Proyecto 02

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12/4/2020

¿Es posible predecir desbalances de tension?

¿Por que no usar series de tiempo?

huecos en las mediciones (faltantes)

Carga de librerias

```
knitr::opts_chunk$set(echo = TRUE)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
#library(RODBC)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following object is masked from 'package:base':
##
##     date
```

```
library(feather)
library(ggplot2)
library(tidyr)
library(caTools)
library(randomForest)
```

```
## randomForest 4.6-14

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

```
##
## Attaching package: 'randomForest'

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

## The following object is masked from 'package:dplyr':
##
##     combine
```

```r
library(caret)
```

```
## Loading required package: lattice
```

```r
library(e1071)
library(mltest)
library(pROC)
```

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

##
## Attaching package: 'pROC'

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

Rango de fechas (lubridate)

```r
final_dateCR <- floor_date(now(), "week") + days(1) ## primer lunes hacia atras
initial_dateCR <- final_dateCR - years(3) ## 3 años hacia atras
```

Fecha-hora a UTC (lubridate) (DB está en UTC)

```r
initial_date <- with_tz(initial_dateCR, tzone = "UTC")
final_date <- with_tz(final_dateCR, tzone = "UTC")
```

Valores Nominales (vectores)

```r
nom_voltage <- 35000
cut_voltage <- 34000
clasif <- c("Low" = 0.3,
                     "Low_Mid" = 0.5,
                     "Mid" = 0.7,
                     "Mid_High" = 0.9,
                     "High" = 1.1)
```

Conexion a SQL Server y carga de tablas (RODBC)

```r
channel <- odbcConnect("SQL_ION", uid="sa", pwd="Con3$adm.")
#sources <- sqlQuery(channel , "select top 100 ID, Name, DisplayName from Source where Name like 'Coope
sources <- sqlQuery(channel , "select top 100 ID, Name, DisplayName from Source where Name like 'Coopeal
#sources$Name <- gsub("Coopeguanacaste.", '', sources$Name)
sources$Name <- gsub("Coopealfaroruiz.", '', sources$Name)l
sources <- sources %>% filter(ID %in% c(9))

quantity <- sqlQuery(channel , "select top 1500000 ID, Name from Quantity where Name like 'Voltage%'")
quantity <- quantity %>% filter(grepl("^Voltage Phases [ABC][ABC] Mean$", Name))
quantity$Name <- c('Vab', 'Vbc', 'Vca')

sources_ids <- paste0(sources$ID, collapse = ",")
quantity_ids <- paste0(quantity$ID, collapse = ",")
dataLog <- sqlQuery(channel , paste0("select top 500000 * from dataLog2 where ",
                                     "SourceID in (", sources_ids, ")",
                                     " and QuantityID in (", quantity_ids, ")",
                                     " and TimestampUTC >= '", initial_date, "'",
                                     " and TimestampUTC < '", final_date, "'"))

odbcCloseAll()
```

Guardar archivos con las tablas

```r
#write_feather(dataLog, "featherFiles/dataLog.feather")
#write_feather(quantity, "featherFiles/quantity.feather")
#write_feather(sources, "featherFiles/sources.feather")
```

Leer Archivos de las tablas

```r
#rm(dataLog, quantity, sources)
dataLog  <- read_feather("featherFiles/dataLog.feather")
quantity <- read_feather("featherFiles/quantity.feather")
sources  <- read_feather("featherFiles/sources.feather")
```

Contenido de las tablas

Datalog

```r
glimpse(dataLog)
```

```
## Observations: 315,360
## Variables: 5
## $ ID           <int> 31652855, 31653877, 31654633, 31655697, 31656715, 316577...
## $ Value        <dbl> 35683.51, 35718.07, 35744.92, 35743.99, 35745.72, 35756....
## $ SourceID     <int> 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9,...
## $ QuantityID   <int> 167, 167, 167, 167, 167, 167, 167, 167, 167, 167, 167, 1...
## $ TimestampUTC <fct> 2017-04-20 06:00:00.0000000, 2017-04-20 06:15:00.0000000...
```

Quantity

```
glimpse(quantity)
```

```
## Observations: 3
## Variables: 2
## $ ID   <int> 167, 173, 176
## $ Name <chr> "Vab", "Vbc", "Vca"
```

Sources

```
glimpse(sources)
```

```
## Observations: 1
## Variables: 3
## $ ID          <int> 9
## $ Name        <chr> "Sub_Laguna"
## $ DisplayName <fct> Coopealfaroruiz.Sub_Laguna
```

Transformacion de datos para analisis previo

Union de tablas, borrado de columnas no importantes y Categorizacion de valores

```
## Transformacion de columnas
dataLog$TimestampUTC <- as_datetime(dataLog$TimestampUTC)
dataLog$TimestampCR <- with_tz(dataLog$TimestampUTC, tzone = "America/Costa_Rica")
dataLog$TimestampUTC <- NULL
dataLog$ID <- NULL
dataLog$year <- year(dataLog$TimestampCR)
dataLog$month <- month(dataLog$TimestampCR)
dataLog$day <- day(dataLog$TimestampCR)
dataLog$hour <- hour(dataLog$TimestampCR)
dataLog$minute <- minute(dataLog$TimestampCR)
dataLog$wday <- wday(dataLog$TimestampCR)
dataLog$wdayName <- weekdays(dataLog$TimestampCR)
dataLog$monthName <- month.abb[dataLog$month]

dataLog$hour2 <- hour(dataLog$TimestampCR)+ (minute(dataLog$TimestampCR)/60)

dataLog <- dataLog %>% left_join(quantity, by = c('QuantityID' = "ID")) %>%
  left_join(sources, by = c('SourceID' = "ID"))

names(dataLog)[names(dataLog) == "Name.x"] <- "Quantity"
names(dataLog)[names(dataLog) == "Name.y"] <- "Meter"

dataLog$SourceID <- NULL
dataLog$QuantityID <- NULL
dataLog$DisplayName <- NULL
#rm(quantity, sources)
```

Contenido de la tabla Datalog

