Classification Model

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2023-05-04

loading required packages

```
library(caret)

library(dplyr)

library(corrplot)

library(glmnet)

library(tidyverse)
```

Reading the data file

```
data<-read.csv("train_v3.csv")
```

Clearing the Null values and checking for percentage of null values in each column

```
#Replacing all NA values with 0

data1 <- data %>% mutate_all(funs(replace_na(.,0)))



# Calculate the percentage of 0 values in each column

null_percent <- apply(data1 == 0, 2, mean)


# Get the names of the columns with less than or equal to 30% of 0(null) values

cols <- names(null_percent[null_percent <= 0.3])

# Create a new data frame with the selected columns

data2 <- data1[, cols]

#Check if the columns with more than 30% null values are deleted

sums<-(colSums(data2==0)/nrow(data2))*100
```

```r
#Adding loss column back to data

data3<-cbind(data2,loss=data1$loss)

# Create a new column called 'default' with a value of 1 is loss is above 0 and 0 is loss is 0


data3$default <- ifelse(data3$loss == 0, 0, 1)
```

Reading cleaned data file

```r
data<-data3
```

Clearing columns with near zero variance,high correlation and median imputation for missing values for smooth running in the model

```r
data<-data[ ,-c(data$f736,data$f764)]

preProcessModel <- preProcess(data, method = c("nzv", "corr", "medianImpute"))

data1 <- predict(preProcessModel, data)
```

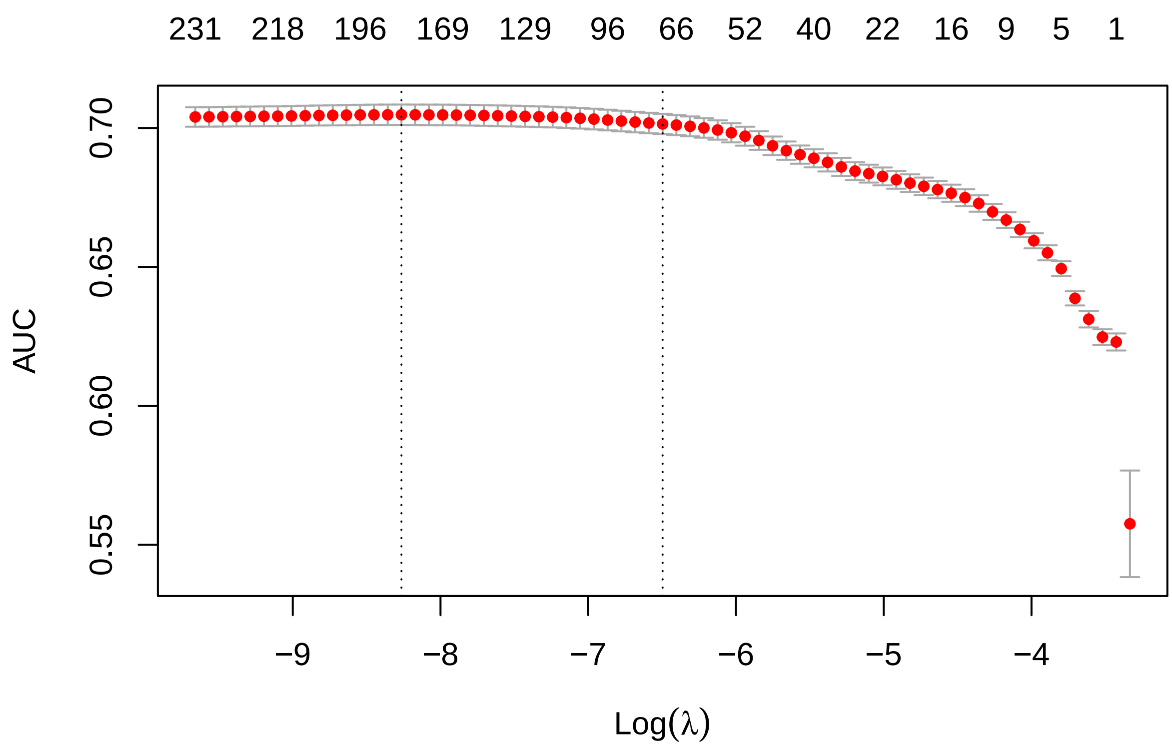
After data cleaning we are left with 261 columns

Building a lasso model

```r
#Creating a matrix

X <- as.matrix(data1[ ,-c(261)])

#Setting default column to factor levels

Y <- as.vector(as.factor(data1$default))

#Building the model with 10 fold cross-validation and performance measure as AUC curve

model<- cv.glmnet(X, Y, alpha = 1, family = "binomial", nfolds = 10, type.measure = "auc")

summary(model)
```

```
##            Length Class  Mode
## lambda     69     -none- numeric
## cvm        69     -none- numeric
## cvsd       69     -none- numeric
## cvup       69     -none- numeric
## cvlo       69     -none- numeric
## nzero      69     -none- numeric
## call        7     -none- call
## name        1     -none- character
## glmnet.fit 13     lognet list
## lambda.min  1     -none- numeric
## lambda.1se  1     -none- numeric
## index       2     -none- numeric
```

```
plot(model)
```




```
#Finding minimum value for lambda

model$lambda.min
```

```
## [1] 0.0002575271
```

```
#Saving the coefficients for lambda minimum

coefs <- coef(model, s = "lambda.min")

# Taking the coefficient values into a data frame for processing

coefs <- data.frame(name = coefs@Dimnames[[1]][coefs@i + 1], coefficient = coefs@x)

# Rounding to the absolute value of all the coefficients in the model

coefs$coefficient <- abs(coefs$coefficient)

# Finding the largest coefficient in the model

coefs <- coefs[order(coefs$coefficient, decreasing = TRUE), ]
```

