15.- Feature Importance_04_06_turismo_origen_completo_v_01

June 11, 2023

#

CU45_Planificación y promoción del destino en base a los patrones en origen de los turistas

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_45_08_03_turismo_receptor.csv
- Sampled Input File: CU_45_07_03_turismo_receptor.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.

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

```
Warning message in Sys.setlocale(category = "LC_ALL", locale = "es_ES.UTF-8"):
"OS reports request to set locale to "es_ES.UTF-8" cannot be honored"
''
```

0.4 Settings

0.4.1 Libraries to use

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

```
Attaching package: 'dplyr'


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

    combine


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

```
[4]: 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

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

OPCION B: Especificar el nombre de archivo

```
[6]: iFile <- "CU_45_08_03_turismo_receptor.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_45_08_03_turismo_receptor.csv

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

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

Rows: 50294 Columns: 9
  Column specification

Delimiter: ","
chr (5): mes, pais_orig_cod, pais_orig, mun_dest, CMUN
dbl (3): mun_dest_cod, turistas, Target
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:

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

```
Rows: 50,294
Columns: 9
$ mes          <chr> "2019-08", "2021-07", "2021-07",
"2022-01", "2019-08", "…
$ pais_orig_cod <chr> "110", "010", "010", "000", "128",
"000", "011", "126", …
$ pais_orig    <chr> "Francia", "Total Europa", "Total
Europa", "Total", "Rum…
$ mun_dest_cod <dbl> 28161, 28176, 28132, 28141, 28130,
28126, 28075, 28005, …
$ mun_dest     <chr> "Valdemoro", "Villanueva de la Cañada",
"San Martín de l…
$ turistas     <dbl> 466, 1375, 465, 54, 135, 30, 285, 768,
31, 1646, 116, 36…
$ CMUN         <chr> "161", "176", "132", "141", "130",
"126", "075", "005", …
$ Target       <dbl> 466, 1375, 465, 54, 135, 30, 285, 768,
31, 1646, 116, 36…
$ is_train     <lgl> TRUE, TRUE, TRUE, TRUE, TRUE, TRUE,
TRUE, TRUE, TRUE, TR…
```

Muestra de los primeros datos:

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

	mes	pais_orig_cod	pais_orig	mun_dest_cod	mun_dest	t
	<chr>	<chr>	<chr>	<dbl>	<chr>	<
A spec_tbl_df: 5 × 9	2019-08	110	Francia	28161	Valdemoro	4
	2021-07	010	Total Europa	28176	Villanueva de la Cañada	1
	2021-07	010	Total Europa	28132	San Martín de la Vega	4
	2022-01	000	Total	28141	Sevilla la Nueva	5
	2019-08	128	Rumania	28130	San Fernando de Henares	1

0.6 Feature importance from model coefficients

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

0.6.1 Linear Regression Feature importance

```
[14]:  # 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"])

       # 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"
```

	Feature
turistas	turistas
(Intercept)	(Intercept)
pais_orig_cod229	pais_orig_cod229
pais_orig_cod424	pais_orig_cod424
pais_orig_cod327	pais_orig_cod327
pais_orig_cod245	pais_orig_cod245
pais_orig_cod404	pais_orig_cod404
pais_orig_cod243	pais_orig_cod243
pais_orig_cod215	pais_orig_cod215
pais_orig_cod433	pais_orig_cod433
pais_orig_cod249	pais_orig_cod249
pais_orig_cod434	pais_orig_cod434
pais_orig_cod447	pais_orig_cod447
pais_orig_cod204	pais_orig_cod204
pais_orig_cod201	pais_orig_cod201
pais_orig_cod315	pais_orig_cod315
pais_orig_cod417	pais_orig_cod417
pais_orig_cod246	pais_orig_cod246
pais_orig_cod247	pais_orig_cod247
pais_orig_cod502	pais_orig_cod502
pais_orig_cod233	pais_orig_cod233
pais_orig_cod442	pais_orig_cod442
pais_orig_cod504	pais_orig_cod504
pais_orig_cod226	pais_orig_cod226
pais_orig_cod156	pais_orig_cod156
pais_orig_cod322	pais_orig_cod322
pais_orig_cod158	pais_orig_cod158
pais_orig_cod210	pais_orig_cod210
pais_orig_cod403	pais_orig_cod403
pais_orig_cod250	pais_orig_cod250
pais_orig_cod231	pais_orig_cod231
pais_orig_cod145	pais_orig_cod145
pais_orig_cod148	pais_orig_cod148
pais_orig_cod505	pais_orig_cod505
pais_orig_cod114	pais_orig_cod114
pais_orig_cod138	pais_orig_cod138
pais_orig_cod443	pais_orig_cod443
pais_orig_cod224	pais_orig_cod224
pais_orig_cod416	pais_orig_cod416
pais_orig_cod218	pais_orig_cod218
pais_orig_cod230	pais_orig_cod230
pais_orig_cod421	pais_orig_cod421
pais_orig_cod106	pais_orig_cod106
pais_orig_cod202	pais_orig_cod202

