviz, data.table, ellipse, fields,\nforeach, geepack, gof (>
##lazyeval "knitr, rmarkdown (>= 0.2.65), testthat, covr"
##lightgbm "Ckmeans.1d.dp (>= 3.3.1), DiagrammeR (>= 0.8.1), ggplot2 (>=1.0.1), igraph (>= 1.0.
##lubridate "testthat, knitr, covr"
##magrittr "testthat, knitr"
##markdown "knitr, RCurl"
## mime NA
## ModelMetrics "testthat"
##modelr "compiler, covr, ggplot2, testthat"
##munsell "ggplot2, testthat"
## numDeriv NA
##openssl "testthat, digest, knitr, rmarkdown, jsonlite, jose"
## PerfMeas NA
## pillar "knitr (>= 1.22), lubridate (>= 1.7.4), testthat (>= 2.1.1),\nwithr (>= 2.1.2)"
##pkgconfig "covr, testthat, disposables (>= 1.0.3)"
## plogr "Rcpp"
##plyr "abind, testthat, tcltk, foreach, doParallel, itertools,\niterators, covr"
##precure "testthat (>= 0.11.0), knitr (>= 1.11), rmarkdown (>= 0.8.1)"

```

```

## prettyunits "testthat"
## pROC "microbenchmark, tcltk, MASS, logcondens, doParallel,\ntestthat, vdiff, ggplot2"
## processx "callr, covr, crayon, curl, debugme, parallel, testthat, withr"
## prodlim NA
## progress "Rcpp, testthat, withr"
## PRROC "testthat, ggplot2, ROCR"
## ps "callr, covr, curl, pingr, processx (>= 3.1.0), R6, rlang,\ntestthat, tibble"
## purrr "covr, crayon, dplyr (>= 0.7.8), knitr, rmarkdown, testthat,\ntibble, tidyselect"
## quantmod "DBI,RMySQL,RSQLite,timeSeries,XML,downloader,jsonlite(>= 1.1)"
## R6 "knitr, microbenchmark, pryr, testthat, ggplot2, scales"
## randomForest "RColorBrewer, MASS"
## RColorBrewer NA
## Rcpp "RUnit, inline, rbenchmark, knitr, rmarkdown, pinp, pkgKitten\n(>= 0.1.2)"
## RcppRoll "zoo, testthat"
## readr "curl, testthat, knitr, rmarkdown, stringi, covr, spelling"
## readxl "covr, knitr, rmarkdown, rprojroot (>= 1.1), testthat"
## recipes "covr, dalpha, dimRed (>= 0.2.2), fastICA, ggplot2, igraph,\nkernlab, knitr, NMF, pls"
## rematch "covr, testthat"
## replex "covr, devtools, fortunes, knitr, miniUI, rprojroot,\nrstudioapi, shiny, styler (>= 1.0.0)"
## reshape2 "covr, lattice, testthat (>= 0.8.0)"
## rlang "covr, crayon, magrittr, methods, pillar, rmarkdown, testthat\n(>= 2.0.0)"
## rmarkdown "shiny (>= 0.11), tufte, testthat, digest, dygraphs, tibble,\nfs, callr (>= 2.0.0)"
## ROCR NA
## rprojroot "testthat, mockr, knitr, withr, rmarkdown"
## rstudioapi "testthat, knitr, rmarkdown"
## rvest "covr, knitr, png, rmarkdown, spelling, stringi (>= 0.3.1),\ntestthat"
## scales "dichromat, bit64, covr, hms, testthat (>= 2.0)"
## selectr "testthat, XML, xml2"
## SQUAREM "setRNG"
## stringi NA
## stringr "covr, htmltools, htmlwidgets, knitr, rmarkdown, testthat"
## sys "unix (>= 1.4), spelling, testthat"
## tibble "bench (>= 1.0.1), covr (>= 3.2.1), dplyr (>= 0.7.8),\nhtmltools (>= 0.3.6), import (>= 1.0.0)"
## tidyr "covr, gapminder, knitr, rmarkdown, testthat"
## tidyselect "covr, dplyr, testthat"