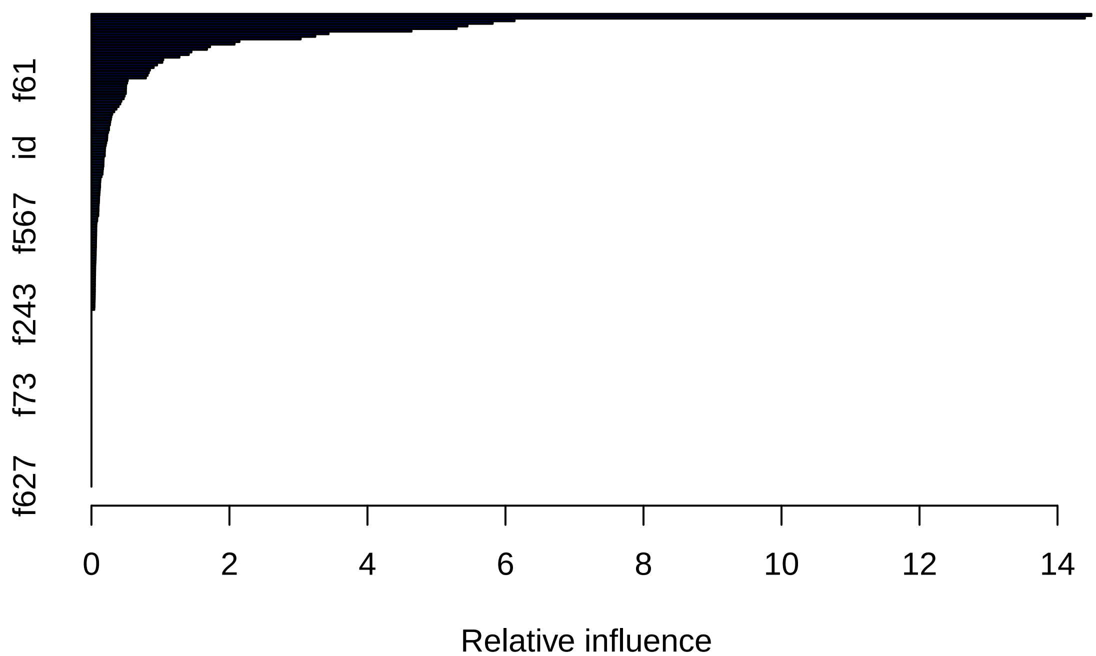
```r
# Taking out the intercept from the data frame

coefs <- coefs[-1, ]

#Converting the coefficients to a  vector type

coefs <- as.vector(coefs$name)

#Combining the default column back to the coefficients

coefs <- c(coefs,"default")

data_new<-select(data1,coefs)
```

Splitting data into 85% training and 15% validation

```r
#Splitting data into Training and Validation

set.seed(6782)

Split_data <- createDataPartition(data_new$default,p=.85,list=FALSE,times=1)

Training <- data_new[Split_data,]

Validation <- data_new[-Split_data,]
```