```
pais_orig_cod426          pais_orig_cod426
pais_orig_cod227          pais_orig_cod227
pais_orig_cod208          pais_orig_cod208
pais_orig_cod137          pais_orig_cod137
pais_orig_cod236          pais_orig_cod236
pais_orig_cod412          pais_orig_cod412
pais_orig_cod211          pais_orig_cod211
pais_orig_cod217          pais_orig_cod217
pais_orig_cod139          pais_orig_cod139
pais_orig_cod437          pais_orig_cod437
pais_orig_cod157          pais_orig_cod157
pais_orig_cod221          pais_orig_cod221
pais_orig_cod432          pais_orig_cod432
pais_orig_cod413          pais_orig_cod413
pais_orig_cod420          pais_orig_cod420
pais_orig_cod323          pais_orig_cod323
pais_orig_cod317          pais_orig_cod317
pais_orig_cod411          pais_orig_cod411
pais_orig_cod124          pais_orig_cod124
pais_orig_cod248          pais_orig_cod248
pais_orig_cod146          pais_orig_cod146
pais_orig_cod341          pais_orig_cod341
pais_orig_cod321          pais_orig_cod321
pais_orig_cod319          pais_orig_cod319
pais_orig_cod174          pais_orig_cod174
pais_orig_cod324          pais_orig_cod324
pais_orig_cod425          pais_orig_cod425
pais_orig_cod418          pais_orig_cod418
pais_orig_cod118          pais_orig_cod118
pais_orig_cod499          pais_orig_cod499
pais_orig_cod101          pais_orig_cod101
pais_orig_cod501          pais_orig_cod501
pais_orig_cod147          pais_orig_cod147
pais_orig_cod409          pais_orig_cod409
pais_orig_cod050          pais_orig_cod050
pais_orig_cod144          pais_orig_cod144
pais_orig_cod314          pais_orig_cod314
pais_orig_cod203          pais_orig_cod203
pais_orig_cod326          pais_orig_cod326
pais_orig_cod111          pais_orig_cod111
pais_orig_cod239          pais_orig_cod239
mun_destMadrid             mun_destMadrid
pais_orig_cod141          pais_orig_cod141
pais_orig_cod213          pais_orig_cod213
pais_orig_cod347          pais_orig_cod347
pais_orig_cod427          pais_orig_cod427
pais_orig_cod032          pais_orig_cod032
pais_orig_cod109          pais_orig_cod109
```

