# 15.- Feature Importance_04_19_vacunacion_completo_v_01

June 8, 2023

#

CU04_Optimización de vacunas

Citizenlab Data Science Methodology > III - Feature Engineering Domain *** > # 15.- Feature Importance

Feature Importance is the process that assigns scores to the input characteristics to a model, which indicate the relative importance of each characteristic, in order, for example, to be able to select the most important ones.

## 0.1 Tasks

Perform Feature importance from model coefficients
- Linear Regression Feature importance
- Logistic Regression Feature importance

Perform Feature importance from Decision Tree
- CART Feature Importance
- Random Forest Regression Feature Importance

Perform Feature importance from Permutation testing

Evaluate a Logistic Regression model with feature selection

## 0.2 Consideraciones casos CitizenLab programados en R

- Algunas de las tareas de este proceso se han realizado en los notebooks del proceso 05 Data Collection porque eran necesarias para las tareas ETL. En esos casos, en este notebook se referencia al notebook del proceso 05 correspondiente
- Otras tareas típicas de este proceso se realizan en los notebooks del dominio IV al ser más eficiente realizarlas en el propio pipeline de modelización.
- Por tanto en los notebooks de este proceso de manera general se incluyen las comprobaciones necesarias, y comentarios si procede
- Las tareas del proceso se van a aplicar solo a los archivos que forman parte del despliegue, ya que hay muchos archivos intermedios que no procede pasar por este proceso
- El nombre de archivo del notebook hace referencia al nombre de archivo del proceso 05 al que se aplica este proceso, por eso pueden no ser correlativa la numeración
- Las comprobaciones se van a realizar teniendo en cuenta que el lenguaje utilizado en el despliegue de este caso es R

## 0.3 File

- Input File: CU_04_08_20_vacunacion_gripe_train_and_test.csv
- Output File: No aplica

### 0.3.1 Encoding

Con la siguiente expresión se evitan problemas con el encoding al ejecutar el notebook. Es posible que deba ser eliminada o adaptada a la máquina en la que se ejecute el código.

```
[ ]: Sys.setlocale(category = "LC_ALL", locale = "es_ES.UTF-8")
```

## 0.4 Settings

### 0.4.1 Libraries to use

```
[1]: library(readr)
     library(dplyr)
     library(tidyr)
     library(forcats)
     library(lubridate)
```

```
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



Attaching package: 'lubridate'


The following objects are masked from 'package:base':

    date, intersect, setdiff, union
```

### 0.4.2 Paths

```
[2]: iPath <- "Data/Input/"
     oPath <- "Data/Output/"
```

## 0.5 Data Load

OPCION A: Seleccionar fichero en ventana para mayor comodidad

Data load using the {tcltk} package. Ucomment the line if using this option

```
[3]: # file_data <- tcltk::tk_choose.files(multi = FALSE)
```

OPCION B: Especificar el nombre de archivo

```
[4]: iFile <- "CU_04_08_20_vacunacion_gripe_train_and_test.csv"
     file_data <- paste0(iPath, iFile)

     if(file.exists(file_data)){
         cat("Se leerán datos del archivo: ", file_data)
     } else{
         warning("Cuidado: el archivo no existe.")
     }
```

```
Se leerán datos del archivo:
Data/Input/CU_04_08_20_vacunacion_gripe_train_and_test.csv
```

**Data file to dataframe** Usar la función adecuada según el formato de entrada (xlsx, csv, json, ...)

```
[5]: data <- read_csv(file_data)
```

```
Rows: 21736 Columns: 49
  Column specification



Delimiter: ","
chr  (3): GEOCODIGO, DESBDT, nombre_zona
dbl (45): ano, semana, n_vacunas, n_citas, tmed, prec, velmedia,
presMax, be…
lgl  (1): is_train


  Use `spec()` to retrieve the full column specification for this
data.
  Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

Estructura de los datos:

```
[6]: data |> glimpse()
```

```
Rows: 21,736
Columns: 49
$ GEOCODIGO        <chr> "259", "260", "041", "025", "046",
"159", "065", "09…
$ DESBDT           <chr> "V Centenario", "Valdeacederas",
"Canillejas", "Bara…
$ ano              <dbl> 2022, 2022, 2022, 2022, 2022, 2022,
2022, 2021, 2023…
$ semana           <dbl> 34, 8, 9, 49, 24, 3, 8, 47, 1, 2,
52, 39, 16, 50, 34…
$ n_vacunas        <dbl> 0, 0, 0, 292, 0, 524, 0, 248, 204,
205, NA, 0, 0, 51…
$ n_citas          <dbl> 0, 0, 0, 280, 0, 498, 0, 228, 198,
187, NA, 0, 0, 51…
$ tmed             <dbl> 27.278748, 9.577289, 8.536554,
9.065363, 29.905728, …
$ prec             <dbl> 0.169955881, 1.264910043,
3.122881160, 7.313886680, …
$ velmedia         <dbl> 2.297067, 1.890425, 2.418071,
1.562328, 2.564749, 1.…
$ presMax          <dbl> 940.0420, 944.1770, 949.7179,
941.8342, 940.5669, 95…
$ benzene          <dbl> 0.1764413, 0.4591543, 0.4099159,
0.4224172, 0.195865…
$ co               <dbl> 0.4987735, 0.3960647, 0.3951587,
NA, 0.2891224, 0.50…
$ no               <dbl> NA, 6.611337, 9.331224, 14.007722,
4.063517, 24.4756…
$ no2              <dbl> 14.21113, 34.67671, 30.29999,
32.54832, 26.06913, 44…
$ nox              <dbl> 18.00109, 48.94660, 45.22346,
56.75574, 30.35311, 74…
$ o3               <dbl> 80.90659, 42.06663, 48.88088,
26.68276, 64.55205, 31…
$ pm10             <dbl> 20.117087, 15.042152, 14.002432,
18.032354, 55.79346…
$ pm2.5            <dbl> 10.628064, 5.539590, 7.124192,
6.793868, 19.520373, …
$ so2              <dbl> 2.794934, 3.507164, 2.692125,
2.351139, 3.397640, 2.…
$ campana          <dbl> NA, NA, NA, 2022, NA, 2021, NA,
2021, 2022, 2021, 20…
$ scampana         <dbl> NA, NA, NA, 14, NA, 20, NA, 12, 18,
19, 17, 4, NA, 1…
$ capacidad_zona   <dbl> 7957, 6537, 7167, 5633, 3864,
```