Building a Gradient Boosting Machine model

```r
library(gbm)

#Cross-vlidation with 10 folds and number of trees are set to 50

gbm_model <- gbm(default ~ ., data = Training, distribution = "bernoulli",
                 n.trees = 100, interaction.depth = 9, shrinkage = 0.02,
                 bag.fraction = 0.8, train.fraction = 0.85,
                 n.minobsinnode = 15,cv.folds = 10)


summary(gbm_model)
```




```
##        var     rel.inf
## f322 f322 14.49036550
## f67   f67 14.39655693
## f674 f674  6.13149462
## f64   f64  5.81482166
## f765 f765  5.44950283
## f471 f471  5.29261823
## f630 f630  4.63841978
## f514 f514  3.43592335
## f13   f13  3.24401161
## f468 f468  3.03193368
## f251 f251  2.14494023
## f221 f221  2.07397569
## f434 f434  1.71871484
## f652 f652  1.67426590
## f260 f260  1.44928864
## f268 f268  1.41078450
## f32   f32  1.27521745
## f461 f461  1.04039864
## f411 f411  1.02690701
## f333 f333  0.95094625
## f229 f229  0.90164913
## f261 f261  0.84726504
## f763 f763  0.83084047
## f272 f272  0.81366463
## f677 f677  0.78891803
```

```
## f61   f61  0.52681463
## f213 f213  0.51716062
## f278 f278  0.50325031
## f536 f536  0.50126347
## f19   f19  0.49877305
## f202 f202  0.49856051
## f420 f420  0.48107377
## f672 f672  0.46772978
## f768 f768  0.43415335
## f146 f146  0.41775577
## f470 f470  0.39293360
## f269 f269  0.36242621
## f421 f421  0.33082845
## f270 f270  0.30184962
## f233 f233  0.28888770
## f144 f144  0.28168502
## f183 f183  0.27265754
## f277 f277  0.26779860
## f54   f54  0.25499490
## f669 f669  0.25422297
## f673 f673  0.24206397
## f94   f94  0.23024905
## f699 f699  0.22849870
## f739 f739  0.22605869
## f238 f238  0.21479759
## f662 f662  0.20769932
## id     id  0.19823772
## f341 f341  0.19511532
## f131 f131  0.19304432
## f524 f524  0.19268205
## f143 f143  0.17733356
## f374 f374  0.17602127
## f628 f628  0.17373100
## f742 f742  0.17295467
## f618 f618  0.16745975
## f198 f198  0.16287088
## f636 f636  0.16065409
## f139 f139  0.14680565
## f150 f150  0.13092641
## f734 f734  0.12842166
## f479 f479  0.12517945
## f99   f99  0.12514775
## f347 f347  0.12115458
## f16   f16  0.11838786
## f638 f638  0.11511888
## f620 f620  0.11085250
## f774 f774  0.11006228
## f90   f90  0.10848512
## f217 f217  0.10490524
## f330 f330  0.10188927
## f590 f590  0.10161796
## f170 f170  0.09917514
## f647 f647  0.09897650
## f637 f637  0.08474235
```

```
## f450 f450  0.08344579
## f567 f567  0.07299141
## f631 f631  0.07080612
## f646 f646  0.06945600
## f587 f587  0.06919687
## f756 f756  0.06851326
## f661 f661  0.06818486
## f129 f129  0.06681447
## f199 f199  0.06623383
## f589 f589  0.06548066
## f349 f349  0.06538572
## f133 f133  0.06353138
## f84   f84  0.06187323
## f653 f653  0.06169639
## f740 f740  0.06085932
## f664 f664  0.05967448
## f775 f775  0.05770165
## f110 f110  0.05569849
## f161 f161  0.05401770
## f533 f533  0.05382205
## f104 f104  0.05281992
## f102 f102  0.05241601
## f649 f649  0.05137703
## f651 f651  0.05067050
## f76   f76  0.05027029
## f412 f412  0.05014326
## f760 f760  0.04916410
## f100 f100  0.04900660
## f203 f203  0.04849675
## f659 f659  0.04803993
## f522 f522  0.04703855
## f80   f80  0.04598116
## f383 f383  0.04440169
## f598 f598  0.04398964
## f609 f609  0.04123584
## f57   f57  0.00000000
## f243 f243  0.00000000
## f249 f249  0.00000000
## f248 f248  0.00000000
## f130 f130  0.00000000
## f188 f188  0.00000000
## f70   f70  0.00000000
## f316 f316  0.00000000
## f65   f65  0.00000000
## f71   f71  0.00000000
## f82   f82  0.00000000
## f385 f385  0.00000000
## f81   f81  0.00000000
## f151 f151  0.00000000
## f153 f153  0.00000000
## f158 f158  0.00000000
## f645 f645  0.00000000
## f340 f340  0.00000000
## f321 f321  0.00000000
```

```
## f384 f384  0.00000000
## f458 f458  0.00000000
## f220 f220  0.00000000
## f218 f218  0.00000000
## f173 f173  0.00000000
## f3     f3  0.00000000
## f289 f289  0.00000000
## f755 f755  0.00000000
## f588 f588  0.00000000
## f331 f331  0.00000000
## f279 f279  0.00000000
## f444 f444  0.00000000
## f601 f601  0.00000000
## f73   f73  0.00000000
## f320 f320  0.00000000
## f350 f350  0.00000000
## f160 f160  0.00000000
## f518 f518  0.00000000
## f425 f425  0.00000000
## f442 f442  0.00000000
## f367 f367  0.00000000
## f725 f725  0.00000000
## f436 f436  0.00000000
## f44   f44  0.00000000
## f733 f733  0.00000000
## f422 f422  0.00000000
## f612 f612  0.00000000
## f288 f288  0.00000000
## f614 f614  0.00000000
## f189 f189  0.00000000
## f358 f358  0.00000000
## f212 f212  0.00000000
## f5     f5  0.00000000
## f403 f403  0.00000000
## f650 f650  0.00000000
## f648 f648  0.00000000
## f378 f378  0.00000000
## f654 f654  0.00000000
## f680 f680  0.00000000
## f285 f285  0.00000000
## f428 f428  0.00000000
## f4     f4  0.00000000
## f679 f679  0.00000000
## f743 f743  0.00000000
## f735 f735  0.00000000
## f526 f526  0.00000000
## f715 f715  0.00000000
## f287 f287  0.00000000
## f627 f627  0.00000000
```

```r
predictions <- predict(gbm_model, newdata = Validation, n.trees = 100, type = "response")

#Threshold value is set to 50 %
```

```r
predictions<-ifelse(predictions>0.5,1,0)

# Building Confusion Matrix

Final_data<-cbind(Validation,predictions)


Final_data$predictions<-as.factor(Final_data$predictions)

Final_data$default<-as.factor(Final_data$default)

confusionMatrix<-confusionMatrix(Final_data$default,Final_data$predictions)
confusionMatrix
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction     0     1
##          0 10920     0
##          1  1079     1
##
##                Accuracy : 0.9101
##                  95% CI : (0.9048, 0.9151)
##     No Information Rate : 0.9999
##     P-Value [Acc > NIR] : 1
##
##                   Kappa : 0.0017
##
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.9100758
##             Specificity : 1.0000000
##          Pos Pred Value : 1.0000000
##          Neg Pred Value : 0.0009259
##              Prevalence : 0.9999167
##          Detection Rate : 0.9100000
##    Detection Prevalence : 0.9100000
##       Balanced Accuracy : 0.9550379
##
##        'Positive' Class : 0
##
```

```r
#Precision<- TP/TP+FP = 0.005%
```

Here Precision was found to be very low .This was expected because from our EDA we have seen that the data has imbalanced classes of default to non-default with almost 1:10 ratio.Therefore we will use stratified sampling for splitting and run the model again

```r
data_sample<-data_new

# Calculate the smallest class size

min_length <- min(table(data_sample$default))
```

```r
# Sample the minority class to the size of the smallest class

balanced_spam <- data_sample %>%group_by(default) %>%sample_n(min_length) %>%ungroup()

# Check the class distribution after balancing

table(balanced_spam$default)
```