```
glimpse(dataLog)
```

```
## Observations: 315,360
## Variables: 13
## $ Value       <dbl> 35683.51, 35718.07, 35744.92, 35743.99, 35745.72, 35756.9...
## $ TimestampCR <dttm> 2017-04-20 00:00:00, 2017-04-20 00:15:00, 2017-04-20 00:...
## $ year        <dbl> 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 201...
## $ month       <dbl> 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, ...
## $ day         <int> 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2...
## $ hour        <int> 0, 0, 0, 0, 1, 1, 1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, ...
## $ minute      <int> 0, 15, 30, 45, 0, 15, 30, 45, 0, 15, 30, 45, 0, 15, 30, 4...
## $ wday        <dbl> 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, ...
## $ wdayName    <chr> "Thursday", "Thursday", "Thursday", "Thursday", "Thursday...
## $ monthName   <chr> "Apr", "Apr", "Apr", "Apr", "Apr", "Apr", "Apr", "Apr", "...
## $ hour2       <dbl> 0.00, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.2...
## $ Quantity    <chr> "Vab", "Vab", "Vab", "Vab", "Vab", "Vab", "Vab", "Vab", "...
## $ Meter       <chr> "Sub_Laguna", "Sub_Laguna", "Sub_Laguna", "Sub_Laguna", "...
```

Análisis de datos

Histogramas y boxplots

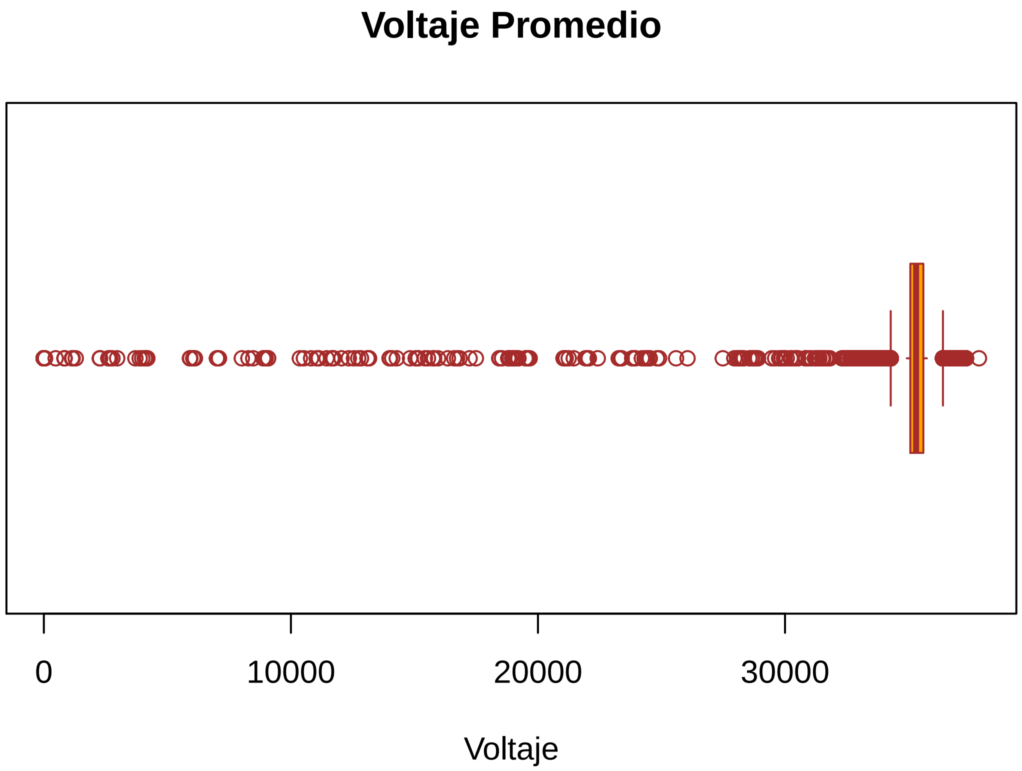
Cantidad de filas inicial

```
initial_rows <- nrow(dataLog)
initial_rows
```

```
## [1] 315360
```

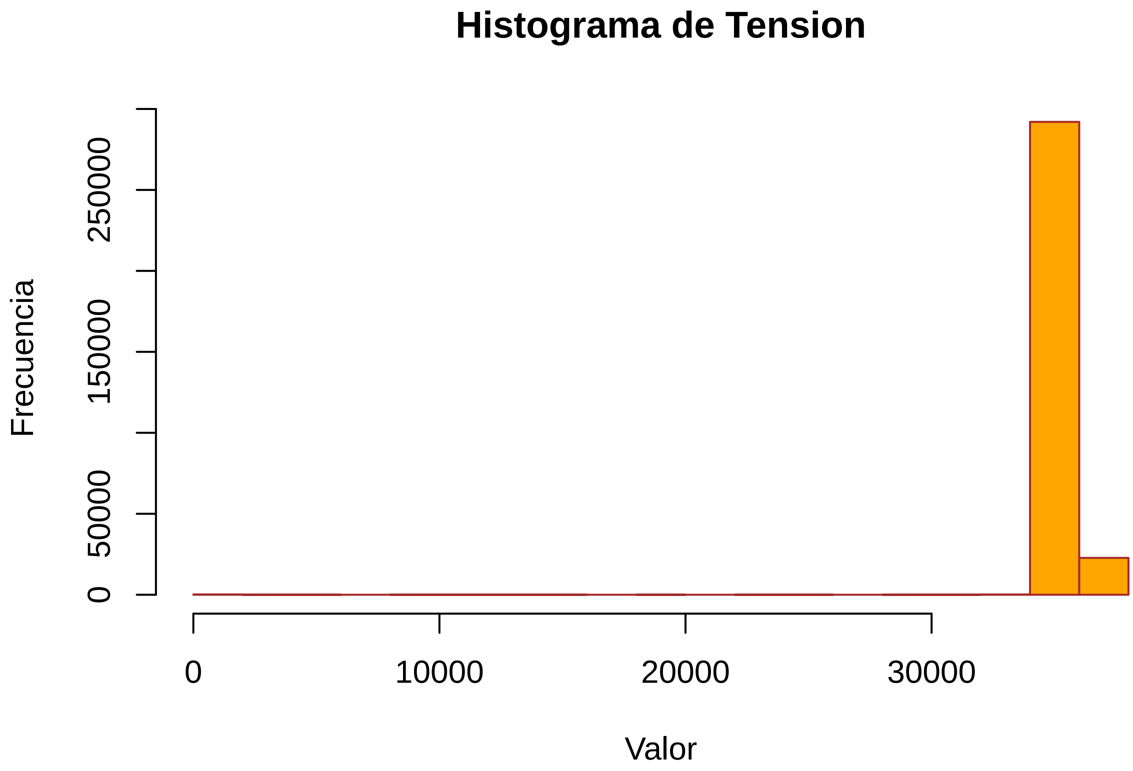
Boxplot del comportamiento de la tension (horizontal)

```
boxplot(dataLog$Value, xlab= "Voltaje", col="Orange", border = "brown", horizontal = T, main = "Voltaje
```



Histograma inicial

