# BankChurners

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## Dataset 1

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

```
## Warning: package 'tidyverse' was built under R version 4.2.2
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.4.0      v purrr   0.3.5
## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.3      v forcats 0.5.2
```

```
## Warning: package 'ggplot2' was built under R version 4.2.2
```

```
## Warning: package 'tibble' was built under R version 4.2.2
```

```
## Warning: package 'tidyr' was built under R version 4.2.2
```

```
## Warning: package 'readr' was built under R version 4.2.2
```

```
## Warning: package 'purrr' was built under R version 4.2.2
```

```
## Warning: package 'dplyr' was built under R version 4.2.2
```

```
## Warning: package 'forcats' was built under R version 4.2.2
```

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

```r
library(readr)
library(dplyr)
library("Amelia")
```

```
## Warning: package 'Amelia' was built under R version 4.2.2
```

```
## Loading required package: Rcpp
```

```
## Warning: package 'Rcpp' was built under R version 4.2.2
```

```
## ##
## ## Amelia II: Multiple Imputation
## ## (Version 1.8.0, built: 2021-05-26)
## ## Copyright (C) 2005-2023 James Honaker, Gary King and Matthew Blackwell
## ## Refer to http://gking.harvard.edu/amelia/ for more information
## ##
```

```r
library(caTools) # for data partioning
```

```
## Warning: package 'caTools' was built under R version 4.2.2
```

```r
library(modelr)
```

```
## Warning: package 'modelr' was built under R version 4.2.2
```

```r
library(readr)
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.2.2
```

```
## Loading required package: lattice
##
## Attaching package: 'caret'
##
## The following object is masked from 'package:purrr':
##
##     lift
```

```r
library(e1071)
```

```
## Warning: package 'e1071' was built under R version 4.2.2
```

```r
library(tidymodels)
```

```
## Warning: package 'tidymodels' was built under R version 4.2.2
```

```
## -- Attaching packages ------------------------------------- tidymodels 1.0.0 --
## v broom        1.0.1     v rsample      1.1.1
## v dials        1.1.0     v tune         1.0.1
## v infer        1.0.4     v workflows    1.1.2
## v modeldata    1.0.1     v workflowsets 1.0.0
## v parsnip      1.0.3     v yardstick    1.1.0
## v recipes      1.0.3
```

```
## Warning: package 'broom' was built under R version 4.2.2
```

```
## Warning: package 'dials' was built under R version 4.2.2

## Warning: package 'scales' was built under R version 4.2.2

## Warning: package 'infer' was built under R version 4.2.2

## Warning: package 'modeldata' was built under R version 4.2.2

## Warning: package 'parsnip' was built under R version 4.2.2

## Warning: package 'recipes' was built under R version 4.2.2

## Warning: package 'rsample' was built under R version 4.2.2

## Warning: package 'tune' was built under R version 4.2.2

## Warning: package 'workflows' was built under R version 4.2.2

## Warning: package 'workflowsets' was built under R version 4.2.2

## Warning: package 'yardstick' was built under R version 4.2.2

## -- Conflicts ---------------------------------------- tidymodels_conflicts() --
## x broom::bootstrap()     masks modelr::bootstrap()
## x scales::discard()      masks purrr::discard()
## x dplyr::filter()        masks stats::filter()
## x recipes::fixed()       masks stringr::fixed()
## x dplyr::lag()           masks stats::lag()
## x caret::lift()          masks purrr::lift()
## x yardstick::mae()       masks modelr::mae()
## x yardstick::mape()      masks modelr::mape()
## x rsample::permutations()  masks e1071::permutations()
## x rsample::populate()    masks Rcpp::populate()
## x yardstick::precision() masks caret::precision()
## x yardstick::recall()    masks caret::recall()
## x yardstick::rmse()      masks modelr::rmse()
## x yardstick::sensitivity() masks caret::sensitivity()
## x yardstick::spec()      masks readr::spec()
## x yardstick::specificity() masks caret::specificity()
## x recipes::step()        masks stats::step()
## x tune::tune()           masks parsnip::tune(), e1071::tune()
## * Dig deeper into tidy modeling with R at https://www.tmwr.org
```

```
library(pROC)
```

```
## Warning: package 'pROC' was built under R version 4.2.2

## Type 'citation("pROC")' for a citation.
##
## Attaching package: 'pROC'
##
## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```
# load & inspect dataset
cc_raw <- read.csv("D:\\Data\\BankChurners.csv")

# inspect dataset
dim(cc_raw)
```

```
## [1] 10127    23
```

```
head(cc_raw)
```

```
##   CLIENTNUM    Attrition_Flag Customer_Age Gender Dependent_count
## 1 768805383 Existing Customer           45      M               3
## 2 818770008 Existing Customer           49      F               5
## 3 713982108 Existing Customer           51      M               3
## 4 769911858 Existing Customer           40      F               4
## 5 709106358 Existing Customer           40      M               3
## 6 713061558 Existing Customer           44      M               2
##   Education_Level Marital_Status Income_Category Card_Category Months_on_book
## 1     High School        Married    $60K - $80K          Blue             39
## 2        Graduate         Single Less than $40K          Blue             44
## 3        Graduate        Married   $80K - $120K          Blue             36
## 4     High School        Unknown Less than $40K          Blue             34
## 5      Uneducated        Married    $60K - $80K          Blue             21
## 6        Graduate        Married    $40K - $60K          Blue             36
##   Total_Relationship_Count Months_Inactive_12_mon Contacts_Count_12_mon
## 1                        5                      1                     3
## 2                        6                      1                     2
## 3                        4                      1                     0
## 4                        3                      4                     1
## 5                        5                      1                     0
## 6                        3                      1                     2
##   Credit_Limit Total_Revolving_Bal Avg_Open_To_Buy Total_Amt_Chng_Q4_Q1
## 1        12691                 777           11914                1.335
## 2         8256                 864            7392                1.541
## 3         3418                   0            3418                2.594
## 4         3313                2517             796                1.405
## 5         4716                   0            4716                2.175
## 6         4010                1247            2763                1.376
##   Total_Trans_Amt Total_Trans_Ct Total_Ct_Chng_Q4_Q1 Avg_Utilization_Ratio
## 1            1144             42               1.625                 0.061
## 2            1291             33               3.714                 0.105
## 3            1887             20               2.333                 0.000
## 4            1171             20               2.333                 0.760
## 5             816             28               2.500                 0.000
## 6            1088             24               0.846                 0.311
##   Naive_Bayes_Classifier_Attrition_Flag_Card_Category_Contacts_Count_12_mon_Dependent_count_Education
## 1
## 2
## 3
## 4
## 5
## 6
```

```
##   Naive_Bayes_Classifier_Attrition_Flag_Card_Category_Contacts_Count_12_mon_Dependent_count_Educatio
## 1
## 2
## 3
## 4
## 5
## 6
```

```r
# missing values
missing_rate_cc <- sapply(cc_raw, function(x) sum(is.na(x))/nrow(cc_raw))
missing_rate_cc <- data.frame(missing_rate = missing_rate_cc)
missing_rate_cc
```

```
##
## CLIENTNUM
## Attrition_Flag
## Customer_Age
## Gender
## Dependent_count
## Education_Level
## Marital_Status
## Income_Category
## Card_Category
## Months_on_book
## Total_Relationship_Count
## Months_Inactive_12_mon
## Contacts_Count_12_mon
## Credit_Limit
## Total_Revolving_Bal
## Avg_Open_To_Buy
## Total_Amt_Chng_Q4_Q1
## Total_Trans_Amt
## Total_Trans_Ct
## Total_Ct_Chng_Q4_Q1
## Avg_Utilization_Ratio
## Naive_Bayes_Classifier_Attrition_Flag_Card_Category_Contacts_Count_12_mon_Dependent_count_Education_L
## Naive_Bayes_Classifier_Attrition_Flag_Card_Category_Contacts_Count_12_mon_Dependent_count_Education_L
```

```r
# arrange(missing_rate_cc, -missing_rate) # arrange missing values in decending order
```