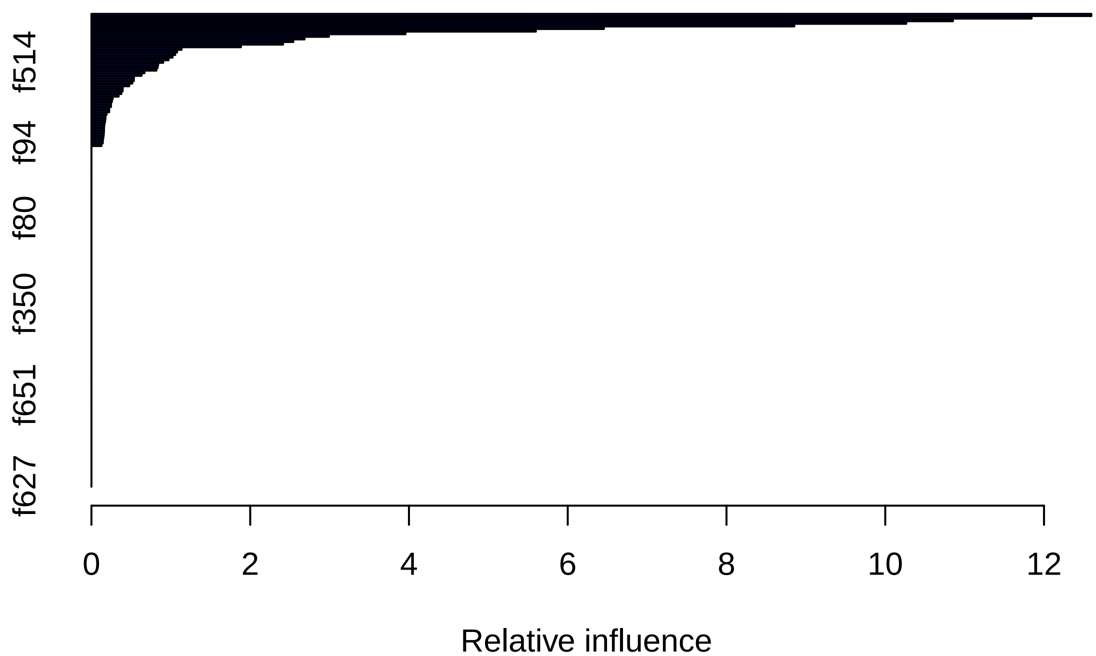
```
##
##    0    1
## 7379 7379
```

Splitting data into 15% test and 85% train within our balanced data

```r
set.seed(6782)


Split_data_sample <- createDataPartition(balanced_spam$default,p=.85,list=FALSE,times=1)

Training_sample <- balanced_spam[Split_data_sample,]

Validation_sample <- balanced_spam[-Split_data_sample,]
```

Building the model again using the new representative dataset

```r
library(gbm)
gbm_model <- gbm(default ~ ., data = Training_sample, distribution = "bernoulli",
                 n.trees = 50, interaction.depth = 5, shrinkage = 0.02,
                 bag.fraction = 0.80, train.fraction = 0.85,
                 n.minobsinnode = 25,cv.folds = 10)
summary(gbm_model)
```