```
12583, 8544, 5077, 494…
$ prop_riesgo      <dbl> 0.11393237, 0.15763986, 0.25500690,
0.14452370, 0.26…
$ tasa_riesgo      <dbl> 0.013477754, 0.015731142,
0.009177382, 0.013099129, …
$ tasa_mayores     <dbl> 0.023033610, 0.032817374,
0.028147027, 0.020829657, …
$ poblacion_mayores <dbl> 0.10330662, 0.14362062, 0.23161874,
0.13058449, 0.24…
$ nombre_zona      <chr> "V Centenario", "Valdeacederas",
"Canillejas", "Bara…
$ nsec             <dbl> 17, 18, 22, 13, 14, 42, 32, 13, 17,
11, NA, 15, 15, …
$ t3_1             <dbl> 36.73039, 41.41412, 45.44882,
39.78001, 46.13171, 46…
$ t1_1             <dbl> 31778, 26202, 28658, 22492, 15450,
50478, 34148, 202…
$ t2_1             <dbl> 0.5084658, 0.5329728, 0.5316594,
0.5189021, 0.551191…
$ t2_2             <dbl> 0.4915342, 0.4670272, 0.4683406,
0.4810979, 0.448809…
$ t4_1             <dbl> 0.22551283, 0.12790298, 0.12603707,
0.18104432, 0.11…
$ t4_2             <dbl> 0.6711962, 0.7284970, 0.6423306,
0.6883785, 0.641173…
$ t4_3             <dbl> 0.10330662, 0.14362062, 0.23161874,
0.13058449, 0.24…
$ t5_1             <dbl> 0.1063332, 0.2295250, 0.1655070,
0.1266086, 0.165893…
$ t6_1             <dbl> 0.1706875, 0.3477631, 0.2511757,
0.1998911, 0.261480…
$ t7_1             <dbl> 0.05131106, 0.04606911, 0.04379644,
0.05585777, 0.06…
$ t8_1             <dbl> 0.03892836, 0.03586418, 0.03207779,
0.04434976, 0.05…
$ t9_1             <dbl> 0.5151383, 0.3863876, 0.3129631,
0.4611972, 0.701812…
$ t10_1            <dbl> 0.09258503, 0.13151901, 0.13926119,
0.10460043, 0.06…
$ t11_1            <dbl> 0.6406787, 0.5451465, 0.4600730,
0.5920292, 0.471769…
$ t12_1            <dbl> 0.7028586, 0.6277335, 0.5346482,
0.6590530, 0.502531…
$ area             <dbl> 2100118.9, 1164622.0, 1597474.5,
3816572.0, 870986.8…
$ densidad_hab_km  <dbl> 15131.52443, 22498.28643,
17939.56640, 5893.24662, 1…
$ tuits_gripe      <dbl> 60, 56, 72, 196, 46, 382, 56, 280,
```

```
24, 508, NA, 126,…
$ interes_gripe     <dbl> 24, 15, 24, 77, 21, 42, 15, 64, 64,
69, NA, 42, 40, …
$ Target            <dbl> 24, 15, 24, 77, 21, 42, 15, 64, 64,
69, NA, 42, 40, …
$ is_train          <lgl> TRUE, TRUE, TRUE, TRUE, TRUE, TRUE,
TRUE, TRUE, TRUE…
```

Muestra de los primeros datos:

[7]:
```
data |> slice_head(n = 5)
```

|  | GEOCODIGO \<chr\> | DESBDT \<chr\> | ano \<dbl\> | semana \<dbl\> | n_vacunas \<dbl\> | n_citas \<dbl\> | tmed \<dbl\> |
|---|---|---|---|---|---|---|---|
| A spec_tbl_df: 5 × 49 | 259 | V Centenario | 2022 | 34 | 0 | 0 | 27.278748 |
|  | 260 | Valdeacederas | 2022 | 8 | 0 | 0 | 9.577289 |
|  | 041 | Canillejas | 2022 | 9 | 0 | 0 | 8.536554 |
|  | 025 | Barajas | 2022 | 49 | 292 | 280 | 9.065363 |
|  | 046 | Castelló | 2022 | 24 | 0 | 0 | 29.905728 |

## 0.6 Feature importance from model coefficients

[8]:
```
data <- data |>
    na.omit()
```

### 0.6.1 Linear Regression Feature importance

[9]:
```
# install the necessary packages if not already installed
if (!require(caret)) {
  install.packages('caret')
}

# load the necessary packages
library(caret)

# create the model
set.seed(123)
train_control <- trainControl(method = "cv", number = 5)
linear_model <- train(Target ~ ., data = data, method = "lm",
                  trControl = train_control)

# extract the coefficients
coef <- summary(linear_model$finalModel)$coefficients

# make a data frame of feature names and their corresponding coefficients
feature_importance <- data.frame(Feature = rownames(coef), Coefficient = coef[,
  ↪"Estimate"])
```

```r
# compute the absolute value of the coefficients
feature_importance$AbsCoefficient <- abs(feature_importance$Coefficient)

# sort the features by the absolute value of their coefficients in descending
  ↪order
feature_importance <-␣
  ↪feature_importance[order(-feature_importance$AbsCoefficient), ]