There is no missing values in the data.

```r
# Preprocess Data
# selected the columns we care about
cc_prepr <- cc_raw %>% select(Customer_Age,Gender,Dependent_count,Education_Level,Marital_Status,Income_
#---------------------------
# Lets see which distinct types there are
(distinct(cc_prepr, Income_Category))  # 6 types:$60K - $80K, Less than $40K ,$80K - $120K  ,$40K - $60
```

```
##   Income_Category
## 1     $60K - $80K
## 2   Less than $40K
```

```
## 3      $80K - $120K
## 4       $40K - $60K
## 5            $120K +
## 6           Unknown

(distinct(cc_prepr, Marital_Status))  # 4 types:  Married, Single, Divorced, Unknown


##   Marital_Status
## 1         Married
## 2          Single
## 3         Unknown
## 4        Divorced

(distinct(cc_prepr, Card_Category))  # 4 types:  Blue, Gold, Siler, Platinum


##   Card_Category
## 1          Blue
## 2          Gold
## 3        Silver
## 4      Platinum
```

```r
#----------------------------
# Drop all the "unknown" rows from Marital_Status & Income_Category
# 82x9, 82 rows must remove these rows
cc_prepr <- cc_prepr %>% select(Customer_Age,Gender,Dependent_count,Education_Level,Marital_Status,Incom
#----------------------------
# shorten target variable Attrition_Flag for faster References
cc_prepr$Attrition_Flag[cc_prepr$Attrition_Flag == "Existing Customer"] <- "Current"
cc_prepr$Attrition_Flag[cc_prepr$Attrition_Flag == "Attrited Customer"] <- "Exited"

# convert categorical data into factor
categorical_cols <- c("Gender", "Education_Level", "Marital_Status", "Income_Category", "Card_Category"
cc_prepr[,categorical_cols] <- lapply(cc_prepr[, categorical_cols], factor)

str(cc_prepr)
```

```
## 'data.frame':    7081 obs. of  9 variables:
##  $ Customer_Age   : int  45 49 51 40 44 37 48 56 57 48 ...
##  $ Gender         : Factor w/ 2 levels "F","M": 2 1 2 2 2 2 2 2 1 2 ...
##  $ Dependent_count: int  3 5 3 3 2 3 2 1 2 4 ...
##  $ Education_Level: Factor w/ 6 levels "College","Doctorate",..: 4 3 3 6 3 6 3 1 3 5 ...
##  $ Marital_Status : Factor w/ 3 levels "Divorced","Married",..: 2 3 2 2 2 3 3 3 2 3 ...
##  $ Income_Category: Factor w/ 5 levels "$120K +","$40K - $60K",..: 3 5 4 3 2 3 4 4 5 4 ...
##  $ Card_Category  : Factor w/ 4 levels "Blue","Gold",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ Credit_Limit   : num  12691 8256 3418 4716 4010 ...
##  $ Attrition_Flag : Factor w/ 2 levels "Current","Exited": 1 1 1 1 1 1 1 1 1 1 ...
```

```r
#----------------------------
# DATA PARTITIONING
#----------------------------
# Class Imbalance
# Inspect the initial distribution of 2 class: Current/Exited in the dataset
table(cc_prepr$Attrition_Flag)  # 84% of the data is in Current Set, which is highly imbalanced
```

```
##
## Current  Exited
##    5968    1113
```

```r
# Train/Test Split & Upsampling
# In this case of very imbalanced outcomes - like a rare churners dataset. When splitting randomly, we
# We will use the initial_split() function to make sure the distribution of 2 classes in train and test

## Balance Split
set.seed(9888)
# Create the balanced data split
exited_split <- initial_split(cc_prepr, prop = 0.75, strata = Attrition_Flag)
# Proportion of 'Exited' outcomes in the training data
counts_train <- table(training(exited_split)$Attrition_Flag)
prop_yes_train <- counts_train["Exited"] / sum(counts_train)
# Proportion of 'Exited' outcomes in the test data
counts_test <- table(testing(exited_split)$Attrition_Flag)
prop_yes_test <- counts_test["Exited"] / sum(counts_test)
# print out to make sure the proportion of 2 class in both train/test are similar
paste("Proportion of positive outcomes in training set:", round(prop_yes_train, 2))
```

```
## [1] "Proportion of positive outcomes in training set: 0.16"
```

```r
paste("Proportion of positive outcomes in test set:", round(prop_yes_test, 2))
```

```
## [1] "Proportion of positive outcomes in test set: 0.16"
```

```r
train_balanced <- training(exited_split)
test_balanced <- testing(exited_split)

## upsample
# Here, I will use the upSample function from the `caret` package to perform upsampling technique.
trainup<-upSample(x=train_balanced[,-ncol(train_balanced)],
                  y=train_balanced$Attrition_Flag, yname = "Attrition_Flag")
table(trainup$Attrition_Flag)   # after upsample, Current/Exited ratio are improved from 5968/1113 to 44
```

```
##
## Current  Exited
##    4476    4476
```

```r
#----------------------------
#BUILD, PREDICT &  EVALUATE the Model
#----------------------------
# BUILD
#----------------------------
# Baseline Accuracy
# Let's evaluate the model further,
# Since the majority class of the target (Y) variable has a #proportion of 0.84, the baseline accuracy
prop.table(table(cc_prepr$Attrition_Flag))
```

```
##
##   Current    Exited
## 0.8428188 0.1571812
```

```r
## Model 1: General Linear Method
model_glm <- glm(Attrition_Flag ~ . , family="binomial",data = trainup)
summary(model_glm)
```

```
##
## Call:
## glm(formula = Attrition_Flag ~ ., family = "binomial", data = trainup)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -1.66528  -1.16991  -0.03705   1.17094   1.42914
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   8.287e-01  2.050e-01   4.043 5.28e-05 ***
## Customer_Age                  2.543e-03  2.678e-03   0.950  0.34236
## GenderM                      -2.621e-01  7.716e-02  -3.398  0.00068 ***
## Dependent_count              -4.546e-03  1.685e-02  -0.270  0.78727
## Education_LevelDoctorate      1.752e-01  1.112e-01   1.576  0.11506
## Education_LevelGraduate       2.885e-02  7.109e-02   0.406  0.68490
## Education_LevelHigh School    6.136e-02  7.594e-02   0.808  0.41904
## Education_LevelPost-Graduate  2.142e-01  1.056e-01   2.030  0.04240 *
## Education_LevelUneducated     8.313e-02  8.065e-02   1.031  0.30264
## Marital_StatusMarried        -2.742e-01  7.852e-02  -3.492  0.00048 ***
## Marital_StatusSingle         -1.230e-01  7.920e-02  -1.553  0.12038
## Income_Category$40K - $60K   -7.104e-01  1.094e-01  -6.496 8.23e-11 ***
## Income_Category$60K - $80K   -5.862e-01  9.792e-02  -5.986 2.15e-09 ***
## Income_Category$80K - $120K  -2.292e-01  9.012e-02  -2.543  0.01098 *
## Income_CategoryLess than $40K -6.847e-01  1.186e-01  -5.773 7.77e-09 ***
## Card_CategoryGold             4.820e-01  2.015e-01   2.392  0.01675 *
## Card_CategoryPlatinum         1.026e+00  4.725e-01   2.172  0.02983 *
## Card_CategorySilver           2.532e-01  1.121e-01   2.260  0.02385 *
## Credit_Limit                 -1.958e-05  3.650e-06  -5.366 8.07e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 12410  on 8951  degrees of freedom
## Residual deviance: 12312  on 8933  degrees of freedom
## AIC: 12350
##
## Number of Fisher Scoring iterations: 4
```

```r
# Generate predictions
pred_glm <- predict(model_glm, newdata = test_balanced)
# Set cut-off threshold = 0.5
pred_glm <- ifelse(pred_glm>=0.5, "Exited", "Current")

# Add the true outcomes
pred_combined_glm <- data.frame(predictions = factor(pred_glm))
pred_combined_glm$true_class <- factor(test_balanced$Attrition_Flag)
```

```r
# Print the first lines of the result
pred_combined_glm
```

```
##       predictions true_class
## 10        Current    Current
## 12        Current    Current
## 13        Current     Exited
## 15        Current    Current
## 18        Current    Current
## 19        Current    Current
## 26        Current    Current
## 28        Current    Current
## 30        Current    Current
## 31        Current    Current
## 33        Current    Current
## 35        Current    Current
## 40        Current    Current
## 43        Current    Current
## 44        Current    Current
## 46        Current    Current
## 54        Current    Current
## 55        Current    Current
## 56        Current    Current
## 57        Current    Current
## 58        Current    Current
## 60        Current    Current
## 63        Current    Current
## 65        Current    Current
## 68        Current    Current
## 71        Current    Current
## 72        Current    Current
## 80        Current    Current
## 90        Current     Exited
## 91        Current    Current
## 100       Current     Exited
## 105       Current    Current
## 107       Current    Current
## 113       Current    Current
## 126       Current    Current
## 129       Current    Current
## 130       Current    Current
## 131       Current    Current
## 134       Current    Current
## 135       Current    Current
## 142       Current    Current
## 143       Current    Current
## 144       Current    Current
## 147       Current    Current
## 153       Current     Exited
## 164       Current    Current
## 168       Current    Current
## 172       Current    Current
## 173       Current     Exited
```

```
## 175     Current     Current
## 176     Current     Current
## 179     Current     Current
## 182     Current      Exited
## 191     Current     Current
## 192     Current     Current
## 196     Current      Exited
## 197     Current     Current
## 199     Current      Exited
## 214     Current      Exited
## 215     Current     Current
## 222     Current     Current
## 230     Current     Current
## 231     Current     Current
## 233     Current     Current
## 237     Current     Current
## 241     Current     Current
## 244     Current     Current
## 245     Current     Current
## 250     Current     Current
## 261     Current     Current
## 274     Current     Current
## 276     Current     Current
## 278     Current     Current
## 280     Current     Current
## 284     Current     Current
## 287     Current     Current
## 289     Current     Current
## 291     Current     Current
## 297     Current     Current
## 301     Current     Current
## 308     Current     Current
## 309     Current     Current
## 311     Current      Exited
## 317     Current     Current
## 320     Current     Current
## 327     Current      Exited
## 328     Current     Current
## 331     Current     Current
## 332     Current     Current
## 335     Current     Current
## 337     Current     Current
## 343     Current     Current
## 353     Current     Current
## 356     Current     Current
## 357     Current     Current
## 358     Current     Current
## 365     Current     Current
## 371     Current     Current
## 377     Current     Current
## 378     Current     Current
## 384     Current     Current
## 390     Current     Current
## 395     Current     Current
```

```
## 398       Current       Exited
## 400       Current      Current
## 401       Current      Current
## 405       Current      Current
## 417       Current      Current
## 421       Current      Current
## 425       Current      Current
## 427       Current      Current
## 430       Current      Current
## 432       Current      Current
## 437       Current      Current
## 443       Current      Current
## 458       Current      Current
## 467       Current      Current
## 470       Current      Current
## 471       Current      Current
## 472       Current      Current
## 473       Current      Current
## 474       Current      Current
## 477       Current       Exited
## 478       Current      Current
## 482       Current      Current
## 483       Current      Current
## 484       Current      Current
## 487       Current       Exited
## 489       Current      Current
## 499       Current      Current
## 500       Current      Current
## 505       Current      Current
## 506       Current      Current
## 509       Current      Current
## 514       Current      Current
## 516       Current       Exited
## 525       Current      Current
## 532       Current      Current
## 533       Current      Current
## 534       Current      Current
## 535       Current      Current
## 536       Current      Current
## 539       Current      Current
## 545       Current      Current
## 549       Current      Current
## 550       Current      Current
## 551       Current      Current
## 554       Current      Current
## 555       Current      Current
## 558       Current      Current
## 560       Current       Exited
## 565       Current      Current
## 567       Current      Current
## 572       Current      Current
## 575       Current       Exited
## 579       Current       Exited
## 583       Current      Current
```

```
## 587      Current      Current
## 588      Current      Current
## 596      Current      Current
## 601      Current      Current
## 602      Current      Current
## 603      Current      Current
## 616      Current      Current
## 620      Current      Current
## 624      Current       Exited
## 625      Current      Current
## 628      Current      Current
## 629      Current      Current
## 632      Current      Current
## 635      Current      Current
## 637      Current      Current
## 639      Current      Current
## 640      Current      Current
## 641      Current      Current
## 642      Current      Current
## 646      Current      Current
## 648      Current      Current
## 650      Current      Current
## 654      Current       Exited
## 660      Current      Current
## 668      Current      Current
## 670      Current      Current
## 673      Current      Current
## 680      Current      Current
## 685      Current      Current
## 688      Current      Current
## 689      Current      Current
## 695      Current      Current
## 699      Current      Current
## 704      Current      Current
## 706      Current      Current
## 709      Current      Current
## 711      Current      Current
## 712      Current      Current
## 716      Current      Current
## 717      Current      Current
## 720      Current      Current
## 726      Current      Current
## 731      Current      Current
## 737      Current      Current
## 747      Current       Exited
## 750      Current      Current
## 754      Current      Current
## 755      Current      Current
## 756      Current      Current
## 757      Current      Current
## 758       Exited      Current
## 761      Current       Exited
## 762      Current      Current
## 764      Current      Current
```

```
## 778        Current      Exited
## 780        Current     Current
## 787        Current     Current
## 788        Current     Current
## 801        Current     Current
## 803        Current     Current
## 808        Current     Current
## 809        Current     Current
## 811        Current     Current
## 816        Current     Current
## 817        Current     Current
## 823        Current     Current
## 824        Current     Current
## 827        Current     Current
## 829        Current     Current
## 835        Current     Current
## 840        Current     Current
## 846        Current     Current
## 862        Current     Current
## 867        Current     Current
## 886        Current     Current
## 893        Current      Exited
## 894        Current     Current
## 897        Current     Current
## 900        Current     Current
## 903        Current     Current
## 905        Current     Current
## 915        Current     Current
## 916        Current     Current
## 918        Current     Current
## 919        Current     Current
## 922        Current     Current
## 924        Current     Current
## 938        Current     Current
## 939        Current     Current
## 942        Current     Current
## 943        Current     Current
## 949        Current     Current
## 951        Current     Current
## 956        Current     Current
## 961        Current     Current
## 963        Current     Current
## 967        Current      Exited
## 970        Current     Current
## 974        Current     Current
## 976        Current     Current
## 979        Current     Current
## 980        Current     Current
## 985        Current     Current
## 986        Current     Current
## 988        Current     Current
## 989        Current     Current
## 990        Current     Current
## 995        Current     Current
```

```
## 997     Current     Current
## 998     Current     Current
## 1007    Current     Current
## 1009    Current     Current
## 1017    Current     Current
## 1022    Current     Current
## 1023    Current     Current
## 1027    Current     Current
## 1031    Current     Current
## 1032    Current     Current
## 1033    Current     Current
## 1036    Current     Current
## 1045    Current     Current
## 1058    Current     Current
## 1059    Current     Current
## 1063    Current     Current
## 1074    Current     Current
## 1080    Current     Current
## 1081    Current     Current
## 1084    Current     Current
## 1088    Current     Current
## 1095    Current     Current
## 1101    Current     Current
## 1105    Current      Exited
## 1108    Current     Current
## 1109    Current     Current
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## 1205    Current      Exited
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## 1232    Current     Current
## 1234    Current      Exited
## 1240    Current     Current
## 1247    Current     Current
```