## tidyverse "feather (>= 0.3.1), knitr (>= 1.17), rmarkdown (>= 1.7.4)"
## timeDate "date, RUnit"
## tinytex "testit, rstudioapi"
## TTR "RUnit"
## utf8 "knitr, rmarkdown, testthat"
## vctrs "covr, generics, knitr, pillar, pkgdown, rmarkdown, testthat,\ntibble"
## viridisLite "hexbin (>= 1.27.0), ggplot2 (>= 1.0.1), testthat, covr"
## webshot "httpuv, knitr, rmarkdown, shiny"
## whisker "markdown"
## withr "testthat, covr, lattice, DBI, RSQLite, methods, knitr,\nrmarkdown"
## xfun "testit, parallel, rstudioapi, tinytex, mime, markdown, knitr,\nhtmltools, base64enc, rmarkdown, rprojroot (>= 1.0.1), DiagrammeR (>= 0.9.0),\nCkmeans.1d.dp (>= 3.3.1)"
## xgboost "knitr, rmarkdown, ggplot2 (>= 1.0.1), DiagrammeR (>= 0.9.0),\nCkmeans.1d.dp (>= 3.3.1)"
## xml2 "testthat, curl, covr, knitr, rmarkdown, magrittr, httr"
## xts "timeSeries, timeDate, tseries, chron, fts, tis, RUnit"
## yaml "RUnit"
## zeallot "testthat, knitr, rmarkdown, purrr, magrittr"
## zoo "coda, chron, DAAG, fts, ggplot2, mondate, scales,\nstrucchange, timeDate, timeSeries, timeSeries, timeSeries"
## base "methods"
## boot "MASS, survival"

```

```

## class NA
## cluster "MASS,Matrix"
## codetools NA
## compiler NA
## datasets NA
## foreign NA
## graphics NA
## grDevices "KernSmooth"
## grid "lattice"
## KernSmooth "MASS"
## lattice "KernSmooth,MASS,latticeExtra"
## MASS "lattice, nlme, nnet, survival"
## Matrix "expm,MASS"
## methods "codetools"
## mgcv "parallel, survival, MASS"
## nlme "Hmisc, MASS"
## nnet "MASS"
## parallel "methods"
## rpart "survival"
## spatial "MASS"
## splines "Matrix,methods"
## stats "MASS, Matrix, SuppDists, methods, stats4"
## stats4 NA
## survival NA
## tcltk NA
## tools "codetools, methods, xml2, curl, commonmark"
## translations NA
## utils "methods,xml2,commonmark"
## Enhances
## abind NA
## askpass NA
## assertthat NA
## backports NA
## base64enc "png"
## BH NA
## bitops NA
## broom NA
## callr NA
## caret NA
## caTools NA
## cellranger NA
## Ckmeans.1d.dp NA
## class NA
## cli NA
## clipr NA
## colorspace NA
## crayon NA
## curl NA
## data.table NA
## DBI NA
## dbplyr NA
## digest NA
## DMwR NA
## DMwR2 NA

```

```

## doParallel      "compiler"
## dplyr           NA
## dslabs          NA
## e1071           NA
## ellipsis        NA
## evaluate        NA
## fansi           NA
## forcats         NA
## foreach         "compiler, doMC, RUnit, doParallel"
## fs              NA
## gbm             NA
## gdata           NA
## generics        NA
## ggplot2         "sp"
## glue            NA
## gower           NA
## gplots          NA
## gridExtra       NA
## gtable          NA
## gtools          NA
## haven           NA
## highr           NA
## hms             NA
## htmltools       "knitr"
## httr            NA
## ipred           NA
## iterators       NA
## jsonlite        NA