```
hist(dataLog$Value, col="Orange", border = "brown", xlab = "Valor", ylab = "Frecuencia", main = "Histog
```



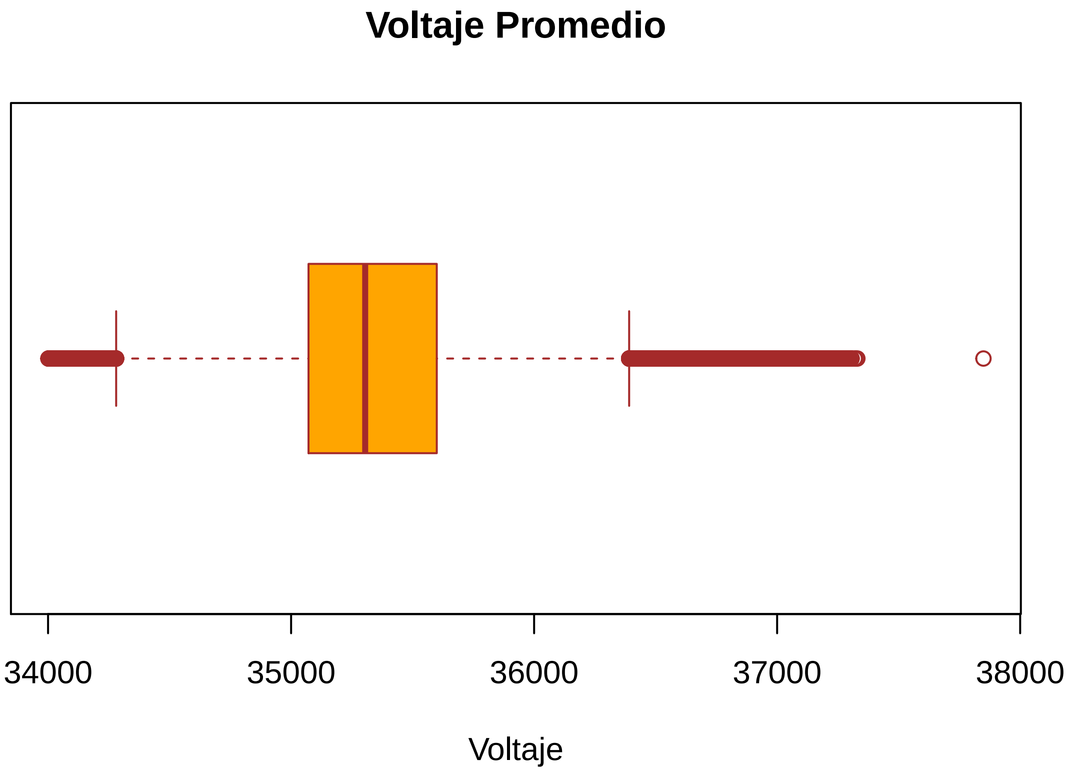
Variable temporal solo para análisis (originalmente se tenian 15825 rows)

```
dl_temp <- dataLog %>% filter(Value > cut_voltage)
### Cantidad de filas
final_rows <- nrow(dl_temp)
print(paste0 ("Se eliminaron el ", round(100*((initial_rows - final_rows)/initial_rows), 2), "% de las
```

```
## [1] "Se eliminaron el 0.18% de las filas"
```

Boxplot con un filtro temporal de los datos (para análisis unicamente)

```
boxplot(dl_temp$Value, xlab= "Voltaje", col="Orange", border = "brown", horizontal = T, main = "Voltaje
```



Histograma eliminando outliers de la tabla temporal

```
hist(dl_temp$Value, col="Orange", border = "brown", xlab = "Tension", ylab = "Frecuencia", breaks = 60,
```

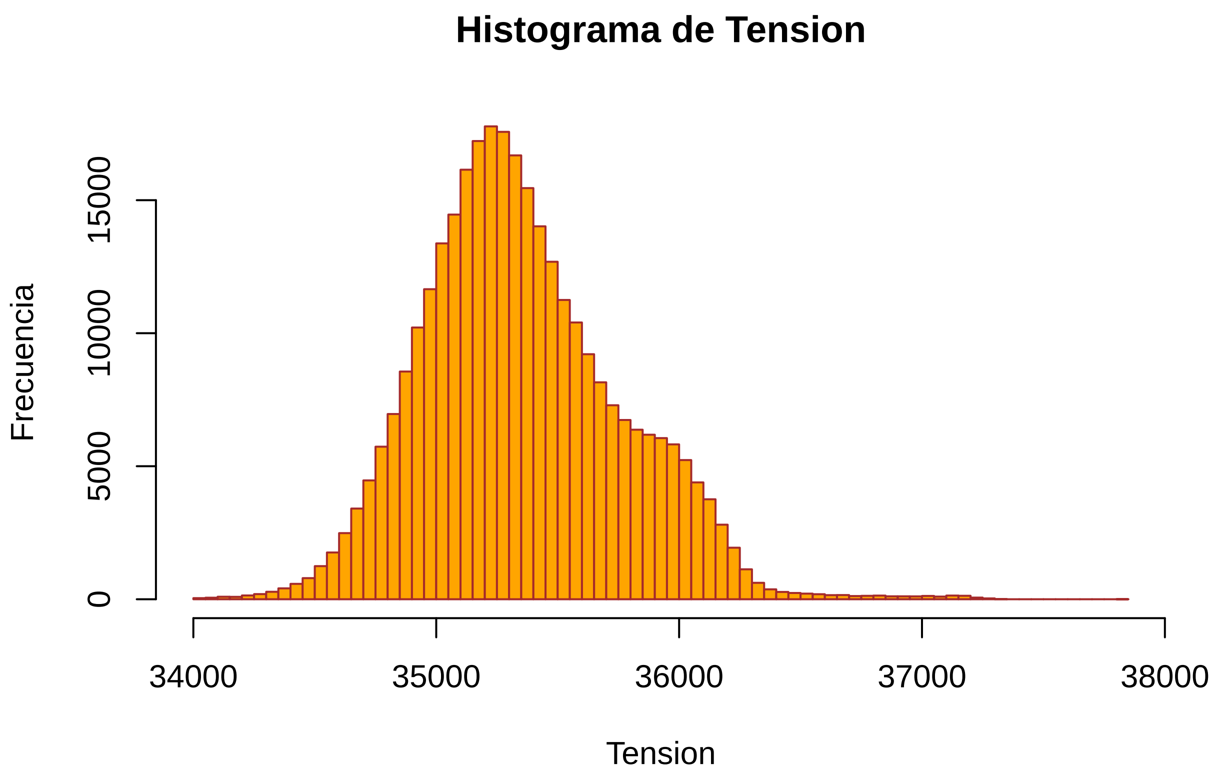
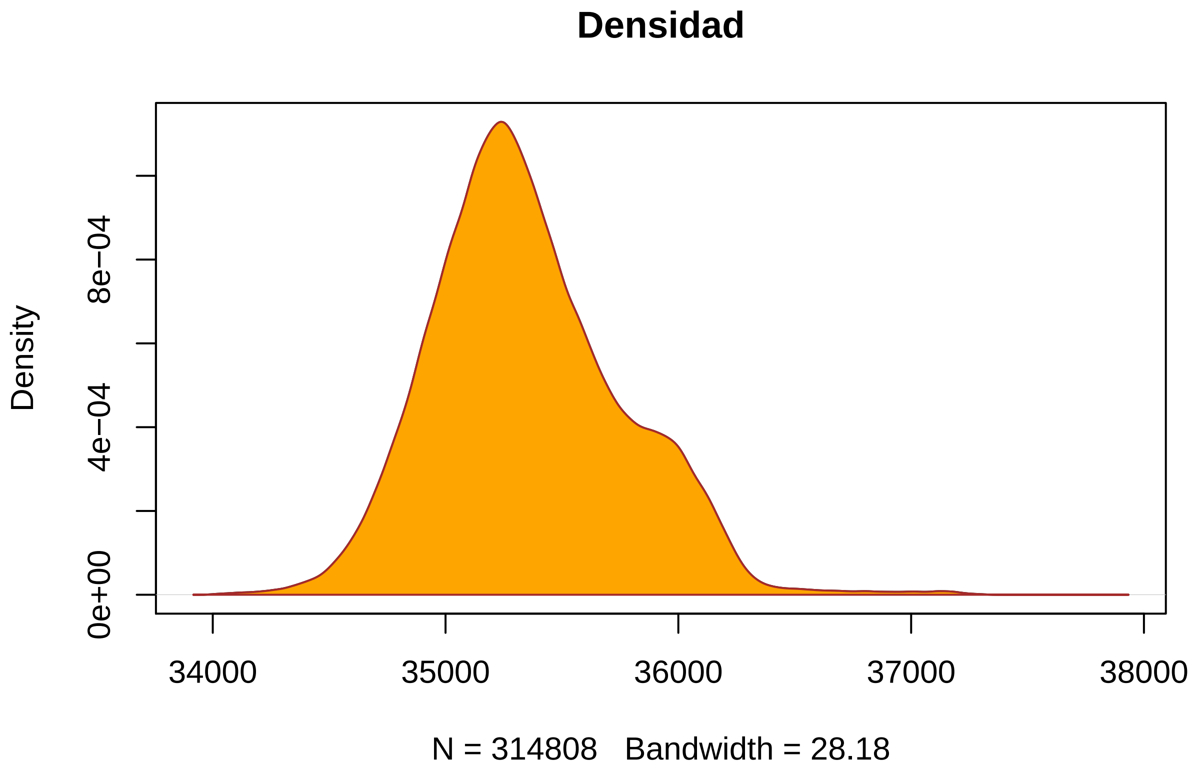


Grafico de densidad