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## 1374      Current       Exited
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## 1464      Current      Current
## 1466      Current      Current
```

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## 1467       Current      Exited
## 1485       Current     Current
## 1491       Current     Current
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## 1579       Current      Exited
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## 1640       Current      Exited
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## 1672       Current     Current
## 1681       Current      Exited
## 1686       Current     Current
## 1689       Current     Current
```

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## 1908       Current       Current
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## 2308      Current       Exited
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## 2459    Current     Exited
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## 2493    Current    Current
## 2494    Current     Exited
## 2496    Current     Exited
## 2502    Current    Current
```

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## 2562      Current       Current
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## 2570      Current        Exited
## 2574      Current       Current
## 2580      Current       Current
## 2583      Current        Exited
## 2586      Current       Current
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## 2737      Current        Exited
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## 2975      Current       Current
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## 3052      Current        Exited
## 3059      Current       Current
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## 3209        Exited       Current
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## 3284       Current       Current
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## 3288      Current    Current
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## 3297      Current     Exited
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## 3502      Current     Exited
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## 3505      Current     Exited
## 3510      Current    Current
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## 3698     Current     Current
## 3701     Current     Current
## 3706     Current      Exited
## 3707     Current      Exited
```

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## 3846    Current     Exited
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## 3923    Current    Current
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## 4014      Current     Current
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## 4603    Current    Current
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## 4706    Current    Current
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## 4722    Current     Exited
## 4724    Current    Current
## 4725    Current     Exited
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## 4761    Current    Current
## 4765    Current    Current
## 4768    Current     Exited
## 4770    Current    Current
## 4771    Current    Current
## 4773    Current    Current
## 4782    Current    Current
## 4784    Current    Current
## 4790    Current    Current
```

```
## 4792    Current     Exited
## 4794    Current    Current
## 4803    Current    Current
## 4805    Current    Current
## 4806    Current    Current
## 4807    Current    Current
## 4812    Current    Current
## 4819    Current    Current
## 4822    Current    Current
## 4824    Current    Current
## 4831    Current    Current
## 4833    Current    Current
## 4838    Current    Current
## 4842    Current    Current
## 4850    Current    Current
## 4856    Current    Current
## 4857    Current    Current
## 4859    Current    Current
## 4872    Current    Current
## 4881    Current    Current
## 4887    Current    Current
## 4889    Current    Current
## 4895    Current     Exited
## 4898    Current     Exited
## 4899    Current    Current
## 4900    Current    Current
## 4901    Current    Current
## 4911    Current     Exited
## 4913    Current    Current
## 4914    Current    Current
## 4918    Current    Current
## 4923    Current    Current
## 4935    Current     Exited
## 4936    Current    Current
## 4941    Current    Current
## 4945    Current     Exited
## 4946    Current    Current
## 4951    Current    Current
## 4953    Current    Current
## 4956     Exited    Current
## 4964    Current    Current
## 4965    Current    Current
## 4966    Current     Exited
## 4968    Current    Current
## 4973    Current     Exited
## 4975    Current    Current
## 4983    Current     Exited
## 4984     Exited    Current
## 4985    Current    Current
## 4987    Current    Current
## 5001    Current    Current
## 5002    Current    Current
## 5007    Current    Current
## 5008    Current    Current
```

```
## 5009      Current      Current
## 5019      Current      Current
## 5024      Current      Current
## 5029      Current      Current
## 5030      Current      Current
## 5039      Current      Current
## 5043      Current      Current
## 5048      Current      Current
## 5058      Current      Current
## 5061      Current      Current
## 5063      Current      Current
## 5069      Current       Exited
## 5076      Current      Current
## 5081      Current      Current
## 5085      Current      Current
## 5087      Current      Current
## 5088      Current      Current
## 5090      Current       Exited
## 5093      Current       Exited
## 5100      Current      Current
## 5103      Current      Current
## 5107      Current      Current
## 5112      Current      Current
## 5113      Current      Current
## 5117      Current      Current
## 5118      Current      Current
## 5128      Current       Exited
## 5130      Current      Current
## 5131      Current      Current
## 5132      Current       Exited
## 5137      Current      Current
## 5148      Current      Current
## 5151      Current      Current
## 5154      Current      Current
## 5155      Current      Current
## 5157      Current       Exited
## 5167      Current      Current
## 5176      Current      Current
## 5177      Current      Current
## 5180      Current      Current
## 5186      Current      Current
## 5189      Current      Current
## 5190      Current      Current
## 5205      Current      Current
## 5207      Current      Current
## 5209      Current       Exited
## 5213      Current      Current
## 5236      Current      Current
## 5242      Current      Current
## 5247      Current      Current
## 5248      Current      Current
## 5252      Current      Current
## 5253      Current      Current
## 5257      Current       Exited
```