## kableExtra      NA
## knitr           NA
## labeling        NA
## lattice         "chron"
## lava            NA
## lazyeval        NA
## lightgbm        NA
## lubridate       "chron, fts, timeSeries, timeDate, tis, tseries, xts, zoo"
## magrittr        NA
## markdown        NA
## mime            NA
## ModelMetrics    NA
## modelr          NA
## munsell         NA
## numDeriv        NA
## openssl         NA
## PerfMeas        NA
## pillar          NA
## pkgconfig       NA
## plogr           NA
## plyr            NA
## precrec         NA
## prettyunits     NA
## pROC            NA
## processx        NA
## prodlim         NA

```

## progress	NA
## PRROC	NA
## ps	NA
## purrr	NA
## quantmod	NA
## R6	NA
## randomForest	NA
## RColorBrewer	NA
## Rcpp	NA
## RcppRoll	NA
## readr	NA
## readxl	NA
## recipes	NA
## rematch	NA
## reprex	NA
## reshape2	NA
## rlang	NA
## rmarkdown	NA
## ROCR	NA
## rprojroot	NA
## rstudioapi	NA
## rvest	NA
## scales	NA
## selectr	NA
## SQUAREM	NA
## stringi	NA
## stringr	NA
## sys	NA
## tibble	NA
## tidyr	NA
## tidyselect	NA
## tidyverse	NA
## timeDate	NA
## tinytex	NA
## TTR	"quantmod"
## utf8	NA
## vctrs	NA
## viridisLite	NA
## webshot	NA
## whisker	NA
## withr	NA
## xfun	NA
## xgboost	NA
## xml2	NA
## xts	NA
## yaml	NA
## zeallot	NA
## zoo	NA
## base	NA
## boot	NA
## class	NA
## cluster	NA
## codetools	NA
## compiler	NA

## datasets	NA	
## foreign	NA	
## graphics	NA	
## grDevices	NA	
## grid	NA	
## KernSmooth	NA	
## lattice	"chron"	
## MASS	NA	
## Matrix	"MatrixModels, graph, SparseM, sfsmisc"	
## methods	NA	
## mgcv	NA	
## nlme	NA	
## nnet	NA	
## parallel	"snow,nws,Rmpi"	
## rpart	NA	
## spatial	NA	
## splines	NA	
## stats	NA	
## stats4	NA	
## survival	NA	
## tcltk	NA	
## tools	NA	
## translations	NA	
## utils	NA	
##	License	License_is_FOSS
## abind	"LGPL (>= 2)"	NA
## askpass	"MIT + file LICENSE"	NA
## assertthat	"GPL-3"	NA
## backports	"GPL-2"	NA
## base64enc	"GPL-2 GPL-3"	NA
## BH	"BSL-1.0"	NA
## bitops	"GPL (>= 2)"	NA
## broom	"MIT + file LICENSE"	NA
## callr	"MIT+fileLICENSE"	NA
## caret	"GPL (>= 2)"	NA
## caTools	"GPL-3"	NA
## cellranger	"MIT+fileLICENSE"	NA
## Ckmeans.1d.dp	"LGPL (>= 3)"	NA
## class	"GPL-2 GPL-3"	NA
## cli	"MIT+fileLICENSE"	NA
## clipr	"GPL-3"	NA
## colorspace	"BSD_3_clause + file LICENSE"	NA
## crayon	"MIT + file LICENSE"	NA
## curl	"MIT + file LICENSE"	NA
## data.table	"MPL-2.0 fileLICENSE"	NA
## DBI	"LGPL (>= 2)"	NA
## dbplyr	"MIT + file LICENSE"	NA
## digest	"GPL (>= 2)"	NA
## DMwR	"GPL (>= 2)"	NA
## DMwR2	"GPL (>= 2)"	NA
## doParallel	"GPL-2"	NA
## dplyr	"MIT + file LICENSE"	NA
## dslabs	"Artistic-2.0"	NA
## e1071	"GPL-2"	NA

## ellipsis	"GPL-3"	NA
## evaluate	"MIT + file LICENSE"	NA
## fansi	"GPL (>= 2)"	NA
## forcats	"GPL-3"	NA
## foreach	"Apache License (== 2.0)"	NA
## fs	"GPL-3"	NA
## gbm	"GPL (>= 2) file