# print the feature importance
print(feature_importance)
```

Loading required package: caret

Loading required package: ggplot2

Loading required package: lattice

Warning message in predict.lm(modelFit, newdata):
"prediction from a rank-deficient fit may be misleading"
Warning message in predict.lm(modelFit, newdata):
"prediction from a rank-deficient fit may be misleading"
Warning message in predict.lm(modelFit, newdata):
"prediction from a rank-deficient fit may be misleading"
Warning message in predict.lm(modelFit, newdata):
"prediction from a rank-deficient fit may be misleading"
Warning message in predict.lm(modelFit, newdata):
"prediction from a rank-deficient fit may be misleading"
Warning message in summary.lm(linear_model$finalModel):
"essentially perfect fit: summary may be unreliable"

|  | Feature | Coefficient | AbsCoefficient |
|---|---|---|---|
| interes_gripe | interes_gripe | 1.000000e+00 | 1.000000e+00 |
| (Intercept) | (Intercept) | -4.412119e-11 | 4.412119e-11 |
| campana | campana | 2.933503e-13 | 2.933503e-13 |
| ano | ano | -2.711501e-13 | 2.711501e-13 |
| GEOCODIGO033 | GEOCODIGO033 | 6.115202e-14 | 6.115202e-14 |
| GEOCODIGO256 | GEOCODIGO256 | 6.094220e-14 | 6.094220e-14 |
| GEOCODIGO279 | GEOCODIGO279 | 5.639716e-14 | 5.639716e-14 |
| GEOCODIGO201 | GEOCODIGO201 | 5.551830e-14 | 5.551830e-14 |
| GEOCODIGO036 | GEOCODIGO036 | 5.539307e-14 | 5.539307e-14 |
| GEOCODIGO228 | GEOCODIGO228 | -5.041923e-14 | 5.041923e-14 |
| GEOCODIGO085 | GEOCODIGO085 | -4.936885e-14 | 4.936885e-14 |
| GEOCODIGO275 | GEOCODIGO275 | 4.741706e-14 | 4.741706e-14 |
| GEOCODIGO241 | GEOCODIGO241 | 4.732671e-14 | 4.732671e-14 |
| GEOCODIGO049 | GEOCODIGO049 | -4.530675e-14 | 4.530675e-14 |
| GEOCODIGO097 | GEOCODIGO097 | -4.495278e-14 | 4.495278e-14 |
| GEOCODIGO184 | GEOCODIGO184 | 4.483504e-14 | 4.483504e-14 |
| GEOCODIGO118 | GEOCODIGO118 | 4.353739e-14 | 4.353739e-14 |

```
GEOCODIGO121    GEOCODIGO121   4.323652e-14    4.323652e-14
GEOCODIGO056    GEOCODIGO056  -3.994818e-14    3.994818e-14
GEOCODIGO055    GEOCODIGO055  -3.934225e-14    3.934225e-14
GEOCODIGO038    GEOCODIGO038   3.822105e-14    3.822105e-14
GEOCODIGO030    GEOCODIGO030  -3.634783e-14    3.634783e-14
GEOCODIGO108    GEOCODIGO108  -3.589486e-14    3.589486e-14
GEOCODIGO059    GEOCODIGO059   3.552827e-14    3.552827e-14
GEOCODIGO180    GEOCODIGO180   3.552245e-14    3.552245e-14
GEOCODIGO105    GEOCODIGO105  -3.504909e-14    3.504909e-14
GEOCODIGO182    GEOCODIGO182   3.498939e-14    3.498939e-14
GEOCODIGO013    GEOCODIGO013  -3.438680e-14    3.438680e-14
GEOCODIGO138    GEOCODIGO138   3.384073e-14    3.384073e-14
GEOCODIGO054    GEOCODIGO054  -3.218474e-14    3.218474e-14
GEOCODIGO080    GEOCODIGO080   3.209474e-14    3.209474e-14
GEOCODIGO230    GEOCODIGO230   3.081440e-14    3.081440e-14
GEOCODIGO215    GEOCODIGO215  -3.038346e-14    3.038346e-14
GEOCODIGO282    GEOCODIGO282   3.024473e-14    3.024473e-14
GEOCODIGO155    GEOCODIGO155  -2.983943e-14    2.983943e-14
GEOCODIGO250    GEOCODIGO250   2.953767e-14    2.953767e-14
GEOCODIGO176    GEOCODIGO176   2.951762e-14    2.951762e-14
GEOCODIGO257    GEOCODIGO257  -2.906245e-14    2.906245e-14
GEOCODIGO168    GEOCODIGO168  -2.905828e-14    2.905828e-14
GEOCODIGO159    GEOCODIGO159  -2.826553e-14    2.826553e-14
GEOCODIGO156    GEOCODIGO156   2.738223e-14    2.738223e-14
GEOCODIGO095    GEOCODIGO095   2.694826e-14    2.694826e-14
GEOCODIGO177    GEOCODIGO177  -2.656150e-14    2.656150e-14
GEOCODIGO115    GEOCODIGO115   2.647622e-14    2.647622e-14
GEOCODIGO120    GEOCODIGO120   2.637973e-14    2.637973e-14
GEOCODIGO064    GEOCODIGO064   2.626559e-14    2.626559e-14
GEOCODIGO251    GEOCODIGO251  -2.616292e-14    2.616292e-14
GEOCODIGO211    GEOCODIGO211   2.600648e-14    2.600648e-14
GEOCODIGO196    GEOCODIGO196   2.541676e-14    2.541676e-14
GEOCODIGO283    GEOCODIGO283   2.516373e-14    2.516373e-14
GEOCODIGO045    GEOCODIGO045   2.457623e-14    2.457623e-14
GEOCODIGO174    GEOCODIGO174   2.385072e-14    2.385072e-14
GEOCODIGO140    GEOCODIGO140  -2.361619e-14    2.361619e-14
GEOCODIGO190    GEOCODIGO190   2.334264e-14    2.334264e-14
GEOCODIGO217    GEOCODIGO217  -2.317229e-14    2.317229e-14
GEOCODIGO017    GEOCODIGO017   2.292853e-14    2.292853e-14
GEOCODIGO046    GEOCODIGO046   2.284804e-14    2.284804e-14
GEOCODIGO181    GEOCODIGO181  -2.277713e-14    2.277713e-14
GEOCODIGO028    GEOCODIGO028   2.236327e-14    2.236327e-14
GEOCODIGO243    GEOCODIGO243  -2.200368e-14    2.200368e-14
GEOCODIGO179    GEOCODIGO179  -2.200012e-14    2.200012e-14
GEOCODIGO161    GEOCODIGO161   2.195473e-14    2.195473e-14
GEOCODIGO144    GEOCODIGO144   2.180516e-14    2.180516e-14
GEOCODIGO048    GEOCODIGO048   2.125090e-14    2.125090e-14
GEOCODIGO222    GEOCODIGO222   2.094436e-14    2.094436e-14
```