```
d <- density(dl_temp$Value)
plot(d, main = "Densidad")
polygon(d, col = "Orange", border = "brown")
```



Boxplot separado por variable

```r
bp <- ggplot(dl_temp, aes(Quantity, Value))
bp <- bp + geom_boxplot(aes(colour = Quantity))
bp <- bp + scale_color_brewer(palette="Dark2")
bp
```

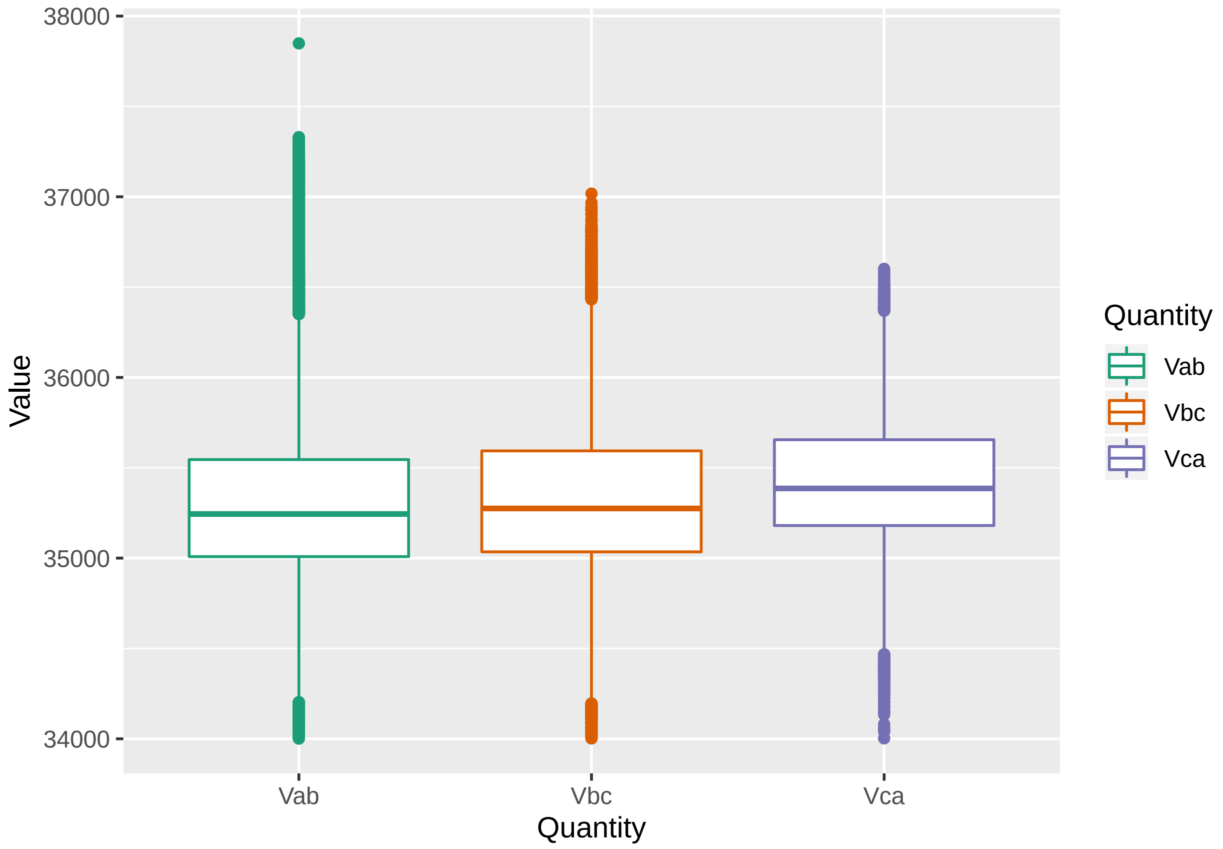
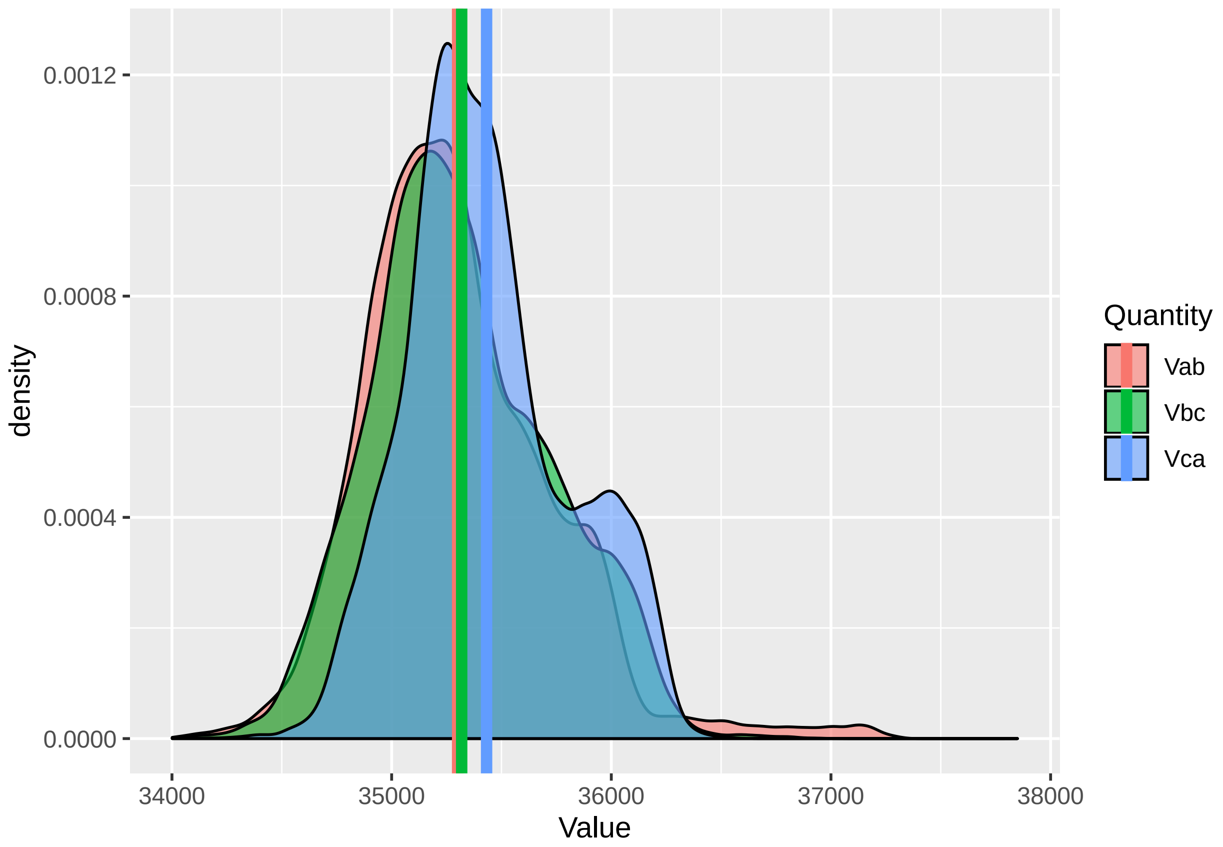


Grafico de densidad para cada variable