```
## 5266      Current      Exited
## 5270      Current      Exited
## 5272      Current      Current
## 5276      Current      Exited
## 5292      Current      Current
## 5300      Current      Current
## 5308      Current      Current
## 5315      Current      Current
## 5317      Current      Current
## 5319      Current      Current
## 5322      Current      Current
## 5323      Current      Current
## 5324      Current      Current
## 5333      Current      Current
## 5334      Current      Exited
## 5335      Current      Current
## 5336      Current      Current
## 5338      Current      Current
## 5339      Current      Current
## 5348      Current      Current
## 5349      Current      Exited
## 5353      Current      Current
## 5358      Current      Current
## 5360      Current      Current
## 5370      Current      Current
## 5377      Current      Exited
## 5379      Current      Exited
## 5380      Current      Current
## 5383      Current      Exited
## 5384      Current      Current
## 5387      Current      Exited
## 5389      Current      Current
## 5394      Current      Current
## 5398      Current      Current
## 5406      Current      Current
## 5407      Current      Current
## 5416      Current      Current
## 5419      Current      Current
## 5420      Current      Exited
## 5429      Current      Current
## 5431      Current      Current
## 5433      Current      Exited
## 5437      Current      Exited
## 5440      Current      Current
## 5443      Current      Current
## 5445      Current      Current
## 5448      Current      Current
## 5449      Current      Current
## 5453      Current      Current
## 5454      Current      Exited
## 5456      Current      Current
## 5461      Current      Current
## 5463      Current      Exited
## 5474      Current      Current
```

```
## 5489    Current    Exited
## 5491    Current    Current
## 5495     Exited    Current
## 5501    Current     Exited
## 5504    Current     Exited
## 5513    Current    Current
## 5514    Current    Current
## 5516    Current    Current
## 5524    Current    Current
## 5528    Current    Current
## 5532    Current     Exited
## 5535    Current    Current
## 5537    Current     Exited
## 5547    Current    Current
## 5552    Current    Current
## 5553    Current     Exited
## 5567    Current     Exited
## 5583    Current     Exited
## 5588    Current    Current
## 5598    Current    Current
## 5601    Current     Exited
## 5602    Current     Exited
## 5604    Current    Current
## 5605    Current    Current
## 5613    Current    Current
## 5615    Current    Current
## 5616    Current    Current
## 5617    Current    Current
## 5620    Current    Current
## 5621    Current    Current
## 5622    Current    Current
## 5628    Current     Exited
## 5631    Current     Exited
## 5633    Current    Current
## 5634    Current    Current
## 5636    Current    Current
## 5638    Current    Current
## 5639    Current    Current
## 5650    Current    Current
## 5652    Current    Current
## 5674    Current     Exited
## 5675    Current    Current
## 5679    Current    Current
## 5681    Current    Current
## 5684    Current    Current
## 5686    Current    Current
## 5691    Current    Current
## 5701    Current    Current
## 5703    Current    Current
## 5705    Current    Current
## 5712    Current    Current
## 5713    Current    Current
## 5716    Current    Current
## 5718    Current    Current
```

```
## 5719     Current     Current
## 5723     Current     Current
## 5727     Current     Current
## 5740     Current     Current
## 5744     Current     Current
## 5751     Current     Current
## 5755     Current     Current
## 5757     Current     Current
## 5758     Current     Current
## 5759     Current     Current
## 5760     Current     Current
## 5765     Current     Current
## 5768     Current     Current
## 5769     Current     Current
## 5770     Current     Current
## 5771      Exited     Current
## 5772     Current     Current
## 5783     Current     Current
## 5785     Current     Current
## 5796     Current     Current
## 5804     Current     Current
## 5806     Current     Current
## 5807     Current     Current
## 5815     Current      Exited
## 5818     Current     Current
## 5822     Current     Current
## 5823     Current      Exited
## 5826     Current     Current
## 5830     Current     Current
## 5834     Current     Current
## 5838     Current     Current
## 5840     Current     Current
## 5841     Current     Current
## 5843     Current     Current
## 5845     Current     Current
## 5846     Current     Current
## 5847     Current     Current
## 5849     Current     Current
## 5852     Current     Current
## 5857     Current     Current
## 5863     Current     Current
## 5874     Current     Current
## 5875     Current     Current
## 5878     Current     Current
## 5880     Current     Current
## 5881     Current     Current
## 5886     Current     Current
## 5890     Current     Current
## 5894     Current     Current
## 5905     Current     Current
## 5906     Current     Current
## 5907     Current     Current
## 5912     Current     Current
## 5920     Current     Current
```

```
## 5922      Current      Current
## 5923      Current      Current
## 5925      Current      Current
## 5929      Current      Current
## 5931      Current       Exited
## 5932      Current      Current
## 5943      Current      Current
## 5945      Current       Exited
## 5955      Current      Current
## 5962      Current      Current
## 5966      Current      Current
## 5967      Current       Exited
## 5969      Current      Current
## 5975      Current      Current
## 5981      Current      Current
## 5982      Current      Current
## 5985      Current      Current
## 5994      Current      Current
## 5995      Current      Current
## 5996      Current      Current
## 5998      Current      Current
## 5999      Current      Current
## 6002      Current      Current
## 6004      Current       Exited
## 6005      Current      Current
## 6006      Current      Current
## 6007      Current      Current
## 6009      Current      Current
## 6010      Current       Exited
## 6013      Current      Current
## 6017      Current      Current
## 6018      Current      Current
## 6019      Current      Current
## 6020      Current      Current
## 6024      Current      Current
## 6028      Current      Current
## 6032      Current      Current
## 6033      Current      Current
## 6038      Current       Exited
## 6042      Current      Current
## 6047      Current      Current
## 6058      Current      Current
## 6059      Current      Current
## 6061      Current      Current
## 6067      Current      Current
## 6068      Current      Current
## 6071      Current      Current
## 6072      Current      Current
## 6076      Current      Current
## 6077      Current      Current
## 6078      Current       Exited
## 6079      Current      Current
## 6080      Current      Current
## 6081      Current      Current
```

```
## 6084     Current     Current
## 6088     Current     Current
## 6089     Current     Current
## 6091     Current      Exited
## 6096     Current     Current
## 6097     Current     Current
## 6098     Current     Current
## 6103     Current      Exited
## 6105     Current     Current
## 6114     Current      Exited
## 6116     Current     Current
## 6123     Current      Exited
## 6127     Current      Exited
## 6130     Current     Current
## 6137     Current     Current
## 6139     Current      Exited
## 6142     Current     Current
## 6148     Current     Current
## 6150     Current      Exited
## 6152     Current     Current
## 6153     Current     Current
## 6155     Current     Current
## 6163     Current     Current
## 6165     Current     Current
## 6168     Current     Current
## 6174     Current     Current
## 6177     Current     Current
## 6179     Current     Current
## 6184     Current     Current
## 6187     Current      Exited
## 6194     Current     Current
## 6195     Current     Current
## 6197     Current     Current
## 6198     Current     Current
## 6201     Current     Current
## 6203     Current      Exited
## 6204     Current     Current
## 6209     Current     Current
## 6210     Current     Current
## 6212     Current     Current
## 6213     Current     Current
## 6215     Current     Current
## 6216     Current     Current
## 6217     Current     Current
## 6226     Current     Current
## 6228     Current     Current
## 6244     Current     Current
## 6250     Current     Current
## 6257     Current     Current
## 6260     Current     Current
## 6265     Current     Current
## 6267     Current     Current
## 6273     Current     Current
## 6277     Current      Exited
```

```
## 6278      Current      Current
## 6280      Current      Current
## 6295      Current      Current
## 6296      Current      Current
## 6301      Current      Current
## 6312      Current      Current
## 6314      Current      Current
## 6320      Current      Current
## 6323      Current      Current
## 6325      Current      Current
## 6326      Current      Current
## 6328      Current      Current
## 6332      Current      Current
## 6338      Current      Current
## 6340      Current      Current
## 6353      Current       Exited
## 6358      Current      Current
## 6375      Current      Current
## 6387      Current      Current
## 6391      Current      Current
## 6396      Current      Current
## 6398      Current      Current
## 6402      Current       Exited
## 6410      Current      Current
## 6413      Current      Current
## 6415      Current       Exited
## 6417      Current      Current
## 6424      Current      Current
## 6426      Current       Exited
## 6427      Current       Exited
## 6431      Current       Exited
## 6433      Current      Current
## 6435      Current      Current
## 6439      Current      Current
## 6454      Current      Current
## 6466      Current      Current
## 6467      Current      Current
## 6475      Current      Current
## 6481      Current      Current
## 6482       Exited      Current
## 6487      Current       Exited
## 6491      Current      Current
## 6493      Current      Current
## 6511      Current      Current
## 6512      Current      Current
## 6514      Current      Current
## 6516      Current      Current
## 6518      Current      Current
## 6520      Current      Current
## 6521      Current      Current
## 6533      Current      Current
## 6535      Current      Current
## 6543      Current      Current
## 6544      Current       Exited
```

```
## 6545     Current     Current
## 6551     Current     Current
## 6555     Current     Current
## 6558     Current      Exited
## 6566     Current     Current
## 6567     Current     Current
## 6569     Current      Exited
## 6572     Current     Current
## 6575     Current     Current
## 6583     Current     Current
## 6590     Current      Exited
## 6595     Current     Current
## 6596     Current      Exited
## 6604     Current      Exited
## 6605     Current     Current
## 6608     Current     Current
## 6613     Current     Current
## 6615     Current     Current
## 6620     Current     Current
## 6624     Current     Current
## 6626     Current     Current
## 6628     Current     Current
## 6629     Current     Current
## 6631     Current     Current
## 6635     Current     Current
## 6636     Current     Current
## 6639     Current     Current
## 6645     Current     Current
## 6647     Current     Current
## 6651     Current     Current
## 6657     Current      Exited
## 6659     Current     Current
## 6664     Current      Exited
## 6665     Current      Exited
## 6666     Current      Exited
## 6667     Current     Current
## 6668     Current     Current
## 6669     Current     Current
## 6672     Current      Exited
## 6673     Current     Current
## 6678     Current     Current
## 6682     Current     Current
## 6686     Current     Current
## 6691     Current     Current
## 6694     Current     Current
## 6695     Current     Current
## 6696     Current      Exited
## 6697     Current     Current
## 6698     Current     Current
## 6703     Current     Current
## 6705     Current     Current
## 6710     Current      Exited
## 6715     Current     Current
## 6721     Current     Current
```