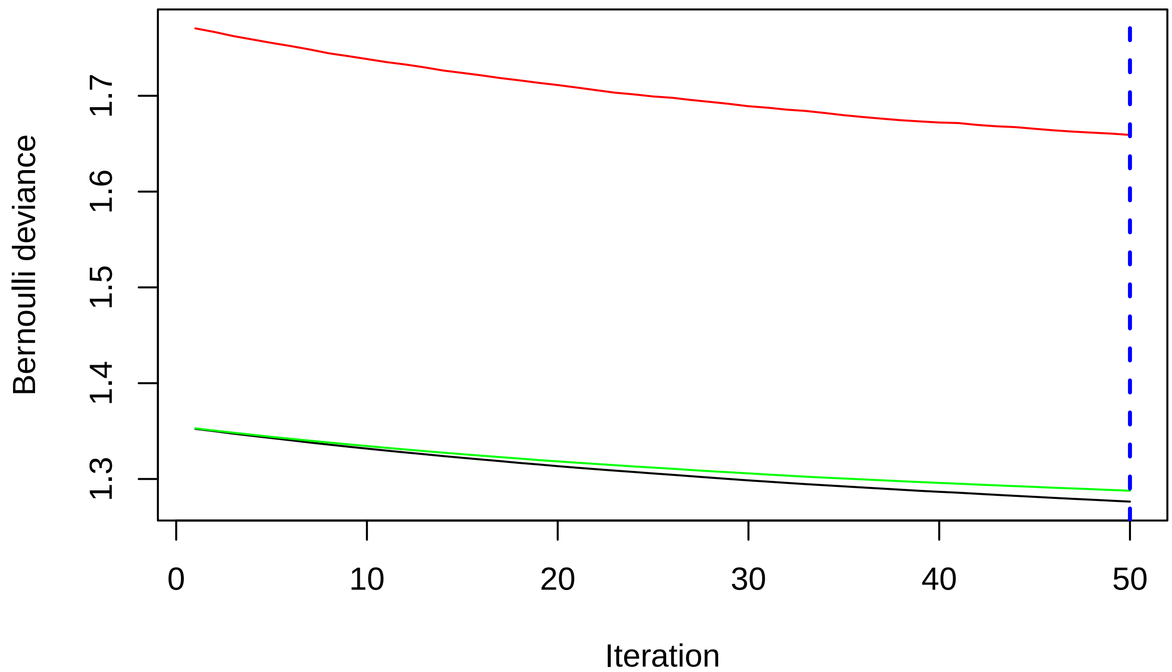

```
##        var    rel.inf
## f630 f630 12.5964053
## f67   f67 11.8433098
## f322 f322 10.8521082
## f64   f64 10.2639996
## f674 f674  8.8543818
## f765 f765  6.4551375
## f32   f32  5.5985196
## f13   f13  3.9561965
## f229 f229  2.9913778
## f19   f19  2.6839004
## f768 f768  2.5424172
## f378 f378  2.4140177
## f260 f260  1.8831030
## f763 f763  1.1353925
## f251 f251  1.0793114
## f268 f268  1.0551172
## f84   f84  1.0223973
## f269 f269  0.9721860
## f514 f514  0.9039666
## f213 f213  0.8399960
## f183 f183  0.8340425
## f270 f270  0.8185144
## f278 f278  0.6673766
## f188 f188  0.6316940
## f221 f221  0.5350747
```

```
## f238 f238  0.5339548
## f65   f65  0.5150226
## f99   f99  0.4761546
## f442 f442  0.3940122
## f233 f233  0.3931776
## f198 f198  0.3766796
## f461 f461  0.3424858
## f411 f411  0.2669712
## f129 f129  0.2587350
## f316 f316  0.2474813
## f100 f100  0.2463719
## f203 f203  0.2231855
## f277 f277  0.2229400
## f434 f434  0.1908153
## f652 f652  0.1778407
## f479 f479  0.1761464
## f272 f272  0.1707954
## f333 f333  0.1633231
## f734 f734  0.1594331
## f420 f420  0.1583693
## f662 f662  0.1574581
## f468 f468  0.1547471
## f699 f699  0.1509614
## f589 f589  0.1443054
## f94   f94  0.1425667
## f261 f261  0.1261224
## f131 f131  0.0000000
## f471 f471  0.0000000
## f57   f57  0.0000000
## f243 f243  0.0000000
## f249 f249  0.0000000
## f760 f760  0.0000000
## f61   f61  0.0000000
## f248 f248  0.0000000
## f536 f536  0.0000000
## f774 f774  0.0000000
## f130 f130  0.0000000
## f756 f756  0.0000000
## f70   f70  0.0000000
## f71   f71  0.0000000
## f82   f82  0.0000000
## f590 f590  0.0000000
## f637 f637  0.0000000
## f598 f598  0.0000000
## f102 f102  0.0000000
## f90   f90  0.0000000
## f620 f620  0.0000000
## f385 f385  0.0000000
## f81   f81  0.0000000
## f110 f110  0.0000000
## f151 f151  0.0000000
## f153 f153  0.0000000
## f158 f158  0.0000000
## f80   f80  0.0000000
```

```
## f631 f631  0.0000000
## f645 f645  0.0000000
## f340 f340  0.0000000
## f321 f321  0.0000000
## f384 f384  0.0000000
## f458 f458  0.0000000
## f450 f450  0.0000000
## f220 f220  0.0000000
## f218 f218  0.0000000
## f173 f173  0.0000000
## f533 f533  0.0000000
## f3     f3  0.0000000
## f330 f330  0.0000000
## f289 f289  0.0000000
## f638 f638  0.0000000
## f170 f170  0.0000000
## f755 f755  0.0000000
## f588 f588  0.0000000
## f331 f331  0.0000000
## f279 f279  0.0000000
## f374 f374  0.0000000
## f150 f150  0.0000000
## f444 f444  0.0000000
## f601 f601  0.0000000
## f341 f341  0.0000000
## f73   f73  0.0000000
## f522 f522  0.0000000
## f775 f775  0.0000000
## f524 f524  0.0000000
## f677 f677  0.0000000
## f609 f609  0.0000000
## f320 f320  0.0000000
## f350 f350  0.0000000
## f160 f160  0.0000000
## f518 f518  0.0000000
## f104 f104  0.0000000
## f425 f425  0.0000000
## f647 f647  0.0000000
## f367 f367  0.0000000
## f143 f143  0.0000000
## f725 f725  0.0000000
## f436 f436  0.0000000
## f44   f44  0.0000000
## f672 f672  0.0000000
## f733 f733  0.0000000
## f422 f422  0.0000000
## f54   f54  0.0000000
## f739 f739  0.0000000
## f76   f76  0.0000000
## f612 f612  0.0000000
## f288 f288  0.0000000
## f646 f646  0.0000000
## f614 f614  0.0000000
## f383 f383  0.0000000
```

```
## f349 f349  0.0000000
## f189 f189  0.0000000
## f161 f161  0.0000000
## f358 f358  0.0000000
## f412 f412  0.0000000
## f673 f673  0.0000000
## f212 f212  0.0000000
## f5     f5  0.0000000
## f403 f403  0.0000000
## f669 f669  0.0000000
## f650 f650  0.0000000
## f648 f648  0.0000000
## f618 f618  0.0000000
## f651 f651  0.0000000
## f144 f144  0.0000000
## f199 f199  0.0000000
## f654 f654  0.0000000
## f653 f653  0.0000000
## f661 f661  0.0000000
## f664 f664  0.0000000
## f680 f680  0.0000000
## f649 f649  0.0000000
## f740 f740  0.0000000
## f285 f285  0.0000000
## f428 f428  0.0000000
## f742 f742  0.0000000
## f4     f4  0.0000000
## f679 f679  0.0000000
## f587 f587  0.0000000
## f139 f139  0.0000000
## id     id  0.0000000
## f743 f743  0.0000000
## f202 f202  0.0000000
## f636 f636  0.0000000
## f133 f133  0.0000000
## f146 f146  0.0000000
## f421 f421  0.0000000
## f470 f470  0.0000000
## f16   f16  0.0000000
## f735 f735  0.0000000
## f526 f526  0.0000000
## f217 f217  0.0000000
## f715 f715  0.0000000
## f287 f287  0.0000000
## f628 f628  0.0000000
## f347 f347  0.0000000
## f659 f659  0.0000000
## f567 f567  0.0000000
## f627 f627  0.0000000
```

```
cv_error<-gbm.perf(gbm_model,method="cv")
```




```
cv_error
```

```
## [1] 50
```