```
lineas <- dl_temp %>% group_by(Quantity) %>% summarise(v = mean(Value))

p <- ggplot(dl_temp, aes(x=Value, fill = Quantity)) +
  geom_density(alpha = 0.6) +
  geom_vline(data=lineas, aes(xintercept=v, color=Quantity), size = 2)
p
```



Aqui inician la modificaciones reales de los datos

Pivot para generar columnas para las 3 variables de tension y eliminar los outliers, Cálculo del procentaje de desbalance y categoria del mismo

```
## pivot respecto de Quantity
dataLog2 <- tidyr::spread(dataLog, Quantity, Value)

## filtro de valores menores al corte
dataLog2 <- dataLog2 %>% filter(Vab > cut_voltage, Vbc>cut_voltage, Vca > cut_voltage)

## definicion de metodos
## Calculo de desbalance maximo
unbal_calc  <- function(va, vb, vc){
  maximo =  pmax(abs(va-vb), abs(vb-vc), abs(vc-va))
  promedio = (va + vb + vc)/3
  unb <- 100*maximo/promedio
  return(unb)
}

## categoria del desbalance
unbal_categ  <- function(unb){
  unb_class <- case_when(unb < clasif["Low"] ~ "Low",
                     unb < clasif["Low_Mid"] ~ "Low_Mid",
                     unb < clasif["Mid"] ~ "Mid",
                      unb < clasif["Mid_High"] ~ "Mid_High",
                      unb < clasif["High"] ~ "High",
                      TRUE ~ "Very_High"
                      )
  return(unb_class)
}

## nuevas columnas
dataLog2 <- dataLog2 %>%
  mutate (unbalance = unbal_calc(Vab, Vbc, Vca)) %>%
  mutate (unbal_cat = factor(unbal_categ(unbalance), levels = c("Low","Low_Mid","Mid","Mid_High","High"
  select (year, monthName, day, hour, minute, wdayName, unbalance, unbal_cat)

## converson de variables
dataLog2$year <- as.integer(dataLog2$year)
dataLog2$monthName <- factor(dataLog2$monthName, levels = month.abb[1:12])
dataLog2$day <- factor(dataLog2$day, levels = c(1:31))
dataLog2$hour <- factor(dataLog2$hour, levels = c(0:23))
dataLog2$minute <- factor(dataLog2$minute, levels = c(0, 15, 30, 45))
dataLog2$wdayName <- factor(dataLog2$wdayName)