```
## 6724      Current      Current
## 6726      Current      Current
## 6729      Current      Current
## 6733      Current      Current
## 6737      Current      Current
## 6738      Current      Current
## 6741      Current      Current
## 6743      Current      Current
## 6745      Current      Current
## 6751      Current       Exited
## 6753      Current      Current
## 6757      Current       Exited
## 6765      Current      Current
## 6767      Current      Current
## 6773      Current       Exited
## 6776      Current      Current
## 6779      Current       Exited
## 6781      Current      Current
## 6783      Current      Current
## 6784      Current      Current
## 6786      Current      Current
## 6791      Current      Current
## 6793      Current      Current
## 6795      Current      Current
## 6796      Current      Current
## 6797      Current       Exited
## 6807      Current      Current
## 6810      Current      Current
## 6814       Exited      Current
## 6821      Current      Current
## 6823      Current       Exited
## 6824      Current      Current
## 6825      Current       Exited
## 6827      Current       Exited
## 6828      Current       Exited
## 6829      Current      Current
## 6833      Current       Exited
## 6841      Current       Exited
## 6844      Current      Current
## 6848      Current       Exited
## 6869      Current       Exited
## 6870      Current      Current
## 6873      Current       Exited
## 6877      Current       Exited
## 6878      Current      Current
## 6880      Current      Current
## 6881      Current       Exited
## 6883      Current      Current
## 6886      Current      Current
## 6890      Current      Current
## 6893      Current      Current
## 6894      Current      Current
## 6897      Current       Exited
## 6903      Current      Current
```

```
## 6906     Current     Current
## 6908     Current     Current
## 6911     Current     Current
## 6912     Current     Current
## 6913     Current     Current
## 6917     Current     Current
## 6918     Current     Current
## 6919     Current     Current
## 6921     Current     Current
## 6928     Current     Current
## 6945     Current     Current
## 6948     Current      Exited
## 6950     Current     Current
## 6966     Current      Exited
## 6970     Current     Current
## 6972     Current     Current
## 6979     Current     Current
## 6985     Current     Current
## 6989     Current     Current
## 6992     Current     Current
## 6994     Current      Exited
## 7001     Current      Exited
## 7006     Current     Current
## 7015     Current     Current
## 7019     Current      Exited
## 7021     Current     Current
## 7022      Exited      Exited
## 7024     Current      Exited
## 7026     Current      Exited
## 7031     Current     Current
## 7032     Current     Current
## 7033     Current     Current
## 7034     Current     Current
## 7036     Current      Exited
## 7039     Current     Current
## 7040     Current     Current
## 7041     Current     Current
## 7042     Current     Current
## 7043     Current     Current
## 7051      Exited     Current
## 7056     Current     Current
## 7058     Current     Current
## 7059     Current      Exited
## 7060     Current     Current
## 7070     Current     Current
## 7072     Current      Exited
## 7080     Current      Exited
## 7081     Current      Exited
```

```r
# use the confusionMatrix() function from the caret package
conf_mat_glm <- confusionMatrix(pred_combined_glm$true_class, pred_combined_glm$predictions, positive =

# Print the matrix
conf_mat_glm
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Current Exited
##     Current   1480     12
##     Exited     277      2
##
##                  Accuracy : 0.8368
##                    95% CI : (0.8188, 0.8537)
##       No Information Rate : 0.9921
##       P-Value [Acc > NIR] : 1
##
##                     Kappa : -0.0014
##
##   Mcnemar's Test P-Value : <2e-16
##
##               Sensitivity : 0.142857
##               Specificity : 0.842345
##            Pos Pred Value : 0.007168
##            Neg Pred Value : 0.991957
##                Prevalence : 0.007905
##            Detection Rate : 0.001129
##      Detection Prevalence : 0.157538
##         Balanced Accuracy : 0.492601
##
##          'Positive' Class : Exited
##
```

```
## Model 2: Support Vector Machine (SVM)
model_svm = svm(formula= Attrition_Flag ~ .,
                data= trainup,
                type= 'C-classification',
                kernel = 'radial')
summary(model_svm)
```

```
##
## Call:
## svm(formula = Attrition_Flag ~ ., data = trainup, type = "C-classification",
##     kernel = "radial")
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##
## Number of Support Vectors:  8299
##
##  ( 4146 4153 )
##
##
## Number of Classes:  2
##
## Levels:
```

```
##  Current Exited
```

```
# predicting Test Set Results
pred_svm = predict(model_svm, newdata = test_balanced)

# Add the true outcomes
pred_combined_svm <- data.frame(predictions = pred_svm)
pred_combined_svm$true_class <- test_balanced$Attrition_Flag
# convert to factor
pred_combined_svm[,c("predictions", "true_class")] <- lapply(pred_combined_svm[, c("predictions", "true_

# Print the first lines of the result
pred_combined_svm
```

```
##       predictions true_class
## 10        Current    Current
## 12        Current    Current
## 13        Current     Exited
## 15         Exited    Current
## 18        Current    Current
## 19        Current    Current
## 26        Current    Current
## 28        Current    Current
## 30        Current    Current
## 31         Exited    Current
## 33        Current    Current
## 35         Exited    Current
## 40        Current    Current
## 43        Current    Current
## 44         Exited    Current
## 46        Current    Current
## 54         Exited    Current
## 55        Current    Current
## 56        Current    Current
## 57         Exited    Current
## 58        Current    Current
## 60         Exited    Current
## 63        Current    Current
## 65         Exited    Current
## 68        Current    Current
## 71         Exited    Current
## 72        Current    Current
## 80         Exited    Current
## 90        Current     Exited
## 91        Current    Current
## 100       Current     Exited
## 105        Exited    Current
## 107       Current    Current
## 113        Exited    Current
## 126       Current    Current
## 129       Current    Current
## 130       Current    Current
## 131       Current    Current
## 134       Current    Current
```

43

```
## 135      Current     Current
## 142      Current     Current
## 143      Current     Current
## 144       Exited     Current
## 147      Current     Current
## 153      Current      Exited
## 164      Current     Current
## 168      Current     Current
## 172      Current     Current
## 173      Current      Exited
## 175       Exited     Current
## 176      Current     Current
## 179      Current     Current
## 182      Current      Exited
## 191      Current     Current
## 192       Exited     Current
## 196      Current      Exited
## 197      Current     Current
## 199      Current      Exited
## 214       Exited      Exited
## 215       Exited     Current
## 222      Current     Current
## 230       Exited     Current
## 231      Current     Current
## 233      Current     Current
## 237      Current     Current
## 241       Exited     Current
## 244      Current     Current
## 245      Current     Current
## 250       Exited     Current
## 261      Current     Current
## 274      Current     Current
## 276       Exited     Current
## 278       Exited     Current
## 280       Exited     Current
## 284      Current     Current
## 287       Exited     Current
## 289       Exited     Current
## 291      Current     Current
## 297      Current     Current
## 301      Current     Current
## 308       Exited     Current
## 309       Exited     Current
## 311      Current      Exited
## 317      Current     Current
## 320       Exited     Current
## 327      Current      Exited
## 328      Current     Current
## 331       Exited     Current
## 332       Exited     Current
## 335      Current     Current
## 337      Current     Current
## 343      Current     Current
## 353      Current     Current
```

```
## 356      Exited    Current
## 357      Exited    Current
## 358      Exited    Current
## 365      Exited    Current
## 371     Current    Current
## 377     Current    Current
## 378     Current    Current
## 384     Current    Current
## 390      Exited    Current
## 395     Current    Current
## 398     Current     Exited
## 400     Current    Current
## 401     Current    Current
## 405      Exited    Current
## 417      Exited    Current
## 421     Current    Current
## 425     Current    Current
## 427     Current    Current
## 430     Current    Current
## 432     Current    Current
## 437      Exited    Current
## 443      Exited    Current
## 458     Current    Current
## 467      Exited    Current
## 470     Current    Current
## 471     Current    Current
## 472      Exited    Current
## 473      Exited    Current
## 474     Current    Current
## 477     Current     Exited
## 478     Current    Current
## 482     Current    Current
## 483     Current    Current
## 484     Current    Current
## 487      Exited     Exited
## 489      Exited    Current
## 499     Current    Current
## 500      Exited    Current
## 505     Current    Current
## 506     Current    Current
## 509     Current    Current
## 514     Current    Current
## 516     Current     Exited
## 525      Exited    Current
## 532      Exited    Current
## 533     Current    Current
## 534     Current    Current
## 535     Current    Current
## 536      Exited    Current
## 539     Current    Current
## 545     Current    Current
## 549     Current    Current
## 550     Current    Current
## 551     Current    Current
```