```
GEOCODIGO089   GEOCODIGO089   2.089226e-14    2.089226e-14
GEOCODIGO219   GEOCODIGO219   2.068343e-14    2.068343e-14
GEOCODIGO258   GEOCODIGO258   2.066934e-14    2.066934e-14
GEOCODIGO267   GEOCODIGO267   2.040372e-14    2.040372e-14
GEOCODIGO160   GEOCODIGO160   2.025745e-14    2.025745e-14
GEOCODIGO096   GEOCODIGO096   2.018002e-14    2.018002e-14
GEOCODIGO212   GEOCODIGO212  -2.011654e-14    2.011654e-14
GEOCODIGO132   GEOCODIGO132  -1.988772e-14    1.988772e-14
GEOCODIGO101   GEOCODIGO101   1.965666e-14    1.965666e-14
GEOCODIGO066   GEOCODIGO066   1.959239e-14    1.959239e-14
GEOCODIGO007   GEOCODIGO007   1.958985e-14    1.958985e-14
GEOCODIGO139   GEOCODIGO139  -1.944571e-14    1.944571e-14
GEOCODIGO135   GEOCODIGO135  -1.916330e-14    1.916330e-14
GEOCODIGO218   GEOCODIGO218   1.896370e-14    1.896370e-14
GEOCODIGO238   GEOCODIGO238   1.874554e-14    1.874554e-14
GEOCODIGO124   GEOCODIGO124   1.861895e-14    1.861895e-14
GEOCODIGO002   GEOCODIGO002   1.853664e-14    1.853664e-14
GEOCODIGO122   GEOCODIGO122   1.851806e-14    1.851806e-14
GEOCODIGO110   GEOCODIGO110   1.849172e-14    1.849172e-14
GEOCODIGO216   GEOCODIGO216   1.815378e-14    1.815378e-14
GEOCODIGO154   GEOCODIGO154  -1.814361e-14    1.814361e-14
GEOCODIGO166   GEOCODIGO166   1.796963e-14    1.796963e-14
GEOCODIGO051   GEOCODIGO051   1.755906e-14    1.755906e-14
GEOCODIGO070   GEOCODIGO070  -1.738501e-14    1.738501e-14
GEOCODIGO015   GEOCODIGO015   1.724818e-14    1.724818e-14
GEOCODIGO242   GEOCODIGO242   1.722469e-14    1.722469e-14
GEOCODIGO014   GEOCODIGO014  -1.715465e-14    1.715465e-14
GEOCODIGO034   GEOCODIGO034   1.704445e-14    1.704445e-14
GEOCODIGO072   GEOCODIGO072   1.699151e-14    1.699151e-14
GEOCODIGO247   GEOCODIGO247   1.693972e-14    1.693972e-14
GEOCODIGO037   GEOCODIGO037   1.679426e-14    1.679426e-14
GEOCODIGO126   GEOCODIGO126  -1.661739e-14    1.661739e-14
GEOCODIGO094   GEOCODIGO094   1.646378e-14    1.646378e-14
GEOCODIGO157   GEOCODIGO157  -1.638246e-14    1.638246e-14
GEOCODIGO252   GEOCODIGO252  -1.590439e-14    1.590439e-14
GEOCODIGO188   GEOCODIGO188   1.585290e-14    1.585290e-14
GEOCODIGO075   GEOCODIGO075   1.574201e-14    1.574201e-14
GEOCODIGO004   GEOCODIGO004   1.558974e-14    1.558974e-14
GEOCODIGO206   GEOCODIGO206   1.558060e-14    1.558060e-14
GEOCODIGO162   GEOCODIGO162   1.556950e-14    1.556950e-14
GEOCODIGO114   GEOCODIGO114   1.534182e-14    1.534182e-14
GEOCODIGO104   GEOCODIGO104   1.502235e-14    1.502235e-14
GEOCODIGO023   GEOCODIGO023   1.476073e-14    1.476073e-14
GEOCODIGO203   GEOCODIGO203   1.470438e-14    1.470438e-14
GEOCODIGO021   GEOCODIGO021   1.441770e-14    1.441770e-14
GEOCODIGO225   GEOCODIGO225   1.421428e-14    1.421428e-14
GEOCODIGO187   GEOCODIGO187   1.420487e-14    1.420487e-14
GEOCODIGO199   GEOCODIGO199   1.398843e-14    1.398843e-14
```