Predicition on Validation data

```
predictions_sample <- predict(gbm_model, newdata = Validation_sample, n.trees = 50, type = "response")
predictions_sample
```

```
##     [1] 0.3512700 0.4583707 0.2847233 0.3483735 0.3073960 0.5240308 0.3334525
##     [8] 0.3236956 0.5142390 0.3808043 0.2382272 0.3549159 0.2773079 0.4165826
##    [15] 0.4804397 0.3539431 0.4292882 0.4366508 0.4090311 0.2776910 0.3649510
##    [22] 0.4287243 0.3638741 0.3848456 0.2656934 0.3978761 0.3468707 0.4608265
##    [29] 0.4259265 0.4345325 0.5081809 0.5265465 0.4204526 0.4574839 0.5177636
##    [36] 0.3474000 0.3251357 0.4866832 0.3903400 0.3943205 0.3954220 0.3082572
##    [43] 0.5294977 0.3130981 0.3250128 0.3831457 0.4857314 0.3736070 0.4369706
##    [50] 0.4545811 0.4168306 0.4666406 0.3242163 0.4670334 0.3719814 0.4571148
##    [57] 0.3192908 0.4356544 0.3689215 0.4407491 0.4237964 0.2394223 0.4850796
##    [64] 0.3786924 0.5133822 0.2450227 0.5088532 0.4428922 0.3557342 0.3810464
##    [71] 0.3931159 0.2447817 0.4356498 0.3438653 0.4530715 0.5067687 0.4597439
##    [78] 0.2414107 0.3125177 0.4058313 0.2768254 0.3917835 0.4209054 0.4866623
##    [85] 0.4061073 0.4949465 0.4915450 0.4192337 0.3712030 0.4803570 0.3277115
##    [92] 0.4329843 0.2942027 0.2519695 0.4699136 0.4793094 0.3644111 0.3999837
##    [99] 0.4840759 0.3231180 0.4540910 0.3720394 0.4381432 0.5065283 0.3626155
##   [106] 0.4560494 0.3660617 0.3245538 0.3592933 0.4132843 0.3195020 0.3948955
```

```
## [113] 0.3271387 0.4742971 0.3495219 0.4261178 0.4395426 0.3385281 0.3933607
## [120] 0.2936933 0.3910811 0.4023028 0.4940776 0.4924153 0.2753641 0.3671475
## [127] 0.2382272 0.4638132 0.3628118 0.2969628 0.3220651 0.4142224 0.3894989
## [134] 0.4570212 0.5248322 0.3528418 0.3912169 0.4161747 0.3927500 0.3869069
## [141] 0.2400447 0.5055612 0.3948634 0.4043886 0.5069293 0.4551695 0.2420100
## [148] 0.5141201 0.3497600 0.4619601 0.4375734 0.4821414 0.3456718 0.4345012
## [155] 0.4790800 0.3116946 0.3479682 0.4155604 0.4718020 0.3605601 0.3925107
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## [1527] 0.4870699 0.3786128 0.4150528 0.3758158 0.4861151 0.5044462 0.4123774
## [1534] 0.4352723 0.4634393 0.4541350 0.3873280 0.5201398 0.4542791 0.3741547
## [1541] 0.4993524 0.4261520 0.3301408 0.4439425 0.4767146 0.4073490 0.5212280
## [1548] 0.4480909 0.4535537 0.3942577 0.3043656 0.4668100 0.5021309 0.5200084
## [1555] 0.5104996 0.3113638 0.4787613 0.3270482 0.3868366 0.4342617 0.4466205
## [1562] 0.4210531 0.4049825 0.2731248 0.5175241 0.4612187 0.4485574 0.4015450
## [1569] 0.5250513 0.4125412 0.4622647 0.5058962 0.4793798 0.4800249 0.5260967
## [1576] 0.4084730 0.4377917 0.2884272 0.4997759 0.4228947 0.5008051 0.5089459
## [1583] 0.4477784 0.4644696 0.5277670 0.3754511 0.4497152 0.4576562 0.4418189
## [1590] 0.3477611 0.4598618 0.5248961 0.4356735 0.4369958 0.5006402 0.5109260
## [1597] 0.4053919 0.4949930 0.3585773 0.2999635 0.3372020 0.4069694 0.5046490
## [1604] 0.4020873 0.5191684 0.4972065 0.5283023 0.5223960 0.4129596 0.5200084
## [1611] 0.4240173 0.5212058 0.3407619 0.4179764 0.4457141 0.4936089 0.3481961
## [1618] 0.4185368 0.5221738 0.2867243 0.3462467 0.4661301 0.4499796 0.5191380
```

```
## [1625] 0.5223960 0.5277670 0.3838713 0.3979241 0.3845763 0.5110165 0.4577745
## [1632] 0.4040396 0.5215344 0.5054188 0.3318778 0.4956593 0.3318281 0.4155314
## [1639] 0.3149034 0.5001885 0.3912766 0.5217243 0.4475816 0.3905089 0.5031136
## [1646] 0.4876507 0.4100389 0.3895370 0.5179508 0.4859382 0.5297480 0.4551478
## [1653] 0.4995104 0.3943315 0.3514473 0.4593389 0.5277670 0.3889434 0.4639519
## [1660] 0.5027747 0.4732947 0.4220048 0.3413078 0.3152034 0.4748484 0.4910379
## [1667] 0.4533196 0.5188056 0.4803517 0.4032232 0.3645862 0.3862831 0.4348337
## [1674] 0.4322972 0.5236356 0.4090486 0.5078071 0.4520435 0.4525950 0.3569424
## [1681] 0.5214238 0.5150377 0.4960598 0.3708088 0.4985417 0.4414871 