```
pais_orig_cod435                            pais_orig_cod435
pais_orig_cod410                            pais_orig_cod410
pais_orig_cod345                            pais_orig_cod345
pais_orig_cod402                            pais_orig_cod402
pais_orig_cod408                            pais_orig_cod408
pais_orig_cod136                            pais_orig_cod136
pais_orig_cod301                            pais_orig_cod301
pais_orig_cod401                            pais_orig_cod401
pais_orig_cod350                            pais_orig_cod350
pais_orig_cod436                            pais_orig_cod436
pais_orig_cod154                            pais_orig_cod154
pais_orig_cod120                            pais_orig_cod120
pais_orig_cod415                            pais_orig_cod415
pais_orig_cod143                            pais_orig_cod143
pais_orig_cod414                            pais_orig_cod414
pais_orig_cod344                            pais_orig_cod344
pais_orig_cod112                            pais_orig_cod112
pais_orig_cod116                            pais_orig_cod116
pais_orig_cod351                            pais_orig_cod351
pais_orig_cod220                            pais_orig_cod220
pais_orig_cod342                            pais_orig_cod342
pais_orig_cod430                            pais_orig_cod430
`mun_destTres Cantos`                       `mun_destTres Cantos`
pais_orig_cod104                            pais_orig_cod104
pais_orig_cod142                            pais_orig_cod142
pais_orig_cod303                            pais_orig_cod303
pais_orig_cod135                            pais_orig_cod135
pais_orig_cod348                            pais_orig_cod348
pais_orig_cod340                            pais_orig_cod340
pais_orig_cod234                            pais_orig_cod234
`mun_destLozoyuela-Navas-Sieteiglesias` `mun_destLozoyuela-Navas-Sieteiglesias`
`mun_destPuentes Viejas`                    `mun_destPuentes Viejas`
pais_orig_cod113                            pais_orig_cod113
pais_orig_cod132                            pais_orig_cod132
pais_orig_cod228                            pais_orig_cod228
pais_orig_cod343                            pais_orig_cod343
pais_orig_cod407                            pais_orig_cod407
pais_orig_cod128                            pais_orig_cod128
pais_orig_cod020                            pais_orig_cod020
pais_orig_cod122                            pais_orig_cod122
pais_orig_cod117                            pais_orig_cod117
pais_orig_cod107                            pais_orig_cod107
pais_orig_cod103                            pais_orig_cod103
pais_orig_cod252                            pais_orig_cod252
pais_orig_cod040                            pais_orig_cod040
pais_orig_cod033                            pais_orig_cod033
pais_orig_cod123                            pais_orig_cod123
`mun_destAlcalá de Henares`                 `mun_destAlcalá de Henares`
```