```
GEOCODIGO0185    GEOCODIGO0185    1.397912e-14    1.397912e-14
GEOCODIGO0073    GEOCODIGO0073   -1.373033e-14    1.373033e-14
GEOCODIGO0009    GEOCODIGO0009    1.370698e-14    1.370698e-14
GEOCODIGO0248    GEOCODIGO0248    1.370470e-14    1.370470e-14
GEOCODIGO0192    GEOCODIGO0192    1.368791e-14    1.368791e-14
GEOCODIGO0129    GEOCODIGO0129    1.367978e-14    1.367978e-14
GEOCODIGO0194    GEOCODIGO0194   -1.348813e-14    1.348813e-14
GEOCODIGO0043    GEOCODIGO0043    1.338216e-14    1.338216e-14
GEOCODIGO0172    GEOCODIGO0172    1.322763e-14    1.322763e-14
GEOCODIGO0164    GEOCODIGO0164    1.322676e-14    1.322676e-14
GEOCODIGO0082    GEOCODIGO0082    1.321655e-14    1.321655e-14
GEOCODIGO0137    GEOCODIGO0137    1.293705e-14    1.293705e-14
GEOCODIGO0204    GEOCODIGO0204    1.284380e-14    1.284380e-14
GEOCODIGO0163    GEOCODIGO0163    1.280443e-14    1.280443e-14
GEOCODIGO0200    GEOCODIGO0200    1.270519e-14    1.270519e-14
GEOCODIGO0268    GEOCODIGO0268    1.267619e-14    1.267619e-14
GEOCODIGO0060    GEOCODIGO0060    1.259206e-14    1.259206e-14
GEOCODIGO0276    GEOCODIGO0276    1.231351e-14    1.231351e-14
GEOCODIGO0240    GEOCODIGO0240   -1.227139e-14    1.227139e-14
GEOCODIGO0074    GEOCODIGO0074   -1.224353e-14    1.224353e-14
GEOCODIGO0175    GEOCODIGO0175    1.223487e-14    1.223487e-14
GEOCODIGO0029    GEOCODIGO0029    1.216554e-14    1.216554e-14
GEOCODIGO0109    GEOCODIGO0109    1.211238e-14    1.211238e-14
GEOCODIGO0209    GEOCODIGO0209    1.202868e-14    1.202868e-14
GEOCODIGO0141    GEOCODIGO0141    1.197890e-14    1.197890e-14
GEOCODIGO0271    GEOCODIGO0271    1.191575e-14    1.191575e-14
GEOCODIGO0285    GEOCODIGO0285   -1.182411e-14    1.182411e-14
so2                        so2   -1.166616e-14    1.166616e-14
GEOCODIGO0128    GEOCODIGO0128   -1.165566e-14    1.165566e-14
GEOCODIGO0170    GEOCODIGO0170    1.152202e-14    1.152202e-14
GEOCODIGO0053    GEOCODIGO0053    1.131479e-14    1.131479e-14
GEOCODIGO0058    GEOCODIGO0058    1.114406e-14    1.114406e-14
GEOCODIGO0260    GEOCODIGO0260    1.096997e-14    1.096997e-14
GEOCODIGO0125    GEOCODIGO0125    1.090624e-14    1.090624e-14
GEOCODIGO0117    GEOCODIGO0117    1.064512e-14    1.064512e-14
GEOCODIGO0231    GEOCODIGO0231    1.049574e-14    1.049574e-14
GEOCODIGO0178    GEOCODIGO0178    1.044514e-14    1.044514e-14
GEOCODIGO0261    GEOCODIGO0261    1.033291e-14    1.033291e-14
GEOCODIGO0266    GEOCODIGO0266   -1.026916e-14    1.026916e-14
GEOCODIGO0112    GEOCODIGO0112    1.014021e-14    1.014021e-14
GEOCODIGO0229    GEOCODIGO0229    1.013749e-14    1.013749e-14
GEOCODIGO0236    GEOCODIGO0236    1.010615e-14    1.010615e-14
GEOCODIGO0022    GEOCODIGO0022   -1.008301e-14    1.008301e-14
GEOCODIGO0153    GEOCODIGO0153   -1.008064e-14    1.008064e-14
GEOCODIGO0061    GEOCODIGO0061    1.004014e-14    1.004014e-14
GEOCODIGO0151    GEOCODIGO0151    9.974774e-15    9.974774e-15
GEOCODIGO0039    GEOCODIGO0039    9.524276e-15    9.524276e-15
GEOCODIGO0193    GEOCODIGO0193    9.272592e-15    9.272592e-15
```

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GEOCODIGO084    GEOCODIGO084   9.267628e-15    9.267628e-15
GEOCODIGO173    GEOCODIGO173   9.242158e-15    9.242158e-15
GEOCODIGO205    GEOCODIGO205  -9.209576e-15    9.209576e-15
GEOCODIGO213    GEOCODIGO213   9.147095e-15    9.147095e-15
GEOCODIGO010    GEOCODIGO010   8.974972e-15    8.974972e-15
GEOCODIGO098    GEOCODIGO098   8.855665e-15    8.855665e-15
GEOCODIGO202    GEOCODIGO202   8.842218e-15    8.842218e-15
GEOCODIGO264    GEOCODIGO264  -8.738713e-15    8.738713e-15
GEOCODIGO148    GEOCODIGO148   8.733031e-15    8.733031e-15
GEOCODIGO068    GEOCODIGO068  -8.709746e-15    8.709746e-15
GEOCODIGO134    GEOCODIGO134   8.703883e-15    8.703883e-15
GEOCODIGO277    GEOCODIGO277  -8.537276e-15    8.537276e-15
GEOCODIGO133    GEOCODIGO133   8.450886e-15    8.450886e-15
GEOCODIGO255    GEOCODIGO255   8.408601e-15    8.408601e-15
GEOCODIGO093    GEOCODIGO093  -8.306698e-15    8.306698e-15
GEOCODIGO102    GEOCODIGO102   8.294903e-15    8.294903e-15
GEOCODIGO197    GEOCODIGO197  -8.162224e-15    8.162224e-15
GEOCODIGO239    GEOCODIGO239   8.132926e-15    8.132926e-15
GEOCODIGO183    GEOCODIGO183  -8.069563e-15    8.069563e-15
GEOCODIGO149    GEOCODIGO149   8.042529e-15    8.042529e-15
GEOCODIGO091    GEOCODIGO091   7.974849e-15    7.974849e-15
GEOCODIGO127    GEOCODIGO127   7.969956e-15    7.969956e-15
GEOCODIGO065    GEOCODIGO065  -7.687629e-15    7.687629e-15
GEOCODIGO263    GEOCODIGO263   7.687085e-15    7.687085e-15
GEOCODIGO143    GEOCODIGO143  -7.679146e-15    7.679146e-15
GEOCODIGO186    GEOCODIGO186   7.529804e-15    7.529804e-15
velmedia            velmedia   7.468246e-15    7.468246e-15
GEOCODIGO052    GEOCODIGO052   7.352651e-15    7.352651e-15
GEOCODIGO142    GEOCODIGO142   7.103378e-15    7.103378e-15
GEOCODIGO111    GEOCODIGO111   7.032409e-15    7.032409e-15
GEOCODIGO130    GEOCODIGO130   7.019133e-15    7.019133e-15
GEOCODIGO107    GEOCODIGO107  -6.863170e-15    6.863170e-15
GEOCODIGO189    GEOCODIGO189   6.854650e-15    6.854650e-15
GEOCODIGO273    GEOCODIGO273   6.722653e-15    6.722653e-15
GEOCODIGO005    GEOCODIGO005  -6.649262e-15    6.649262e-15
GEOCODIGO006    GEOCODIGO006   6.641116e-15    6.641116e-15
GEOCODIGO237    GEOCODIGO237  -6.537978e-15    6.537978e-15
GEOCODIGO092    GEOCODIGO092   6.421496e-15    6.421496e-15
GEOCODIGO265    GEOCODIGO265  -6.361985e-15    6.361985e-15
GEOCODIGO083    GEOCODIGO083   6.357894e-15    6.357894e-15
GEOCODIGO026    GEOCODIGO026   6.325071e-15    6.325071e-15
GEOCODIGO214    GEOCODIGO214   6.277091e-15    6.277091e-15
GEOCODIGO220    GEOCODIGO220   6.097355e-15    6.097355e-15
GEOCODIGO227    GEOCODIGO227  -6.075078e-15    6.075078e-15
GEOCODIGO076    GEOCODIGO076   6.040635e-15    6.040635e-15
GEOCODIGO146    GEOCODIGO146  -6.036466e-15    6.036466e-15
GEOCODIGO041    GEOCODIGO041  -5.967446e-15    5.967446e-15