LICENSE"	NA
## gdata	"GPL-2"	NA
## generics	"GPL-2"	NA
## ggplot2	"GPL-2 file LICENSE"	NA
## glue	"MIT + file LICENSE"	NA
## gower	"GPL-3"	NA
## gplots	"GPL-2"	NA
## gridExtra	"GPL (>= 2)"	NA
## gtable	"GPL-2"	NA
## gtools	"GPL-2"	NA
## haven	"MIT + file LICENSE"	NA
## highr	"GPL"	NA
## hms	"GPL-3"	NA
## htmltools	"GPL (>= 2)"	NA
## httr	"MIT + file LICENSE"	NA
## ipred	"GPL (>= 2)"	NA
## iterators	"Apache License (== 2.0)"	NA
## jsonlite	"MIT + file LICENSE"	NA
## kableExtra	"MIT + file LICENSE"	NA
## knitr	"GPL"	NA
## labeling	"MIT + file LICENSE Unlimited"	NA
## lattice	"GPL (>= 2)"	NA
## lava	"GPL-3"	NA
## lazyeval	"GPL-3"	NA
## lightgbm	"MIT + file LICENSE"	NA
## lubridate	"GPL (>= 2)"	NA
## magrittr	"MIT + file LICENSE"	NA
## markdown	"GPL-2"	NA
## mime	"GPL"	NA
## ModelMetrics	"GPL (>= 2)"	NA
## modelr	"GPL-3"	NA
## munsell	"MIT + file LICENSE"	NA
## numDeriv	"GPL-2"	NA
## openssl	"MIT + file LICENSE"	NA
## PerfMeas	"GPL (>= 2)"	NA
## pillar	"GPL-3"	NA
## pkgconfig	"MIT + file LICENSE"	NA
## plogr	"MIT + file LICENSE"	NA
## plyr	"MIT + file LICENSE"	NA
## precrec	"GPL-3"	NA
## prettyunits	"MIT + file LICENSE"	NA
## pROC	"GPL (>= 3)"	NA
## processx	"MIT + file LICENSE"	NA
## prodlim	"GPL (>= 2)"	NA
## progress	"MIT + file LICENSE"	NA
## PRROC	"GPL-3"	NA
## ps	"BSD_3_clause + file LICENSE"	NA
## purrr	"GPL-3 file LICENSE"	NA

## quantmod	"GPL-3"	NA
## R6	"MIT + file LICENSE"	NA
## randomForest	"GPL (>= 2)"	NA
## RColorBrewer	"Apache License 2.0"	NA
## Rcpp	"GPL (>= 2)"	NA
## RcppRoll	"GPL (>= 2)"	NA
## readr	"GPL (>= 2) file LICENSE"	NA
## readxl	"GPL-3"	NA
## recipes	"GPL-2"	NA
## rematch	"MIT + file LICENSE"	NA
## reprex	"MIT + file LICENSE"	NA
## reshape2	"MIT + file LICENSE"	NA
## rlang	"GPL-3"	NA
## rmarkdown	"GPL-3"	NA
## ROCR	"GPL (>= 2)"	NA
## rprojroot	"GPL-3"	NA
## rstudioapi	"MIT + file LICENSE"	NA
## rvest	"GPL-3"	NA
## scales	"MIT + file LICENSE"	NA
## selectr	"BSD_3_clause + file LICENCE"	NA
## SQUAREM	"GPL (>= 2)"	NA
## stringi	"file LICENSE"	"yes"
## stringr	"GPL-2 file LICENSE"	NA
## sys	"MIT + file LICENSE"	NA
## tibble	"MIT + file LICENSE"	NA
## tidyr	"MIT + file LICENSE"	NA
## tidyselect	"GPL-3"	NA
## tidyverse	"GPL-3 file LICENSE"	NA
## timeDate	"GPL (>= 2)"	NA
## tinytex	"MIT + file LICENSE"	NA
## TTR	"GPL-2"	NA
## utf8	"Apache License (== 2.0) file LICENSE"	NA
## vctrs	"GPL-3"	NA
## viridisLite	"MIT + file LICENSE"	NA
## webshot	"GPL-2"	NA
## whisker	"GPL-3"	NA
## withr	"GPL (>= 2)"	NA
## xfun	"MIT + file LICENSE"	NA
## xgboost	"Apache License (== 2.0) file LICENSE"	NA
## xml2	"GPL (>= 2)"	NA
## xts	"GPL (>= 2)"	NA
## yaml	"BSD_3_clause + file LICENSE"	NA
## zeallot	"MIT + file LICENSE"	NA
## zoo	"GPL-2 GPL-3"	NA
## base	"Part of R 3.6.0"	NA
## boot	"Unlimited"	NA
## class	"GPL-2 GPL-3"	NA
## cluster	"GPL (>= 2)"	NA
## codetools	"GPL"	NA