## tabla resultado
glimpse(dataLog2)
```

```
## Observations: 104,917
## Variables: 8
## $ year      <int> 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017,...
## $ monthName <fct> Apr, Apr, Apr, Apr, Apr, Apr, Apr, Apr, Apr, Apr, Apr, Apr,...
## $ day       <fct> 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,...
## $ hour      <fct> 0, 0, 0, 0, 1, 1, 1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, 4,...
## $ minute    <fct> 0, 15, 30, 45, 0, 15, 30, 45, 0, 15, 30, 45, 0, 15, 30, 45,...
## $ wdayName  <fct> Thursday, Thursday, Thursday, Thursday, Thursday, Thursday,...
## $ unbalance <dbl> 0.7842734, 0.7162294, 0.7333590, 0.7271818, 0.7305882, 0.74...
## $ unbal_cat <fct> Mid_High, Mid_High, Mid_High, Mid_High, Mid_High, Mid_High,...
```

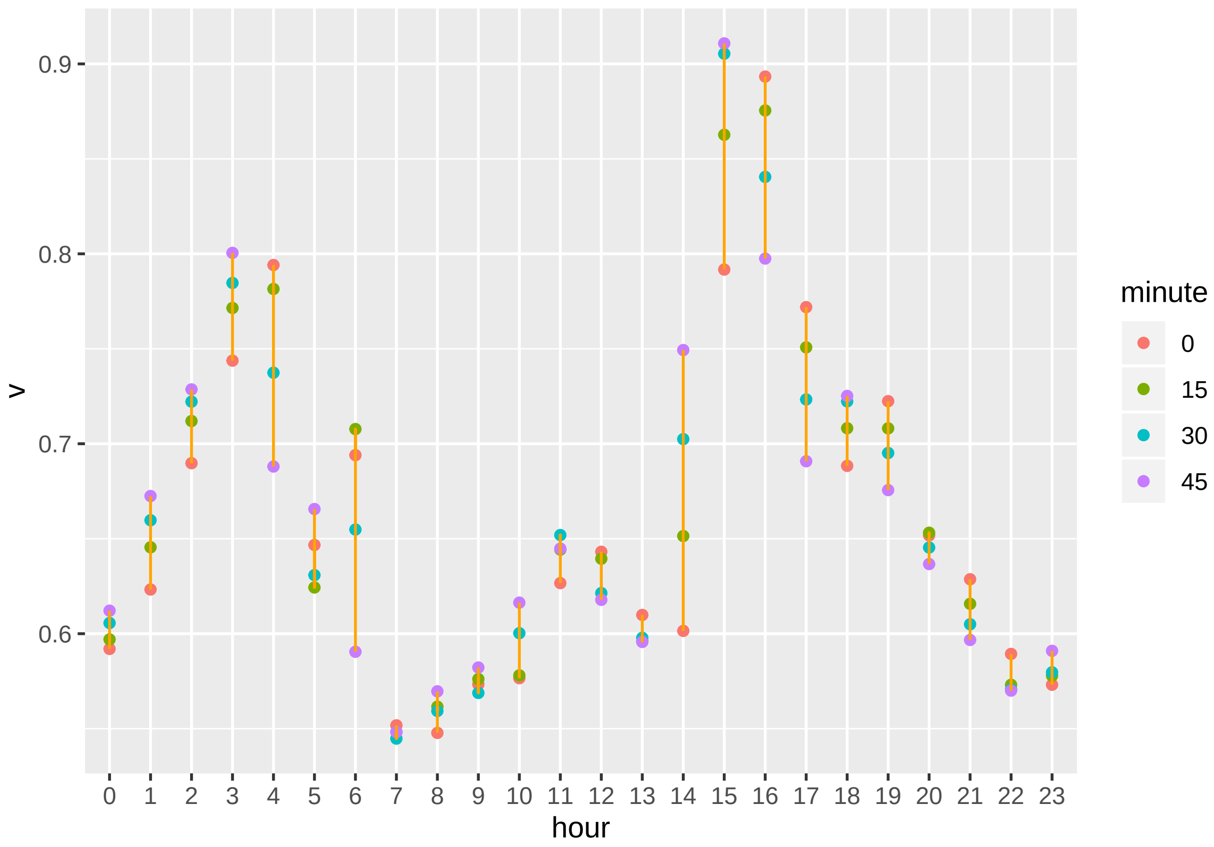
tabla de conteo de elementos en cada categoria

```
table(dataLog2$unbal_cat)
```

```
##
##       Low   Low_Mid       Mid  Mid_High      High Very_High
##      9825     27384     32487     19206      7412      8603
```

Desbalance promedio

```
a <- dataLog2 %>% group_by(hour, minute) %>% summarise(v = mean(unbalance))
ggplot(a, aes(hour, v)) + geom_point(aes(colour = minute)) + geom_line(col = "orange")
```



Particionamiento de los datos

```
dL <- dataLog2 %>% filter (year %in% c(2019))  %>%
  select(-unbalance)

  ##  select(-unbalance, -day, -minute)

set.seed(4)
mascara <- sample.split(dL$unbal_cat, SplitRatio = 7/10)
training_data <- dL[mascara,]
test_data <- dL[!mascara,]

table(dL$unbal_cat)
```

```
##
##       Low   Low_Mid       Mid  Mid_High      High Very_High
##      3265     11587     12565      4911      1158      1492
```

para obtener la importancia de la variables

Modelo 1

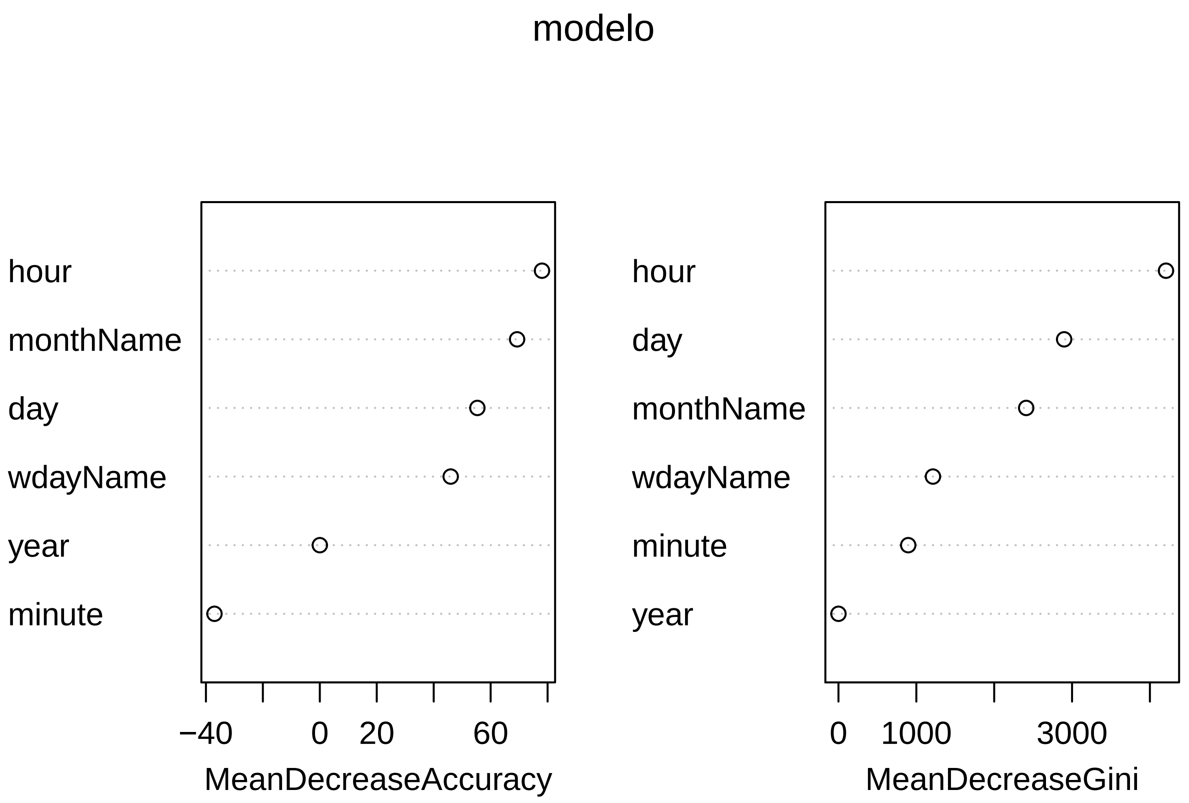
```
start_time <- Sys.time()

modelo <- randomForest(formula = unbal_cat ~ .,
                       data = training_data, ntree=100,
                       importance=TRUE,
                       test=test_data)
end_time <- Sys.time()
end_time - start_time