GEOCODIGO234    GEOCODIGO234   5.957902e-15    5.957902e-15
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GEOCODIGO284    GEOCODIGO284   5.835275e-15    5.835275e-15
GEOCODIGO119    GEOCODIGO119  -5.826391e-15    5.826391e-15
GEOCODIGO062    GEOCODIGO062   5.793850e-15    5.793850e-15
GEOCODIGO272    GEOCODIGO272   5.768298e-15    5.768298e-15
GEOCODIGO077    GEOCODIGO077  -5.705706e-15    5.705706e-15
GEOCODIGO208    GEOCODIGO208   5.653040e-15    5.653040e-15
tmed                    tmed  -5.645617e-15    5.645617e-15
GEOCODIGO008    GEOCODIGO008   5.512154e-15    5.512154e-15
GEOCODIGO087    GEOCODIGO087  -5.451613e-15    5.451613e-15
GEOCODIGO027    GEOCODIGO027   5.430499e-15    5.430499e-15
GEOCODIGO012    GEOCODIGO012   5.367830e-15    5.367830e-15
GEOCODIGO207    GEOCODIGO207   5.347509e-15    5.347509e-15
GEOCODIGO032    GEOCODIGO032   5.326909e-15    5.326909e-15
GEOCODIGO152    GEOCODIGO152  -5.246170e-15    5.246170e-15
semana                semana  -5.181520e-15    5.181520e-15
GEOCODIGO088    GEOCODIGO088  -5.173313e-15    5.173313e-15
GEOCODIGO278    GEOCODIGO278   5.169027e-15    5.169027e-15
GEOCODIGO167    GEOCODIGO167   5.046559e-15    5.046559e-15
GEOCODIGO270    GEOCODIGO270   5.018251e-15    5.018251e-15
GEOCODIGO221    GEOCODIGO221   4.927506e-15    4.927506e-15
GEOCODIGO281    GEOCODIGO281  -4.825751e-15    4.825751e-15
GEOCODIGO103    GEOCODIGO103   4.822206e-15    4.822206e-15
GEOCODIGO249    GEOCODIGO249  -4.728840e-15    4.728840e-15
GEOCODIGO100    GEOCODIGO100   4.709529e-15    4.709529e-15
GEOCODIGO078    GEOCODIGO078   4.577270e-15    4.577270e-15
GEOCODIGO044    GEOCODIGO044   4.441032e-15    4.441032e-15
GEOCODIGO246    GEOCODIGO246   4.286484e-15    4.286484e-15
GEOCODIGO280    GEOCODIGO280   4.184614e-15    4.184614e-15
prec                    prec   3.865762e-15    3.865762e-15
pm10                    pm10   3.848193e-15    3.848193e-15
GEOCODIGO198    GEOCODIGO198  -3.678668e-15    3.678668e-15
GEOCODIGO223    GEOCODIGO223   3.609401e-15    3.609401e-15
GEOCODIGO147    GEOCODIGO147  -3.601896e-15    3.601896e-15
benzene              benzene  -3.495366e-15    3.495366e-15
GEOCODIGO020    GEOCODIGO020   3.419734e-15    3.419734e-15
GEOCODIGO210    GEOCODIGO210   3.418016e-15    3.418016e-15
GEOCODIGO090    GEOCODIGO090   3.413952e-15    3.413952e-15
GEOCODIGO063    GEOCODIGO063   3.330066e-15    3.330066e-15
GEOCODIGO099    GEOCODIGO099   3.269780e-15    3.269780e-15
GEOCODIGO269    GEOCODIGO269  -3.027114e-15    3.027114e-15
GEOCODIGO233    GEOCODIGO233   2.980871e-15    2.980871e-15
GEOCODIGO131    GEOCODIGO131  -2.957958e-15    2.957958e-15
GEOCODIGO274    GEOCODIGO274  -2.877303e-15    2.877303e-15
GEOCODIGO081    GEOCODIGO081   2.625062e-15    2.625062e-15
GEOCODIGO019    GEOCODIGO019  -2.600442e-15    2.600442e-15
GEOCODIGO067    GEOCODIGO067  -2.473551e-15    2.473551e-15
GEOCODIGO003    GEOCODIGO003   2.463516e-15    2.463516e-15
GEOCODIGO145    GEOCODIGO145  -2.426997e-15    2.426997e-15
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GEOCODIGO235    GEOCODIGO235    2.402835e-15    2.402835e-15
GEOCODIGO158    GEOCODIGO158    2.252205e-15    2.252205e-15
GEOCODIGO086    GEOCODIGO086    2.054451e-15    2.054451e-15
GEOCODIGO050    GEOCODIGO050    2.053475e-15    2.053475e-15
GEOCODIGO286    GEOCODIGO286   -1.908625e-15    1.908625e-15
o3                        o3   -1.844939e-15    1.844939e-15
GEOCODIGO245    GEOCODIGO245    1.791983e-15    1.791983e-15
GEOCODIGO106    GEOCODIGO106   -1.535206e-15    1.535206e-15
GEOCODIGO195    GEOCODIGO195   -1.469323e-15    1.469323e-15
GEOCODIGO025    GEOCODIGO025    1.427787e-15    1.427787e-15
GEOCODIGO079    GEOCODIGO079   -1.326788e-15    1.326788e-15
GEOCODIGO262    GEOCODIGO262    1.302302e-15    1.302302e-15
GEOCODIGO224    GEOCODIGO224   -1.265762e-15    1.265762e-15
GEOCODIGO040    GEOCODIGO040   -1.257494e-15    1.257494e-15
GEOCODIGO042    GEOCODIGO042   -1.207480e-15    1.207480e-15
co                        co   -1.120073e-15    1.120073e-15
GEOCODIGO011    GEOCODIGO011   -1.118055e-15    1.118055e-15
GEOCODIGO169    GEOCODIGO169    1.026639e-15    1.026639e-15
GEOCODIGO136    GEOCODIGO136   -9.893035e-16    9.893035e-16
GEOCODIGO259    GEOCODIGO259   -8.719533e-16    8.719533e-16
GEOCODIGO018    GEOCODIGO018   -8.710594e-16    8.710594e-16
GEOCODIGO035    GEOCODIGO035   -6.956178e-16    6.956178e-16
GEOCODIGO232    GEOCODIGO232   -5.687241e-16    5.687241e-16
GEOCODIGO191    GEOCODIGO191   -5.608885e-16    5.608885e-16
GEOCODIGO069    GEOCODIGO069   -5.375048e-16    5.375048e-16
GEOCODIGO253    GEOCODIGO253    5.323516e-16    5.323516e-16
no2                      no2   -4.960132e-16    4.960132e-16
GEOCODIGO047    GEOCODIGO047    4.912500e-16    4.912500e-16
GEOCODIGO016    GEOCODIGO016    4.907245e-16    4.907245e-16
GEOCODIGO244    GEOCODIGO244   -4.305242e-16    4.305242e-16
GEOCODIGO254    GEOCODIGO254    3.896931e-16    3.896931e-16
presMax              presMax   -3.449334e-16    3.449334e-16
GEOCODIGO113    GEOCODIGO113   -3.331622e-16    3.331622e-16
is_trainTRUE    is_trainTRUE    3.101909e-16    3.101909e-16
GEOCODIGO024    GEOCODIGO024    2.857620e-16    2.857620e-16
GEOCODIGO116    GEOCODIGO116   -2.821347e-16    2.821347e-16
GEOCODIGO150    GEOCODIGO150    2.797148e-16    2.797148e-16
GEOCODIGO031    GEOCODIGO031   -2.019895e-16    2.019895e-16
n_vacunas          n_vacunas    1.761763e-16    1.761763e-16
tuits_gripe      tuits_gripe    1.528383e-16    1.528383e-16
GEOCODIGO057    GEOCODIGO057   -1.477188e-16    1.477188e-16
pm2.5                  pm2.5    1.422193e-16    1.422193e-16
nox                      nox   -5.214295e-17    5.214295e-17
no                        no   -4.413159e-17    4.413159e-17
n_citas              n_citas   -1.964112e-17    1.964112e-17
GEOCODIGO071    GEOCODIGO071    1.214984e-17    1.214984e-17
```