0.3694571
## [1688] 0.4267901 0.4002712 0.4121760 0.4936437 0.3212546 0.4305096 0.5135035
## [1695] 0.3963896 0.4200318 0.2611146 0.5074820 0.5240308 0.5265711 0.4581389
## [1702] 0.4250385 0.4119115 0.5183511 0.4436773 0.4007029 0.5100954 0.4844638
## [1709] 0.5200641 0.4201751 0.5142041 0.4373039 0.5212571 0.4577064 0.3610803
## [1716] 0.4174009 0.4095036 0.3869852 0.3948178 0.3852682 0.3714093 0.4446295
## [1723] 0.5173112 0.3904721 0.3974721 0.5201488 0.4920389 0.4528984 0.4863321
## [1730] 0.4074186 0.4276824 0.3266865 0.4727408 0.4367946 0.4028661 0.4061248
## [1737] 0.4786525 0.4719120 0.3039735 0.3154286 0.3594266 0.5219193 0.4780580
## [1744] 0.4617646 0.5051834 0.5091959 0.5176695 0.4759463 0.3992711 0.5196317
## [1751] 0.3946399 0.4655299 0.4052073 0.4082876 0.2933727 0.4235894 0.5026665
## [1758] 0.4751446 0.3332413 0.4815183 0.4433187 0.3365595 0.3697489 0.3575471
## [1765] 0.3903277 0.4659068 0.4250650 0.3849458 0.5014552 0.3735846 0.4364550
## [1772] 0.4384164 0.3653702 0.4515301 0.4463038 0.5198717 0.5223960 0.3550373
## [1779] 0.5097759 0.4289733 0.5107439 0.3386797 0.4360107 0.3130279 0.3775043
## [1786] 0.5277670 0.4310861 0.3835082 0.4718020 0.4545102 0.4611574 0.5120182
## [1793] 0.5213635 0.4951256 0.4951466 0.4042681 0.4836244 0.4565611 0.3594547
## [1800] 0.3143242 0.3770253 0.4208540 0.4342203 0.5080937 0.4118950 0.4203947
## [1807] 0.4976509 0.4437480 0.4079953 0.5107307 0.4066230 0.4372846 0.4901143
## [1814] 0.4497604 0.5167847 0.5118191 0.3858443 0.4820172 0.5091473 0.4248919
## [1821] 0.4951290 0.3550760 0.4045657 0.3890482 0.5098001 0.4184643 0.4440948
## [1828] 0.4946667 0.5144490 0.3529215 0.5032972 0.5021548 0.4548017 0.5240966
## [1835] 0.4556950 0.4654161 0.3479853 0.4326849 0.3824252 0.5163304 0.4553038
## [1842] 0.4397953 0.5064623 0.4890727 0.3207490 0.3889101 0.4896468 0.4343006
## [1849] 0.3585623 0.4165826 0.4770064 0.3850337 0.5122684 0.3064394 0.4651830
## [1856] 0.4296355 0.4359713 0.5091691 0.4309280 0.4026815 0.5277670 0.3087265
## [1863] 0.3013120 0.4458148 0.4493573 0.4091712 0.4703479 0.5163295 0.4979158
## [1870] 0.4475638 0.4292322 0.4594780 0.4463142 0.5183919 0.4983775 0.4317023
## [1877] 0.3657432 0.3905366 0.4824330 0.3778525 0.4990532 0.3907164 0.4461972
## [1884] 0.3572679 0.4942015 0.4191359 0.4602716 0.3728530 0.4065995 0.4723876
## [1891] 0.2925247 0.4670268 0.3980566 0.3557082 0.3273305 0.3402681 0.4465846
## [1898] 0.5029980 0.5103263 0.4446621 0.4311359 0.4499107 0.5184136 0.4482264
## [1905] 0.3435591 0.4036853 0.2719229 0.5233632 0.3722168 0.4930096 0.5241212
## [1912] 0.4921866 0.5037354 0.3285624 0.3962073 0.4753412 0.5212571 0.3797314
## [1919] 0.4667473 0.4926130 0.3589247 0.4972083 0.5169122 0.4541131 0.3876446
## [1926] 0.4602626 0.4043588 0.4065517 0.5029455 0.3572730 0.3834898 0.5199008
## [1933] 0.3350587 0.2978913 0.2526993 0.5236356 0.3097355 0.4921671 0.4395644
## [1940] 0.4263772 0.4014018 0.5100863 0.3788018 0.4609233 0.4616837 0.4620810
## [1947] 0.4139310 0.4300873 0.4401410 0.4395842 0.4471475 0.4729101 0.4806438
## [1954] 0.4412190 0.4310938 0.5018921 0.4959105 0.4834192 0.5249707 0.4641964
## [1961] 0.3514369 0.3705732 0.3748734 0.5212058 0.4788730 0.4229896 0.4744556
## [1968] 0.4517719 0.4101421 0.5067991 0.5106667 0.4578660 0.3904136 0.5052157
## [1975] 0.5128578 0.4472007 0.3975229 0.3897610 0.5065958 0.5018276 0.5002392
## [1982] 0.4833914 0.5253177 0.4004174 0.4423822 0.4420089 0.5048214 0.3103310
## [1989] 0.4317535 0.5189537 0.3896964 0.3432867 0.4171938 0.5253503 0.5021290
## [1996] 0.3344425 0.5083434 0.4410658 0.3546063 0.4789949 0.3014026 0.3965599
```

```