```
## 554     Exited    Current
## 555     Exited    Current
## 558    Current    Current
## 560    Current     Exited
## 565    Current    Current
## 567     Exited    Current
## 572    Current    Current
## 575    Current     Exited
## 579    Current     Exited
## 583    Current    Current
## 587     Exited    Current
## 588     Exited    Current
## 596     Exited    Current
## 601    Current    Current
## 602    Current    Current
## 603    Current    Current
## 616    Current    Current
## 620    Current    Current
## 624     Exited     Exited
## 625    Current    Current
## 628    Current    Current
## 629    Current    Current
## 632    Current    Current
## 635     Exited    Current
## 637    Current    Current
## 639    Current    Current
## 640    Current    Current
## 641     Exited    Current
## 642     Exited    Current
## 646     Exited    Current
## 648     Exited    Current
## 650     Exited    Current
## 654    Current     Exited
## 660    Current    Current
## 668    Current    Current
## 670    Current    Current
## 673    Current    Current
## 680     Exited    Current
## 685     Exited    Current
## 688     Exited    Current
## 689    Current    Current
## 695    Current    Current
## 699    Current    Current
## 704    Current    Current
## 706     Exited    Current
## 709    Current    Current
## 711     Exited    Current
## 712    Current    Current
## 716    Current    Current
## 717    Current    Current
## 720     Exited    Current
## 726    Current    Current
## 731    Current    Current
## 737    Current    Current
```

```
## 747      Current      Exited
## 750       Exited     Current
## 754      Current     Current
## 755      Current     Current
## 756      Current     Current
## 757       Exited     Current
## 758       Exited     Current
## 761      Current      Exited
## 762      Current     Current
## 764      Current     Current
## 778       Exited      Exited
## 780      Current     Current
## 787      Current     Current
## 788      Current     Current
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## 963      Current     Current
## 967      Current      Exited
## 970      Current     Current
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## 2475     Exited    Current
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## 4311    Current      Exited
## 4317    Current     Current
## 4325    Current     Current
## 4327     Exited      Exited
## 4337     Exited     Current
## 4343     Exited     Current
## 4344     Exited     Current
## 4355    Current     Current
```

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## 4356      Exited     Current
## 4360      Exited     Current
## 4361      Exited     Current
## 4362      Exited     Current
## 4374     Current     Current
## 4375     Current     Current
## 4385     Current     Current
## 4390      Exited     Current
## 4393     Current     Current
## 4395      Exited     Current
## 4400      Exited     Current
## 4401     Current     Current
## 4402      Exited     Current
## 4405     Current      Exited
## 4408     Current      Exited
## 4412      Exited     Current
## 4416     Current     Current
## 4420     Current      Exited
## 4423      Exited      Exited
## 4429      Exited     Current
## 4432      Exited      Exited
## 4441      Exited     Current
## 4445     Current     Current
## 4447      Exited     Current
## 4457     Current     Current
## 4463      Exited     Current
## 4464      Exited     Current
## 4465      Exited      Exited
## 4466      Exited     Current
## 4473      Exited      Exited
## 4476      Exited     Current
## 4480      Exited     Current
## 4481     Current     Current
## 4484      Exited      Exited
## 4485     Current     Current
## 4495     Current     Current
## 4496     Current      Exited
## 4500     Current     Current
## 4502      Exited     Current
## 4508      Exited     Current
## 4509     Current      Exited
## 4517      Exited     Current
## 4523     Current      Exited
## 4525      Exited      Exited
## 4527      Exited     Current
## 4536      Exited      Exited
## 4537     Current     Current
## 4538      Exited     Current
## 4540      Exited     Current
## 4544     Current      Exited
## 4545      Exited     Current
## 4548     Current     Current
## 4556     Current     Current
## 4558      Exited      Exited
```

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## 4559    Current     Exited
## 4561     Exited    Current
## 4562     Exited    Current
## 4571     Exited     Exited
## 4587     Exited    Current
## 4592     Exited     Exited
## 4593    Current    Current
## 4596     Exited    Current
## 4600    Current    Current
## 4603     Exited    Current
## 4604    Current    Current
## 4606     Exited     Exited
## 4609     Exited    Current
## 4613     Exited    Current
## 4614     Exited    Current
## 4616     Exited    Current
## 4620     Exited    Current
## 4623    Current    Current
## 4624     Exited    Current
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## 4626    Current    Current
## 4641    Current    Current
## 4643    Current    Current
## 4647     Exited     Exited
## 4650     Exited    Current
## 4652    Current    Current
## 4653    Current    Current
## 4657    Current     Exited
## 4661     Exited    Current
## 4664     Exited    Current
## 4667     Exited     Exited
## 4674     Exited    Current
## 4675    Current    Current
## 4676     Exited    Current
## 4677    Current    Current
## 4680     Exited    Current
## 4687    Current    Current
## 4690     Exited    Current
## 4694     Exited    Current
## 4696     Exited    Current
## 4697    Current    Current
## 4702     Exited    Current
## 4703     Exited    Current
## 4706     Exited    Current
## 4712     Exited    Current
## 4718     Exited    Current
## 4722    Current     Exited
## 4724    Current    Current
## 4725     Exited     Exited
## 4729     Exited    Current
## 4734    Current    Current
## 4736     Exited    Current
## 4746     Exited    Current
## 4750     Exited    Current
```

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## 4759    Current    Current
## 4761    Current    Current
## 4765     Exited    Current
## 4768     Exited     Exited
## 4770     Exited    Current
## 4771     Exited    Current
## 4773    Current    Current
## 4782     Exited    Current
## 4784    Current    Current
## 4790     Exited    Current
## 4792     Exited     Exited
## 4794     Exited    Current
## 4803    Current    Current
## 4805     Exited    Current
## 4806     Exited    Current
## 4807     Exited    Current
## 4812     Exited    Current
## 4819     Exited    Current
## 4822     Exited    Current
## 4824     Exited    Current
## 4831     Exited    Current
## 4833     Exited    Current
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## 4842     Exited    Current
## 4850     Exited    Current
## 4856     Exited    Current
## 4857    Current    Current
## 4859    Current    Current
## 4872     Exited    Current
## 4881    Current    Current
## 4887     Exited    Current
## 4889     Exited    Current
## 4895     Exited     Exited
## 4898    Current     Exited
## 4899     Exited    Current
## 4900     Exited    Current
## 4901    Current    Current
## 4911    Current     Exited
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## 4914     Exited    Current
## 4918     Exited    Current
## 4923    Current    Current
## 4935    Current     Exited
## 4936     Exited    Current
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## 4945     Exited     Exited
## 4946    Current    Current
## 4951    Current    Current
## 4953     Exited    Current
## 4956     Exited    Current
## 4964     Exited    Current
## 4965    Current    Current
## 4966    Current     Exited
## 4968    Current    Current
```

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## 4973    Current    Exited
## 4975    Current   Current
## 4983     Exited    Exited
## 4984     Exited   Current
## 4985    Current   Current
## 4987     Exited   Current
## 5001    Current   Current
## 5002    Current   Current
## 5007     Exited   Current
## 5008     Exited   Current
## 5009     Exited   Current
## 5019     Exited   Current
## 5024     Exited   Current
## 5029    Current   Current
## 5030    Current   Current
## 5039     Exited   Current
## 5043    Current   Current
## 5048    Current   Current
## 5058     Exited   Current
## 5061    Current   Current
## 5063    Current   Current
## 5069     Exited    Exited
## 5076     Exited   Current
## 5081     Exited   Current
## 5085     Exited   Current
## 5087    Current   Current
## 5088    Current   Current
## 5090     Exited    Exited
## 5093     Exited    Exited
## 5100     Exited   Current
## 5103     Exited   Current
## 5107     Exited   Current
## 5112    Current   Current
## 5113     Exited   Current
## 5117     Exited   Current
## 5118     Exited   Current
## 5128     Exited    Exited
## 5130     Exited   Current
## 5131     Exited   Current
## 5132     Exited    Exited
## 5137     Exited   Current
## 5148     Exited   Current
## 5151     Exited   Current
## 5154     Exited   Current
## 5155     Exited   Current
## 5157     Exited    Exited
## 5167     Exited   Current
## 5176    Current   Current
## 5177     Exited   Current
## 5180     Exited   Current
## 5186     Exited   Current
## 5189    Current   Current
## 5190    Current   Current
## 5205     Exited   Current
```

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## 5207     Exited    Current
## 5209     Exited     Exited
## 5213     Exited    Current
## 5236    Current    Current
## 5242    Current    Current
## 5247     Exited    Current
## 5248     Exited    Current
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## 5253     Exited    Current
## 5257     Exited     Exited
## 5266     Exited     Exited
## 5270    Current     Exited
## 5272    Current    Current
## 5276     Exited     Exited
## 5292     Exited    Current
## 5300     Exited    Current
## 5308     Exited    Current
## 5315     Exited    Current
## 5317    Current    Current
## 5319     Exited    Current
## 5322    Current    Current
## 5323    Current    Current
## 5324     Exited    Current
## 5333    Current    Current
## 5334    Current     Exited
## 5335    Current    Current
## 5336     Exited    Current
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## 5339    Current    Current
## 5348    Current    Current
## 5349     Exited     Exited
## 5353     Exited    Current
## 5358     Exited    Current
## 5360    Current    Current
## 5370     Exited    Current
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## 5379    Current     Exited
## 5380     Exited    Current
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## 5387     Exited     Exited
## 5389     Exited    Current
## 5394     Exited    Current
## 5398     Exited    Current
## 5406     Exited    Current
## 5407    Current    Current
## 5416     Exited    Current
## 5419    Current    Current
## 5420     Exited     Exited
## 5429     Exited    Current
## 5431     Exited    Current
## 5433     Exited     Exited
## 5437     Exited     Exited
## 5440     Exited    Current
```

```
## 5443      Exited     Current
## 5445      Exited     Current
## 5448     Current     Current
## 5449      Exited     Current
## 5453      Exited     Current
## 5454      Exited      Exited
## 5456      Exited     Current
## 5461      Exited     Current
## 5463      Exited      Exited
## 5474     Current     Current
## 5489      Exited      Exited
## 5491     Current     Current
## 5495      Exited     Current
## 5501      Exited      Exited
## 5504     Current      Exited
## 5513     Current     Current
## 5514      Exited     Current
## 5516      Exited     Current
## 5524     Current     Current
## 5528      Exited     Current
## 5532      Exited      Exited
## 5535      Exited     Current
## 5537      Exited      Exited
## 5547      Exited     Current
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## 5553      Exited      Exited
## 5567      Exited      Exited
## 5583      Exited      Exited
## 5588      Exited     Current
## 5598      Exited     Current
## 5601      Exited      Exited
## 5602      Exited      Exited
## 5604      Exited     Current
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## 5613     Current     Current
## 5615      Exited     Current
## 5616      Exited     Current
## 5617      Exited     Current
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## 5621     Current     Current
## 5622     Current     Current
## 5628      Exited      Exited
## 5631      Exited      Exited
## 5633      Exited     Current
## 5634      Exited     Current
## 5636      Exited     Current
## 5638      Exited     Current
## 5639      Exited     Current
## 5650     Current     Current
## 5652      Exited     Current
## 5674     Current      Exited
## 5675      Exited     Current
## 5679      Exited     Current
## 5681      Exited     Current
```