### 0.6.2 Logistic Regression Feature importance

No aplica

## 0.7 Decision Tree Feature Importance

### 0.7.1 CART Regression Feature Importance

```
[10]: # install the necessary packages if not already installed
      if (!require(rpart)) {
        install.packages('rpart')
      }

      # load the necessary packages
      library(rpart)

      # fit the model
      cart_model <- rpart(Target ~ ., data = data, method = "anova")

      # compute feature importances
      importance <- as.data.frame(varImp(cart_model))

      # sort by importance
      importance <- importance[order(-importance$Overall), ]

      # print the feature importance
      print(importance)
```

Loading required package: rpart

```
 [1] 3.1708648 1.4384476 1.2730982 1.1835086 0.5392957 0.5263859 0.4977876
 [8] 0.4391151 0.3306283 0.2629820 0.1173294 0.0000000 0.0000000 0.0000000
[15] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
[22] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
[29] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
[36] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
[43] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
```

### 0.7.2 CART Classification Feature Importance

No aplica

### 0.7.3 Random Forest Regression Feature Importance

```
[18]: # install the necessary packages if not already installed
      if (!require(randomForest)) {
        install.packages('randomForest')
      }
```

```
# load the necessary packages
library(randomForest)

# fit the model
rf_model <- randomForest(Target ~ ., data = data, importance = TRUE)

# get feature importances
importance <- rf_model$importance

# make a data frame of feature names and their corresponding importances
feature_importance <- data.frame(Feature = rownames(importance), Importance =
 ↪importance[,1]) # Adjust the index based on your requirement

# sort the features by importance in descending order
feature_importance <- feature_importance[order(-feature_importance$Importance),
 ↪]

# print the feature importance
print(feature_importance)
```

|              | Feature      | Importance   |
|--------------|--------------|--------------|
| interes_gripe | interes_gripe | 665.041924825 |
| tuits_gripe  | tuits_gripe  | 148.284259879 |
| scampana     | scampana     | 146.581337214 |
| semana       | semana       | 90.136665620 |
| n_vacunas    | n_vacunas    | 61.363162786 |
| n_citas      | n_citas      | 58.783013919 |
| prec         | prec         | 29.412115470 |
| benzene      | benzene      | 12.936875246 |
| tmed         | tmed         | 11.263259346 |
| so2          | so2          | 8.412109795 |
| pm10         | pm10         | 7.820897289 |
| ano          | ano          | 6.614590753 |
| pm2.5        | pm2.5        | 6.428949390 |
| campana      | campana      | 5.185778031 |
| o3           | o3           | 3.662270853 |
| no           | no           | 3.129776410 |
| velmedia     | velmedia     | 2.484920743 |
| nox          | nox          | 1.642691242 |
| no2          | no2          | 1.194571534 |
| co           | co           | 0.696934189 |
| GEOCODIGO    | GEOCODIGO    | 0.317690358 |
| DESBDT       | DESBDT       | 0.265026645 |
| nombre_zona  | nombre_zona  | 0.223058360 |
| prop_riesgo  | prop_riesgo  | 0.173890498 |
| t4_3         | t4_3         | 0.149066106 |

```
densidad_hab_km      densidad_hab_km    0.145619155
poblacion_mayores  poblacion_mayores    0.133757698
t2_1                            t2_1    0.080100193
area                            area    0.067242660
t12_1                          t12_1    0.065372391
presMax                      presMax    0.063929068
nsec                            nsec    0.063551397
capacidad_zona        capacidad_zona    0.053062868
t6_1                            t6_1    0.049762605
t10_1                          t10_1    0.044360141
t4_1                            t4_1    0.043590444
t1_1                            t1_1    0.042297268
t4_2                            t4_2    0.037693132
t7_1                            t7_1    0.034866311
t9_1                            t9_1    0.032525707
t3_1                            t3_1    0.022146521
t8_1                            t8_1    0.015283011
t5_1                            t5_1    0.010346115
t2_2                            t2_2    0.003709971
t11_1                          t11_1   -0.009720072
is_train                    is_train   -0.014410352
tasa_mayores            tasa_mayores   -0.015156100
tasa_riesgo              tasa_riesgo   -0.105808303
```