## Guardar el modelo en disco
saveRDS(modelo, file = "models/modelo2019.modelo")
```

Grafica de importancia

```
modelo <- readRDS(file = "models/modelo2019.modelo")
varImpPlot(modelo)
```



Calculo del area bajo la curva

```
pred <- predict(modelo, newdata = test_data, type = "prob")
pred_f <- predict(modelo, newdata = test_data)
roc.multi <- multiclass.roc(test_data$unbal_cat, pred)
```

```
modelo1_auc <- auc(roc.multi)
modelo1_auc
```

```
## Multi-class area under the curve: 0.9189
```

```
cm1 <- confusionMatrix(test_data$unbal_cat, pred_f)
cm1$table
```

```
##             Reference
## Prediction   Low Low_Mid  Mid Mid_High High Very_High
##   Low        389     538   51        0    0         1
##   Low_Mid    115    2607  744        9    0         1
##   Mid          4     691 2851      219    2         2
##   Mid_High     1      58  588      804   17         5
##   High         0      13   37      238   44        15
##   Very_High    0      12    6       15    7       408
```

Modelo 2

Quitando la variablde del modelo

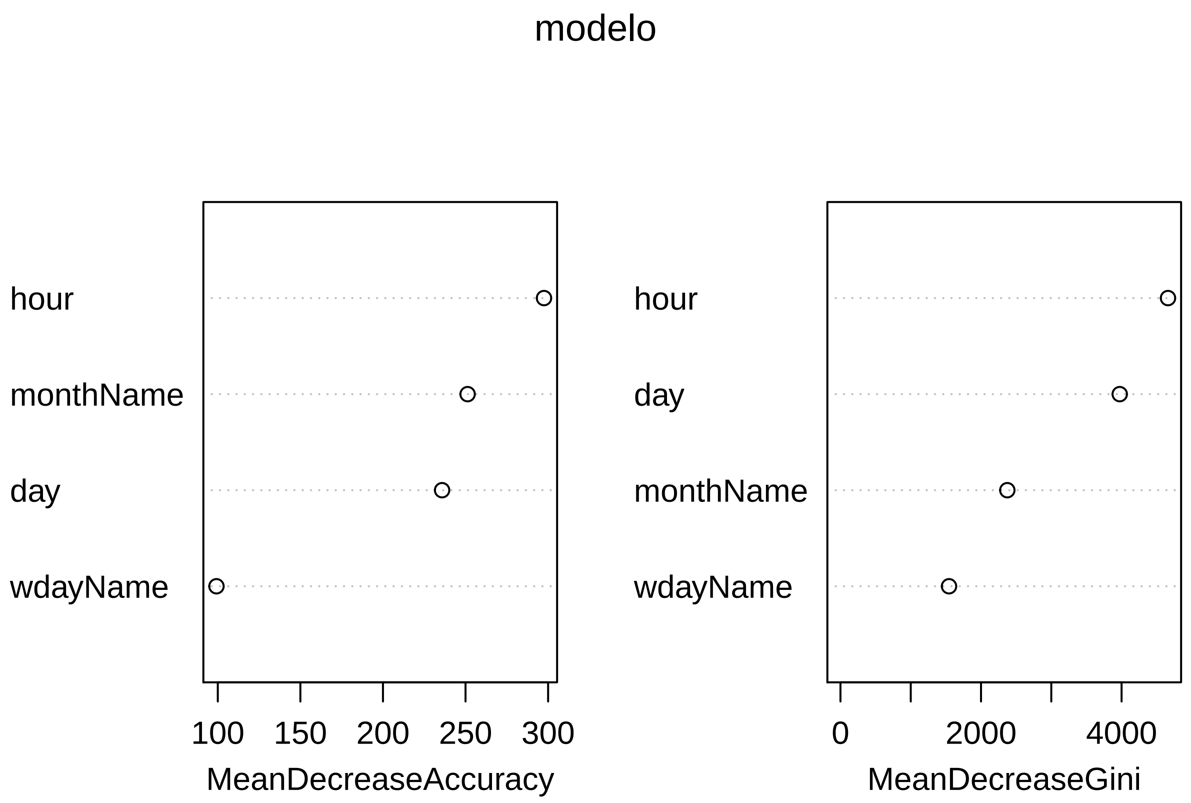
```
start_time <- Sys.time()

modelo <- randomForest(formula = unbal_cat ~ . - year - minute,
                       data = training_data, ntree=100,
                       importance=TRUE,
                       test=test_data)
end_time <- Sys.time()
end_time - start_time

## Guardar el modelo en disco
saveRDS(modelo, file = "models/modelo2019_2.modelo")
```

Grafica de importancia

```
modelo <- readRDS(file = "models/modelo2019_2.modelo")
varImpPlot(modelo)
```



Calculo del area bajo la curva

```
pred <- predict(modelo, newdata = test_data, type = "prob")
pred_f <- predict(modelo, newdata = test_data)
roc.multi <- multiclass.roc(test_data$unbal_cat, pred)