## [2003] 0.4080739 0.3797217 0.4116581 0.3976703 0.4255272 0.4888568 0.3785775
## [2010] 0.3933660 0.4965192 0.5149856 0.4465957 0.4865149 0.5121116 0.2630291
## [2017] 0.4644833 0.3106212 0.4749776 0.5155384 0.3217429 0.3662761 0.4955474
## [2024] 0.4803587 0.4065280 0.4721465 0.3171899 0.4692601 0.5126628 0.5004642
## [2031] 0.5209020 0.3319260 0.4865726 0.3480320 0.3883719 0.3990147 0.4492459
## [2038] 0.4919254 0.3072939 0.5144350 0.5212571 0.4141456 0.4096180 0.4805248
## [2045] 0.4533987 0.5183949 0.3715966 0.5200974 0.4217298 0.4834091 0.4138096
## [2052] 0.4916418 0.4015661 0.4077723 0.3907653 0.4963692 0.3437809 0.4132648
## [2059] 0.3515854 0.4943797 0.3064700 0.5082259 0.3397400 0.3745714 0.4791788
## [2066] 0.3936707 0.4192036 0.3846652 0.5029413 0.4880423 0.4537894 0.5034929
## [2073] 0.4455376 0.4906925 0.4775747 0.5086723 0.5223960 0.5273607 0.4916731
## [2080] 0.5256378 0.4330602 0.4453570 0.3882133 0.3914404 0.4537279 0.4584422
## [2087] 0.3646563 0.3952638 0.4421872 0.4982729 0.4320770 0.4382397 0.3605990
## [2094] 0.4065666 0.3058969 0.3692252 0.3551358 0.4213501 0.2862315 0.3340529
## [2101] 0.4751144 0.3689430 0.4484602 0.4249923 0.5210601 0.4589301 0.5191676
## [2108] 0.3599598 0.4044857 0.4961386 0.4889267 0.5178989 0.3091333 0.4866749
## [2115] 0.5054158 0.3763911 0.4417171 0.5050683 0.4972325 0.4469730 0.3226085
## [2122] 0.5178989 0.4246372 0.4338195 0.4818553 0.4342770 0.5146331 0.4655531
## [2129] 0.4029186 0.4842781 0.4838781 0.4835916 0.5172865 0.4314756 0.4498697
## [2136] 0.2909402 0.5200598 0.3935388 0.4485244 0.3052052 0.5247393 0.4571644
## [2143] 0.4074055 0.3923029 0.4995140 0.4851179 0.3313621 0.5073830 0.4962912
## [2150] 0.4742469 0.4311456 0.4371466 0.3165552 0.3186550 0.4236628 0.4549449
## [2157] 0.5150992 0.3718849 0.3603331 0.3254122 0.4563500 0.2840436 0.5170422
## [2164] 0.4272580 0.4501518 0.3770963 0.5212058 0.4429468 0.3739283 0.3820310
## [2171] 0.4395728 0.2811430 0.4440070 0.4223111 0.3893688 0.4688476 0.4749514
## [2178] 0.4301926 0.4991201 0.4329813 0.4983901 0.4553344 0.5249813 0.4709925
## [2185] 0.5142212 0.5241286 0.2514505 0.4742971 0.5057014 0.3521234 0.3501947
## [2192] 0.3102723 0.3894873 0.4096069 0.3984634 0.4472556 0.4352035 0.3944463
## [2199] 0.4560962 0.3186417 0.4233926 0.4318051 0.4198159 0.5223960 0.4284945
## [2206] 0.4902417 0.4681692 0.4494077 0.5265711 0.3982494 0.4162528 0.4262469
```

```r
# Here the threshold value is set to be 35% ,that we are becoming more pickier while selecting customer

predictions_sample<-ifelse(predictions_sample>0.35,1,0)


Final_data_sample<-cbind(Validation_sample,predictions_sample)


Final_data_sample$predictions_sample<-as.factor(Final_data_sample$predictions_sample)

Final_data_sample$default<-as.factor(Final_data_sample$default)

#Building Confusion Matrix

confusionMatrix_sample<-confusionMatrix(Final_data_sample$default,Final_data_sample$predictions_sample)

confusionMatrix_sample
```

```
## Confusion Matrix and Statistics
##
##            Reference
## Prediction   0   1
##          0 319 787
```

```
##          1 120 986
##
##                Accuracy : 0.59
##                  95% CI : (0.5691, 0.6106)
##     No Information Rate : 0.8015
##     P-Value [Acc > NIR] : 1
##
##                   Kappa : 0.1799
##
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.7267
##             Specificity : 0.5561
##          Pos Pred Value : 0.2884
##          Neg Pred Value : 0.8915
##              Prevalence : 0.1985
##          Detection Rate : 0.1442
##    Detection Prevalence : 0.5000
##       Balanced Accuracy : 0.6414
##
##        'Positive' Class : 0
##
```

Calculating Precision for the new model

Precision<-TP/(TP+FP)= 1004/(1004+102)=90.77%

Running the model on test data

```r
Test_data<-read.csv("testv3.csv")

Test_Prediction<-predict(gbm_model, newdata = Test_data, n.trees = 50, type = "response")


Test_Prediction<-ifelse(Test_Prediction>0.35,1,0)


Test_datafile<- cbind(Test_data,Test_Prediction)


Default_test<- subset(Test_datafile, Test_datafile$Test_Prediction == 1)


#Writing data frame to a new csv file containing the list of customers who defaults the loan

#write.csv(Default_test,file="defaulted_test_customers.csv")
```