[17]: `rf_model$importance`

|  | %IncMSE | IncNodePurity |
|---|---|---|
| GEOCODIGO | 0.317690358 | 7.478272e-01 |
| DESBDT | 0.265026645 | 5.051162e-01 |
| ano | 6.614590753 | 1.931740e+04 |
| semana | 90.136665620 | 4.710209e+05 |
| n_vacunas | 61.363162786 | 2.002295e+05 |
| n_citas | 58.783013919 | 1.984159e+05 |
| tmed | 11.263259346 | 4.787210e+04 |
| prec | 29.412115470 | 1.168580e+05 |
| velmedia | 2.484920743 | 3.490770e+04 |
| presMax | 0.063929068 | 1.956558e+02 |
| benzene | 12.936875246 | 1.268288e+05 |
| co | 0.696934189 | 1.760577e+03 |
| no | 3.129776410 | 4.136604e+04 |
| no2 | 1.194571534 | 6.065672e+03 |
| nox | 1.642691242 | 1.287343e+04 |
| o3 | 3.662270853 | 2.339107e+04 |
| pm10 | 7.820897289 | 5.183155e+04 |
| pm2.5 | 6.428949390 | 4.858137e+04 |
| so2 | 8.412109795 | 4.302407e+04 |
| campana | 5.185778031 | 1.414884e+04 |
| scampana | 146.581337214 | 9.183421e+05 |
| capacidad_zona | 0.053062868 | 4.113672e+00 |
| prop_riesgo | 0.173890498 | 3.210903e-01 |
| tasa_riesgo | -0.105808303 | 2.329904e-01 |
| tasa_mayores | -0.015156100 | 6.482611e-02 |
| poblacion_mayores | 0.133757698 | 2.669380e+00 |
| nombre_zona | 0.223058360 | 2.140744e+00 |
| nsec | 0.063551397 | 3.292341e+00 |
| t3_1 | 0.022146521 | 4.105629e+00 |
| t1_1 | 0.042297268 | 3.368476e+00 |
| t2_1 | 0.080100193 | 4.973171e+01 |
| t2_2 | 0.003709971 | 1.868699e+01 |
| t4_1 | 0.043590444 | 1.547176e+01 |
| t4_2 | 0.037693132 | 1.856270e+00 |
| t4_3 | 0.149066106 | 2.377697e-01 |
| t5_1 | 0.010346115 | 1.143387e+01 |
| t6_1 | 0.049762605 | 1.600634e+00 |
| t7_1 | 0.034866311 | 7.694122e+00 |
| t8_1 | 0.015283011 | 8.255059e+00 |
| t9_1 | 0.032525707 | 7.166661e+00 |
| t10_1 | 0.044360141 | 3.504122e+00 |
| t11_1 | -0.009720072 | 9.065964e+00 |
| t12_1 | 0.065372391 | 6.403215e-01 |
| area | 0.067242660 | 2.439165e+01 |
| densidad_hab_km | 0.145619155 | 6.314780e+01 |
| tuits_gripe | 148.284259879 | 9.254715e+05 |
| interes_gripe | 665.041924825 | 2.795582e+06 |
| is_train | -0.014410352 | 9.835381e-01 |

A matrix: 48 × 2 of type dbl

### 0.7.4 Random Forest Classification Feature Importance

No aplica

## 0.8 Permutation Feature Importance

### 0.8.1 Permutation Feature Importance for Regression

```r
# install the necessary packages if not already installed
if (!require(ranger)) {
  install.packages('ranger')
}

# load the necessary packages
library(ranger)

# fit the model
rf_model <- ranger(Target ~ ., data = data, importance = 'permutation')

# get feature importances
importance <- data.frame(Feature = names(rf_model$variable.importance),
  Importance = rf_model$variable.importance)

# sort the features by importance in descending order
importance <- importance[order(-importance$Importance), ]

# print the feature importance
print(importance)
```

[12]:

Loading required package: ranger


Attaching package: 'ranger'


The following object is masked from 'package:randomForest':

    importance


|              | Feature      | Importance   |
|--------------|--------------|--------------|
| interes_gripe | interes_gripe | 3.589550e+02 |
| tuits_gripe  | tuits_gripe  | 1.777444e+02 |
| scampana     | scampana     | 1.741863e+02 |
| semana       | semana       | 1.599750e+02 |
| n_vacunas    | n_vacunas    | 1.032406e+02 |
| n_citas      | n_citas      | 9.647796e+01 |
| tmed         | tmed         | 5.065526e+01 |

```
prec                               prec   4.564980e+01
benzene                         benzene   3.644910e+01
ano                                 ano   2.478358e+01
so2                                 so2   2.366207e+01
pm10                               pm10   2.044931e+01
o3                                   o3   1.952931e+01
pm2.5                             pm2.5   1.813701e+01
no                                   no   1.749017e+01
campana                         campana   1.630669e+01
velmedia                       velmedia   1.574798e+01
no2                                 no2   1.089645e+01
nox                                 nox   8.764699e+00
co                                   co   3.307979e+00
presMax                         presMax   1.835227e+00
area                               area   4.717773e-01
densidad_hab_km         densidad_hab_km   4.399667e-01
t2_1                               t2_1   3.219288e-01
t2_2                               t2_2   3.056317e-01
t1_1                               t1_1   1.566538e-01
t4_1                               t4_1   1.097111e-01
capacidad_zona           capacidad_zona   1.039774e-01
poblacion_mayores     poblacion_mayores   9.624182e-02
t9_1                               t9_1   9.154759e-02
t3_1                               t3_1   6.410058e-02
t6_1                               t6_1   5.434363e-02
t8_1                               t8_1   5.348162e-02
t4_2                               t4_2   4.152267e-02
t7_1                               t7_1   3.342118e-02
t10_1                             t10_1   2.916619e-02
nsec                               nsec   2.334047e-02
t4_3                               t4_3   1.915116e-02
t5_1                               t5_1   1.833996e-02
GEOCODIGO                     GEOCODIGO   1.495837e-02
prop_riesgo                 prop_riesgo   1.435767e-02
t11_1                             t11_1   1.432857e-02
t12_1                             t12_1   5.761710e-03
tasa_riesgo                 tasa_riesgo   4.829077e-03
tasa_mayores               tasa_mayores   2.380711e-03
nombre_zona                 nombre_zona   4.976843e-04
is_train                       is_train  -8.571006e-03
DESBDT                           DESBDT  -1.420096e-02
```

### 0.8.2 Permutation Feature Importance for Classification

```
[ ]: No aplica
```

## 0.9 Evaluating a Logistic Regression model with feature selection.

### 0.9.1 Evaluating with all selected features.

`[ ]:`

### 0.9.2 Evaluating with feature selection performed using feature importance.

Select type of Feature Importance to use

`[ ]:`

Operation