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## 5684      Exited     Current
## 5686     Current     Current
## 5691     Current     Current
## 5701     Current     Current
## 5703     Current     Current
## 5705     Current     Current
## 5712     Current     Current
## 5713      Exited     Current
## 5716     Current     Current
## 5718     Current     Current
## 5719      Exited     Current
## 5723      Exited     Current
## 5727     Current     Current
## 5740      Exited     Current
## 5744     Current     Current
## 5751     Current     Current
## 5755      Exited     Current
## 5757      Exited     Current
## 5758     Current     Current
## 5759      Exited     Current
## 5760      Exited     Current
## 5765      Exited     Current
## 5768      Exited     Current
## 5769      Exited     Current
## 5770     Current     Current
## 5771      Exited     Current
## 5772     Current     Current
## 5783      Exited     Current
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## 5796     Current     Current
## 5804     Current     Current
## 5806      Exited     Current
## 5807      Exited     Current
## 5815      Exited      Exited
## 5818      Exited     Current
## 5822     Current     Current
## 5823      Exited      Exited
## 5826     Current     Current
## 5830     Current     Current
## 5834      Exited     Current
## 5838     Current     Current
## 5840     Current     Current
## 5841     Current     Current
## 5843      Exited     Current
## 5845      Exited     Current
## 5846     Current     Current
## 5847      Exited     Current
## 5849      Exited     Current
## 5852      Exited     Current
## 5857      Exited     Current
## 5863      Exited     Current
## 5874      Exited     Current
## 5875     Current     Current
## 5878     Current     Current
```

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## 5880      Exited     Current
## 5881      Exited     Current
## 5886      Exited     Current
## 5890      Exited     Current
## 5894      Exited     Current
## 5905     Current     Current
## 5906      Exited     Current
## 5907      Exited     Current
## 5912     Current     Current
## 5920     Current     Current
## 5922      Exited     Current
## 5923      Exited     Current
## 5925      Exited     Current
## 5929      Exited     Current
## 5931      Exited      Exited
## 5932      Exited     Current
## 5943     Current     Current
## 5945     Current      Exited
## 5955      Exited     Current
## 5962      Exited     Current
## 5966      Exited     Current
## 5967      Exited      Exited
## 5969      Exited     Current
## 5975      Exited     Current
## 5981     Current     Current
## 5982      Exited     Current
## 5985     Current     Current
## 5994     Current     Current
## 5995      Exited     Current
## 5996     Current     Current
## 5998      Exited     Current
## 5999      Exited     Current
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## 6004      Exited      Exited
## 6005     Current     Current
## 6006      Exited     Current
## 6007     Current     Current
## 6009      Exited     Current
## 6010     Current      Exited
## 6013     Current     Current
## 6017      Exited     Current
## 6018      Exited     Current
## 6019     Current     Current
## 6020     Current     Current
## 6024     Current     Current
## 6028     Current     Current
## 6032     Current     Current
## 6033      Exited     Current
## 6038     Current      Exited
## 6042     Current     Current
## 6047     Current     Current
## 6058     Current     Current
## 6059      Exited     Current
## 6061      Exited     Current
```