## compiler	"Part of R 3.6.0"	NA
## datasets	"Part of R 3.6.0"	NA
## foreign	"GPL (>= 2)"	NA
## graphics	"Part of R 3.6.0"	NA
## grDevices	"Part of R 3.6.0"	NA

## grid	"Part of R 3.6.0"			NA
## KernSmooth	"Unlimited"			NA
## lattice	"GPL (>= 2)"			NA
## MASS	"GPL-2 GPL-3"			NA
## Matrix	"GPL (>= 2) file LICENCE"			NA
## methods	"Part of R 3.6.0"			NA
## mgcv	"GPL (>= 2)"			NA
## nlme	"GPL (>= 2) file LICENCE"			NA
## nnet	"GPL-2 GPL-3"			NA
## parallel	"Part of R 3.6.0"			NA
## rpart	"GPL-2 GPL-3"			NA
## spatial	"GPL-2 GPL-3"			NA
## splines	"Part of R 3.6.0"			NA
## stats	"Part of R 3.6.0"			NA
## stats4	"Part of R 3.6.0"			NA
## survival	"LGPL (>= 2)"			NA
## tcltk	"Part of R 3.6.0"			NA
## tools	"Part of R 3.6.0"			NA
## translations	"Part of R 3.6.0"			NA
## utils	"Part of R 3.6.0"			NA
##	License_restricts_use	OS_type	MD5sum	NeedsCompilation
## abind	NA	NA	NA	"no"
## askpass	NA	NA	NA	"yes"
## assertthat	NA	NA	NA	"no"
## backports	NA	NA	NA	"yes"
## base64enc	NA	NA	NA	"yes"
## BH	NA	NA	NA	"no"
## bitops	NA	NA	NA	"yes"
## broom	NA	NA	NA	"no"
## callr	NA	NA	NA	"no"
## caret	NA	NA	NA	"yes"
## caTools	NA	NA	NA	"yes"
## cellranger	NA	NA	NA	"no"
## Ckmeans.1d.dp	NA	NA	NA	"yes"
## class	NA	NA	NA	"yes"
## cli	NA	NA	NA	"no"
## clipr	NA	NA	NA	"no"
## colorspace	NA	NA	NA	"yes"
## crayon	NA	NA	NA	"no"
## curl	NA	NA	NA	"yes"
## data.table	NA	NA	NA	"yes"
## DBI	NA	NA	NA	"no"
## dbplyr	NA	NA	NA	"no"
## digest	NA	NA	NA	"yes"
## DMwR	NA	NA	NA	"no"
## DMwR2	NA	NA	NA	"no"
## doParallel	NA	NA	NA	"no"
## dplyr	NA	NA	NA	"yes"
## dslabs	NA	NA	NA	"no"
## e1071	NA	NA	NA	"yes"
## ellipsis	NA	NA	NA	"yes"
## evaluate	NA	NA	NA	"no"
## fansi	NA	NA	NA	"yes"
## forcats	NA	NA	NA	"no"

## foreach	NA	NA	NA	"no"
## fs	NA	NA	NA	"yes"
## gbm	NA	NA	NA	"yes"
## gdata	NA	NA	NA	"no"
## generics	NA	NA	NA	"no"
## ggplot2	NA	NA	NA	"no"
## glue	NA	NA	NA	"yes"
## gower	NA	NA	NA	"yes"
## gplots	NA	NA	NA	"no"
## gridExtra	NA	NA	NA	"no"
## gtable	NA	NA	NA	"no"
## gtools	NA	NA	NA	"yes"
## haven	NA	NA	NA	"yes"
## highr	NA	NA	NA	"no"
## hms	NA	NA	NA	"no"
## htmltools	NA	NA	NA	"yes"
## httr	NA	NA	NA	"no"
## ipred	NA	NA	NA	"yes"
## iterators	NA	NA	NA	"no"
## jsonlite	NA	NA	NA	"yes"
## kableExtra	NA	NA	NA	"no"
## knitr	NA	NA	NA	"no"
## labeling	NA	NA	NA	"no"
## lattice	NA	NA	NA	"yes"
## lava	NA	NA	NA	"no"
## lazyeval	NA	NA	NA	"yes"
## lightgbm	NA	NA	NA	"yes"
## lubridate	NA	NA	NA	"yes"
## magrittr	NA	NA	NA	"no"
## markdown	NA	NA	NA	"yes"
## mime	NA	NA	NA	"yes"
## ModelMetrics	NA	NA	NA	"yes"
## modelr	NA	NA	NA	"no"
## munsell	NA	NA	NA	"no"
## numDeriv	NA	NA	NA	"no"
## openssl	NA	NA	NA	"yes"
## PerfMeas	NA	NA	NA	"yes"
## pillar	NA	NA	NA	"no"
## pkgconfig	NA	NA	NA	"no"
## plogr	NA	NA	NA	"no"
## plyr	NA	NA	NA	"yes"
## precrec	NA	NA	NA	"yes"
## prettyunits	NA	NA	NA	"no"
## pROC	NA	NA	NA	"yes"
## processx	NA	NA	NA	"yes"