modelo2_auc <- auc(roc.multi)
modelo2_auc
```

```
## Multi-class area under the curve: 0.9227
```

```
cm2 <- confusionMatrix(test_data$unbal_cat, pred_f)
cm2$table
```

```
##             Reference
## Prediction   Low Low_Mid  Mid Mid_High High Very_High
##   Low        605     347   26        1    0         0
##   Low_Mid    256    2559  632       24    4         1
##   Mid         18     649 2778      305   17         2
##   Mid_High     3      41  432      900   94         3
##   High         0       7   15      177  131        17
##   Very_High    0       3    6        8   15       416
```

Modelo 3

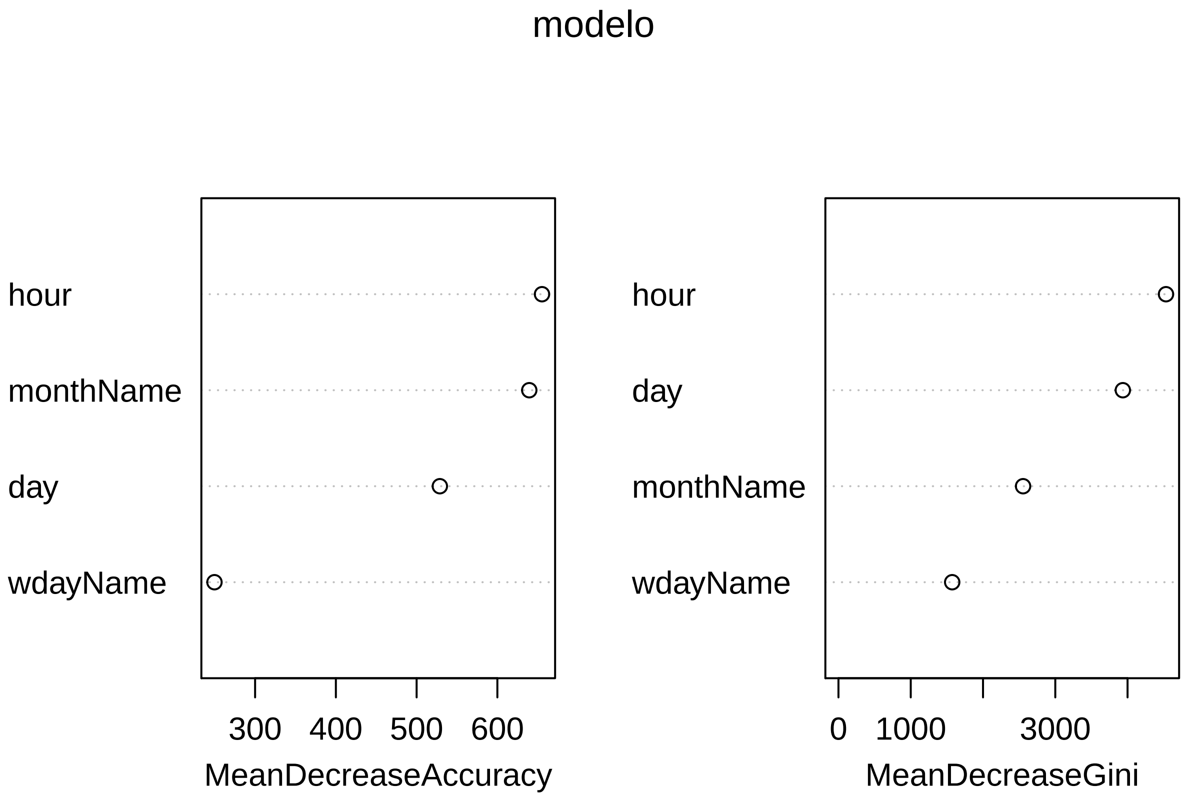
```
start_time <- Sys.time()

modelo <- randomForest(formula = unbal_cat ~ . - year - minute,
                       data = training_data,
                       ntree=500,
                       keep.forest=TRUE,
                       importance=TRUE,
                       test=test_data)
end_time <- Sys.time()
end_time - start_time

## Guardar el modelo en disco
saveRDS(modelo, file = "models/modelo2019_3.modelo")
```

Grafica de importancia

```
modelo <- readRDS(file = "models/modelo2019_3.modelo")
varImpPlot(modelo)
```



Calculo del area bajo la curva

```r
pred <- predict(modelo, newdata = test_data, type = "prob")
pred_f <- predict(modelo, newdata = test_data)
roc.multi <- multiclass.roc(test_data$unbal_cat, pred)

modelo3_auc <- auc(roc.multi)
modelo3_auc
```

```
## Multi-class area under the curve: 0.9299
```

```r
cm3 <- confusionMatrix(test_data$unbal_cat, pred_f)
cm3$table
```

```
##            Reference
## Prediction   Low Low_Mid  Mid Mid_High High Very_High
##   Low        605     347   26        1    0         0
##   Low_Mid    252    2556  641       22    4         1
##   Mid         16     627 2792      316   16         2
##   Mid_High     3      40  436      899   92         3
##   High         0       5   12      179  132        19
##   Very_High    0       2    5        8   15       418
```

Comparacion de las AUC

```r
print(paste("Area bajo la curva modelo 1: ", modelo1_auc))
```

```
## [1] "Area bajo la curva modelo 1:  0.918866574356504"
```

```r
print(paste("Area bajo la curva modelo 2: ", modelo2_auc))
```

```
## [1] "Area bajo la curva modelo 2:  0.922737168107493"
```

```r
print(paste("Area bajo la curva modelo 3: ", modelo3_auc))
```

```
## [1] "Area bajo la curva modelo 3:  0.929945486482963"
```

Comparacionde las matrices de confucion

```r
aciertos <- 0
for (i in 1:nrow(cm1$table)){
  aciertos <- aciertos + cm1$table[i,i]
}

print(paste("Se acertaron:", aciertos, "predicciones"))
```

```
## [1] "Se acertaron: 7103 predicciones"
```

```
cm1$table
```

```
##             Reference
## Prediction    Low Low_Mid  Mid Mid_High High Very_High
##   Low         389     538   51        0    0         1
##   Low_Mid     115    2607  744        9    0         1
##   Mid           4     691 2851      219    2         2
##   Mid_High      1      58  588      804   17         5
##   High          0      13   37      238   44        15
##   Very_High     0      12    6       15    7       408
```

```
aciertos <- 0
for (i in 1:nrow(cm2$table)){
  aciertos <- aciertos + cm2$table[i,i]
}

print(paste("Se acertaron:", aciertos, "predicciones"))
```

```
## [1] "Se acertaron: 7389 predicciones"
```

```
cm2$table
```

```
##             Reference
## Prediction    Low Low_Mid  Mid Mid_High High Very_High
##   Low         605     347   26        1    0         0
##   Low_Mid     256    2559  632       24    4         1
##   Mid          18     649 2778      305   17         2
##   Mid_High      3      41  432      900   94         3
##   High          0       7   15      177  131        17
##   Very_High     0       3    6        8   15       416
```

```
aciertos <- 0
for (i in 1:nrow(cm3$table)){
  aciertos <- aciertos + cm3$table[i,i]
}

print(paste("Se acertaron:", aciertos, "predicciones"))
```

```
## [1] "Se acertaron: 7402 predicciones"
```

```
cm3$table
```

```
##             Reference
## Prediction    Low Low_Mid  Mid Mid_High High Very_High
##   Low         605     347   26        1    0         0
##   Low_Mid     252    2556  641       22    4         1
##   Mid          16     627 2792      316   16         2
##   Mid_High      3      40  436      899   92         3
##   High          0       5   12      179  132        19
##   Very_High     0       2    5        8   15       418
```