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## 6067      Current      Current
## 6068      Current      Current
## 6071       Exited      Current
## 6072       Exited      Current
## 6076       Exited      Current
## 6077      Current      Current
## 6078      Current       Exited
## 6079      Current      Current
## 6080      Current      Current
## 6081      Current      Current
## 6084      Current      Current
## 6088      Current      Current
## 6089       Exited      Current
## 6091      Current       Exited
## 6096      Current      Current
## 6097      Current      Current
## 6098      Current      Current
## 6103       Exited       Exited
## 6105       Exited      Current
## 6114      Current       Exited
## 6116       Exited      Current
## 6123      Current       Exited
## 6127       Exited       Exited
## 6130       Exited      Current
## 6137      Current      Current
## 6139      Current       Exited
## 6142      Current      Current
## 6148      Current      Current
## 6150       Exited       Exited
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## 6153      Current      Current
## 6155       Exited      Current
## 6163      Current      Current
## 6165      Current      Current
## 6168       Exited      Current
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## 6177       Exited      Current
## 6179      Current      Current
## 6184      Current      Current
## 6187      Current       Exited
## 6194      Current      Current
## 6195      Current      Current
## 6197       Exited      Current
## 6198       Exited      Current
## 6201       Exited      Current
## 6203       Exited       Exited
## 6204      Current      Current
## 6209      Current      Current
## 6210       Exited      Current
## 6212       Exited      Current
## 6213       Exited      Current
## 6215       Exited      Current
## 6216      Current      Current
## 6217       Exited      Current
```

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## 6226      Current      Current
## 6228      Current      Current
## 6244      Current      Current
## 6250      Current      Current
## 6257       Exited      Current
## 6260      Current      Current
## 6265      Current      Current
## 6267      Current      Current
## 6273      Current      Current
## 6277      Current       Exited
## 6278       Exited      Current
## 6280       Exited      Current
## 6295      Current      Current
## 6296      Current      Current
## 6301      Current      Current
## 6312      Current      Current
## 6314      Current      Current
## 6320      Current      Current
## 6323       Exited      Current
## 6325      Current      Current
## 6326       Exited      Current
## 6328      Current      Current
## 6332      Current      Current
## 6338      Current      Current
## 6340       Exited      Current
## 6353       Exited       Exited
## 6358      Current      Current
## 6375      Current      Current
## 6387      Current      Current
## 6391      Current      Current
## 6396      Current      Current
## 6398      Current      Current
## 6402       Exited       Exited
## 6410      Current      Current
## 6413      Current      Current
## 6415       Exited       Exited
## 6417      Current      Current
## 6424       Exited      Current
## 6426       Exited       Exited
## 6427      Current       Exited
## 6431      Current       Exited
## 6433      Current      Current
## 6435      Current      Current
## 6439      Current      Current
## 6454      Current      Current
## 6466      Current      Current
## 6467      Current      Current
## 6475       Exited      Current
## 6481       Exited      Current
## 6482       Exited      Current
## 6487      Current       Exited
## 6491      Current      Current
## 6493      Current      Current
## 6511      Current      Current
```

```
## 6512     Current    Current
## 6514      Exited    Current
## 6516     Current    Current
## 6518     Current    Current
## 6520      Exited    Current
## 6521     Current    Current
## 6533     Current    Current
## 6535      Exited    Current
## 6543     Current    Current
## 6544     Current     Exited
## 6545     Current    Current
## 6551      Exited    Current
## 6555     Current    Current
## 6558     Current     Exited
## 6566     Current    Current
## 6567     Current    Current
## 6569      Exited     Exited
## 6572     Current    Current
## 6575      Exited    Current
## 6583     Current    Current
## 6590      Exited     Exited
## 6595     Current    Current
## 6596      Exited     Exited
## 6604     Current     Exited
## 6605      Exited    Current
## 6608     Current    Current
## 6613     Current    Current
## 6615      Exited    Current
## 6620      Exited    Current
## 6624      Exited    Current
## 6626     Current    Current
## 6628      Exited    Current
## 6629     Current    Current
## 6631      Exited    Current
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## 6636     Current    Current
## 6639     Current    Current
## 6645      Exited    Current
## 6647      Exited    Current
## 6651      Exited    Current
## 6657      Exited     Exited
## 6659      Exited    Current
## 6664      Exited     Exited
## 6665      Exited     Exited
## 6666      Exited     Exited
## 6667      Exited    Current
## 6668     Current    Current
## 6669      Exited    Current
## 6672     Current     Exited
## 6673     Current    Current
## 6678     Current    Current
## 6682      Exited    Current
## 6686     Current    Current
## 6691     Current    Current
```

```
## 6694      Current      Current
## 6695      Current      Current
## 6696      Current       Exited
## 6697      Current      Current
## 6698      Current      Current
## 6703       Exited      Current
## 6705      Current      Current
## 6710      Current       Exited
## 6715      Current      Current
## 6721      Current      Current
## 6724       Exited      Current
## 6726      Current      Current
## 6729      Current      Current
## 6733      Current      Current
## 6737      Current      Current
## 6738      Current      Current
## 6741      Current      Current
## 6743      Current      Current
## 6745      Current      Current
## 6751      Current       Exited
## 6753      Current      Current
## 6757       Exited       Exited
## 6765       Exited      Current
## 6767      Current      Current
## 6773      Current       Exited
## 6776      Current      Current
## 6779       Exited       Exited
## 6781      Current      Current
## 6783       Exited      Current
## 6784      Current      Current
## 6786      Current      Current
## 6791      Current      Current
## 6793      Current      Current
## 6795      Current      Current
## 6796      Current      Current
## 6797      Current       Exited
## 6807      Current      Current
## 6810      Current      Current
## 6814       Exited      Current
## 6821      Current      Current
## 6823      Current       Exited
## 6824      Current      Current
## 6825      Current       Exited
## 6827      Current       Exited
## 6828       Exited       Exited
## 6829       Exited      Current
## 6833      Current       Exited
## 6841      Current       Exited
## 6844      Current      Current
## 6848      Current       Exited
## 6869      Current       Exited
## 6870      Current      Current
## 6873      Current       Exited
## 6877      Current       Exited
```

```
## 6878    Current    Current
## 6880    Current    Current
## 6881    Current     Exited
## 6883    Current    Current
## 6886    Current    Current
## 6890     Exited    Current
## 6893     Exited    Current
## 6894    Current    Current
## 6897    Current     Exited
## 6903     Exited    Current
## 6906    Current    Current
## 6908     Exited    Current
## 6911     Exited    Current
## 6912    Current    Current
## 6913     Exited    Current
## 6917    Current    Current
## 6918    Current    Current
## 6919    Current    Current
## 6921    Current    Current
## 6928     Exited    Current
## 6945    Current    Current
## 6948     Exited     Exited
## 6950     Exited    Current
## 6966    Current     Exited
## 6970     Exited    Current
## 6972     Exited    Current
## 6979     Exited    Current
## 6985     Exited    Current
## 6989    Current    Current
## 6992    Current    Current
## 6994    Current     Exited
## 7001     Exited     Exited
## 7006    Current    Current
## 7015    Current    Current
## 7019    Current     Exited
## 7021    Current    Current
## 7022     Exited     Exited
## 7024    Current     Exited
## 7026     Exited     Exited
## 7031    Current    Current
## 7032    Current    Current
## 7033     Exited    Current
## 7034    Current    Current
## 7036    Current     Exited
## 7039    Current    Current
## 7040     Exited    Current
## 7041    Current    Current
## 7042    Current    Current
## 7043     Exited    Current
## 7051     Exited    Current
## 7056    Current    Current
## 7058    Current    Current
## 7059     Exited     Exited
## 7060     Exited    Current
```

```
## 7070       Exited     Current
## 7072      Current      Exited
## 7080      Current      Exited
## 7081      Current      Exited
```

```r
# use the confusionMatrix() function from the caret package
conf_mat_svm <- confusionMatrix(pred_combined_svm$true_class, pred_combined_svm$predictions, positive =

# Print the matrix
conf_mat_svm
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Current Exited
##    Current     779    713
##    Exited      133    146
##
##               Accuracy : 0.5223
##                 95% CI : (0.4987, 0.5458)
##    No Information Rate : 0.515
##    P-Value [Acc > NIR] : 0.2762
##
##                  Kappa : 0.0246
##
##  Mcnemar's Test P-Value : <2e-16
##
##            Sensitivity : 0.16997
##            Specificity : 0.85417
##         Pos Pred Value : 0.52330
##         Neg Pred Value : 0.52212
##             Prevalence : 0.48504
##         Detection Rate : 0.08244
##   Detection Prevalence : 0.15754
##      Balanced Accuracy : 0.51207
##
##       'Positive' Class : Exited
##
```

```r
## Model 3: Decision Trees
# Build the specification of the model
tree_spec <- decision_tree() %>%
  set_engine("rpart") %>%
  set_mode("classification")

# Train the model
model_dt <- tree_spec %>%
  fit(formula = Attrition_Flag ~ ., data = trainup)

# Generate predictions
pred_dt = predict(model_dt, new_data = test_balanced)

# Add the true outcomes
```

```r
pred_combined_dt <- data.frame(predictions = pred_dt$.pred_class)
pred_combined_dt$true_class <- test_balanced$Attrition_Flag
# # convert to factor
# pred_combined_dt[,c("predictions", "true_class")] <- lapply(pred_combined_dt[, c("predictions", "true_

# Print the first lines of the result
pred_combined_dt
```

```
##      predictions true_class
## 1        Exited    Current
## 2       Current    Current
## 3        Exited     Exited
## 4       Current    Current
## 5       Current    Current
## 6       Current    Current
## 7        Exited    Current
## 8       Current    Current
## 9       Current    Current
## 10       Exited    Current
## 11      Current    Current
## 12      Current    Current
## 13       Exited    Current
## 14      Current    Current
## 15      Current    Current
## 16      Current    Current
## 17      Current    Current
## 18      Current    Current
## 19      Current    Current
## 20       Exited    Current
## 21      Current    Current
## 22       Exited    Current
## 23       Exited    Current
## 24      Current    Current
## 25       Exited    Current
## 26      Current    Current
## 27      Current    Current
## 28       Exited    Current
## 29      Current     Exited
## 30      Current    Current
## 31      Current     Exited
## 32      Current    Current
## 33      Current    Current
## 34      Current    Current
## 35      Current    Current
## 36      Current    Current
## 37      Current    Current
## 38      Current    Current
## 39      Current    Current
## 40      Current    Current
## 41      Current    Current
## 42      Current    Current
## 43      Current    Current
## 44      Current    Current
```

```
## 45        Exited      Exited
## 46        Exited     Current
## 47        Exited     Current
## 48       Current     Current
## 49        Exited      Exited
## 50        Exited     Current
## 51       Current     Current
## 52       Current     Current
## 53       Current      Exited
## 54       Current     Current
## 55       Current     Current
## 56        Exited      Exited
## 57       Current     Current
## 58       Current      Exited
## 59       Current      Exited
## 60       Current     Current
## 61       Current     Current
## 62        Exited     Current
## 63       Current     Current
## 64        Exited     Current
## 65       Current     Current
## 66        Exited     Current
## 67       Current     Current
## 68       Current     Current
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## 96        Exited     Current
## 97        Exited     Current
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## 985      Exited      Exited
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## 989      Exited      Exited
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## 999      Exited      Exited
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## 1016      Exited      Exited
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## 1017   Current   Current
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## 1119      Exited      Exited
## 1120      Exited      Exited
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## 1125    Current      Exited
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## 1179    Current    Current
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## 1341   Current    Exited
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## 1403     Current     Current
## 1404     Current     Current
## 1405     Current     Current
## 1406     Current     Current
## 1407     Current     Current
## 1408     Current     Current
## 1409      Exited     Current
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## 1503     Current     Current
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## 1665     Exited    Current
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## 1771     Current       Exited
```

```r
# use the confusionMatrix() function from the caret package
conf_mat_dt <- confusionMatrix(pred_combined_dt$true_class, pred_combined_dt$predictions, positive = "E:

# Print the matrix
conf_mat_dt
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Current Exited
##     Current    1018    474
##     Exited      153    126
##
##                Accuracy : 0.646
##                  95% CI : (0.6232, 0.6683)
##     No Information Rate : 0.6612
##     P-Value [Acc > NIR] : 0.9159
##
##                   Kappa : 0.0912
##
##  Mcnemar's Test P-Value : <2e-16
##
##             Sensitivity : 0.21000
##             Specificity : 0.86934
##          Pos Pred Value : 0.45161
##          Neg Pred Value : 0.68231
##              Prevalence : 0.33879
##          Detection Rate : 0.07115
##    Detection Prevalence : 0.15754
##       Balanced Accuracy : 0.53967
##
##        'Positive' Class : Exited
##
```

## Compare and Evaluate

The evaluation metric for this competition is AUC (Area Under the Curve) ROC (Receiver Operating Characteristics) curve.

`rocit` is the main function of ROCit package. With the diagnostic score and the class of each observation, it calculates true positive rate (sensitivity) and false positive rate (1-Specificity) at convenient cutoff values to construct ROC curve.

```r
#calculate GLM AUC
# library(pROC)
roc_glm=roc(response=pred_combined_glm$true_class,
            predictor= factor(pred_combined_glm$predictions, ordered = TRUE), plot=FALSE)
```

```
## Setting levels: control = Current, case = Exited
```

```
## Warning in value[[3L]](cond): Ordered predictor converted to numeric vector.
## Threshold values will not correspond to values in predictor.
```

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

```
auc_glm<-auc(roc_glm)
auc_glm
```

```
## Area under the curve: 0.4996
```

```
#calculate SVM AUC
roc_svm=roc(response=pred_combined_svm$true_class,
            predictor= factor(pred_combined_svm$predictions, ordered = TRUE), plot=FALSE)
```

```
## Setting levels: control = Current, case = Exited
```

```
## Warning in value[[3L]](cond): Ordered predictor converted to numeric vector.
## Threshold values will not correspond to values in predictor.
```

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

```
auc_svm<-auc(roc_svm)
auc_svm
```

```
## Area under the curve: 0.5227
```

```
#calculate DT AUC
roc_dt=roc(response=pred_combined_dt$true_class,
           predictor= factor(pred_combined_dt$predictions, ordered = TRUE), plot=FALSE)
```

```
## Setting levels: control = Current, case = Exited
```

```
## Warning in value[[3L]](cond): Ordered predictor converted to numeric vector.
## Threshold values will not correspond to values in predictor.
```

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

```
auc_dt<-auc(roc_dt)
auc_dt
```

```
## Area under the curve: 0.567
```

```
# compare
auc_combine <- data.frame(AUC_AOC = c(auc_glm, auc_svm, auc_dt),
                          row.names = c("GLM", "SVM", "Decision Tree"))
auc_combine
```

```
##                 AUC_AOC
## GLM           0.4995628
## SVM           0.5227077
## Decision Tree 0.5669593
```

The higher AUC_AOC, the better the classifier. So Decision Tree is the best model of all.