## prodlim	NA	NA	NA	"yes"
## progress	NA	NA	NA	"no"
## PRROC	NA	NA	NA	"no"
## ps	NA	NA	NA	"yes"
## purrr	NA	NA	NA	"yes"
## quantmod	NA	NA	NA	"no"
## R6	NA	NA	NA	"no"
## randomForest	NA	NA	NA	"yes"
## RColorBrewer	NA	NA	NA	"no"

## Rcpp	NA	NA	NA	"yes"
## RcppRoll	NA	NA	NA	"yes"
## readr	NA	NA	NA	"yes"
## readxl	NA	NA	NA	"yes"
## recipes	NA	NA	NA	"no"
## rematch	NA	NA	NA	"no"
## replex	NA	NA	NA	"no"
## reshape2	NA	NA	NA	"yes"
## rlang	NA	NA	NA	"yes"
## rmarkdown	NA	NA	NA	"no"
## ROCR	NA	NA	NA	"no"
## rprojroot	NA	NA	NA	"no"
## rstudioapi	NA	NA	NA	"no"
## rvest	NA	NA	NA	"no"
## scales	NA	NA	NA	"yes"
## selectr	NA	NA	NA	"no"
## SQUAREM	NA	NA	NA	"no"
## stringi	NA	NA	NA	"yes"
## stringr	NA	NA	NA	"no"
## sys	NA	NA	NA	"yes"
## tibble	NA	NA	NA	"yes"
## tidyr	NA	NA	NA	"yes"
## tidyselect	NA	NA	NA	"yes"
## tidyverse	NA	NA	NA	"no"
## timeDate	NA	NA	NA	"no"
## tinytex	NA	NA	NA	"no"
## TTR	NA	NA	NA	"yes"
## utf8	NA	NA	NA	"yes"
## vctrs	NA	NA	NA	"yes"
## viridisLite	NA	NA	NA	"no"
## webshot	NA	NA	NA	"no"
## whisker	NA	NA	NA	"no"
## withr	NA	NA	NA	"no"
## xfun	NA	NA	NA	"no"
## xgboost	NA	NA	NA	"yes"
## xml2	NA	NA	NA	"yes"
## xts	NA	NA	NA	"yes"
## yaml	NA	NA	NA	"yes"
## zeallot	NA	NA	NA	"no"
## zoo	NA	NA	NA	"yes"
## base	NA	NA	NA	NA
## boot	NA	NA	NA	"no"
## class	NA	NA	NA	"yes"
## cluster	NA	NA	NA	"yes"
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## compiler	NA	NA	NA	NA
## datasets	NA	NA	NA	NA
## foreign	NA	NA	NA	"yes"
## graphics	NA	NA	NA	"yes"
## grDevices	NA	NA	NA	"yes"
## grid	NA	NA	NA	"yes"
## KernSmooth	NA	NA	NA	"yes"
## lattice	NA	NA	NA	"yes"
## MASS	NA	NA	NA	"yes"

## Matrix	NA	NA	NA	"yes"
## methods	NA	NA	NA	"yes"
## mgcv	NA	NA	NA	"yes"
## nlme	NA	NA	NA	"yes"
## nnet	NA	NA	NA	"yes"
## parallel	NA	NA	NA	"yes"
## rpart	NA	NA	NA	"yes"
## spatial	NA	NA	NA	"yes"
## splines	NA	NA	NA	"yes"
## stats	NA	NA	NA	"yes"
## stats4	NA	NA	NA	NA
## survival	NA	NA	NA	"yes"
## tcltk	NA	NA	NA	"yes"
## tools	NA	NA	NA	"yes"
## translations	NA	NA	NA	NA
## utils	NA	NA	NA	"yes"
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## gplots	"3.6.0"
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## gtools	"3.6.0"
## haven	"3.6.0"
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## htmltools	"3.6.0"
## http	"3.6.0"
## ipred	"3.6.0"
## iterators	"3.6.0"
## jsonlite	"3.6.0"
## kableExtra	"3.6.0"
## knitr	"3.6.0"
## labeling	"3.6.0"
## lattice	"3.6.0"
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## munsell	"3.6.0"
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## quantmod	"3.6.0"
## R6	"3.6.0"
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## methods	"3.6.0"
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## stats	"3.6.0"
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## tcltk	"3.6.0"
## tools	"3.6.0"
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