```
pais_orig_cod131                                                pais_orig_cod131
pais_orig_cod102                                                pais_orig_cod102
pais_orig_cod115                                                pais_orig_cod115
pais_orig_cod302                                                pais_orig_cod302
mun_destAlcobendas                                            mun_destAlcobendas
mun_destGetafe                                                    mun_destGetafe
`mun_destTorrejón de Ardoz`                        `mun_destTorrejón de Ardoz`
mun_destValdemoro                                              mun_destValdemoro
pais_orig_cod125                                                pais_orig_cod125
`mun_destSan Sebastián de los Reyes`    `mun_destSan Sebastián de los Reyes`
`mun_destRozas de Madrid, Las`                  `mun_destRozas de Madrid, Las`
pais_orig_cod031                                                pais_orig_cod031
mun_destMóstoles                                                mun_destMóstoles
`mun_destSan Fernando de Henares`          `mun_destSan Fernando de Henares`
`mun_destPozuelo de Alarcón`                      `mun_destPozuelo de Alarcón`
mun_destLeganés                                                  mun_destLeganés
pais_orig_cod126                                                pais_orig_cod126
mun_destFuenlabrada                                          mun_destFuenlabrada
mun_destParla                                                      mun_destParla
`mun_destVillaviciosa de Odón`                  `mun_destVillaviciosa de Odón`
mun_destPinto                                                      mun_destPinto
`mun_destRivas-Vaciamadrid`                        `mun_destRivas-Vaciamadrid`
`mun_destParacuellos de Jarama`              `mun_destParacuellos de Jarama`
mun_destMajadahonda                                          mun_destMajadahonda
pais_orig_cod030                                                pais_orig_cod030
mun_destAlcorcón                                                mun_destAlcorcón
mun_destCoslada                                                  mun_destCoslada
pais_orig_cod121                                                pais_orig_cod121
`mun_destVillanueva de la Cañada`        `mun_destVillanueva de la Cañada`
mun_destTorrelodones                                        mun_destTorrelodones
`mun_destCollado Villalba`                        `mun_destCollado Villalba`
`mun_destBoadilla del Monte`                      `mun_destBoadilla del Monte`
mun_destAranjuez                                                mun_destAranjuez
`mun_destBerzosa del Lozoya`                      `mun_destBerzosa del Lozoya`
pais_orig_cod110                                                pais_orig_cod110
`mes2020-04`                                                      `mes2020-04`
`mun_destArganda del Rey`                          `mun_destArganda del Rey`
`mun_destColmenar Viejo`                            `mun_destColmenar Viejo`
`mes2020-05`                                                      `mes2020-05`
mun_destCiempozuelos                                        mun_destCiempozuelos
`mun_destSan Lorenzo de El Escorial`    `mun_destSan Lorenzo de El Escorial`
mun_destGalapagar                                              mun_destGalapagar
mun_destNavalcarnero                                        mun_destNavalcarnero
`mun_destSantos de la Humosa, Los`        `mun_destSantos de la Humosa, Los`
mun_destChapinería                                          mun_destChapinería
`mun_destTorres de la Alameda`                  `mun_destTorres de la Alameda`
`mun_destOlmeda de las Fuentes`              `mun_destOlmeda de las Fuentes`
`mun_destSan Martín de la Vega`              `mun_destSan Martín de la Vega`
```

`mes2021-02`	`mes2021-02`
`mes2020-06`	`mes2020-06`
`mun_destVillanueva del Pardillo`	`mun_destVillanueva del Pardillo`
`mun_destVelilla de San Antonio`	`mun_destVelilla de San Antonio`
`mes2021-01`	`mes2021-01`
`mes2021-04`	`mes2021-04`
`mes2020-11`	`mes2020-11`
`mun_destBelmonte de Tajo`	`mun_destBelmonte de Tajo`
mun_destMeco	mun_destMeco
mun_destGascones	mun_destGascones
`mun_destRozas de Puerto Real`	`mun_destRozas de Puerto Real`
mun_destBraojos	mun_destBraojos
`mun_destColmenar del Arroyo`	`mun_destColmenar del Arroyo`
`mes2020-10`	`mes2020-10`
mun_destValdemorillo	mun_destValdemorillo
mun_destAmbite	mun_destAmbite
`mun_destAtazar, El`	`mun_destAtazar, El`
`mes2021-03`	`mes2021-03`
`mun_destMejorada del Campo`	`mun_destMejorada del Campo`
`mes2020-09`	`mes2020-09`
`mes2021-05`	`mes2021-05`
`mun_destSan Agustín del Guadalix`	`mun_destSan Agustín del Guadalix`
`mes2020-12`	`mes2020-12`
mun_destAnchuelo	mun_destAnchuelo
mun_destGuadarrama	mun_destGuadarrama
mun_destArroyomolinos	mun_destArroyomolinos
`mes2020-08`	`mes2020-08`
`mes2020-07`	`mes2020-07`
mun_destBatres	mun_destBatres
mun_destVillalbilla	mun_destVillalbilla
`mun_destCabanillas de la Sierra`	`mun_destCabanillas de la Sierra`
mun_destAlgete	mun_destAlgete
`mun_destPiñuécar-Gandullas`	`mun_destPiñuécar-Gandullas`
`mun_destBerrueco, El`	`mun_destBerrueco, El`
`mes2021-06`	`mes2021-06`
`mun_destHumanes de Madrid`	`mun_destHumanes de Madrid`
`mun_destBrea de Tajo`	`mun_destBrea de Tajo`
`mun_destTorremocha de Jarama`	`mun_destTorremocha de Jarama`
`mun_destFresnedillas de la Oliva`	`mun_destFresnedillas de la Oliva`
mun_destLoeches	mun_destLoeches
`mun_destCadalso de los Vidrios`	`mun_destCadalso de los Vidrios`
`mun_destTorrejón de Velasco`	`mun_destTorrejón de Velasco`
`mun_destEscorial, El`	`mun_destEscorial, El`
`mun_destSoto del Real`	`mun_destSoto del Real`
mun_destCorpa	mun_destCorpa
`mun_destVilla del Prado`	`mun_destVilla del Prado`
`mes2022-02`	`mes2022-02`
`mun_destAldea del Fresno`	`mun_destAldea del Fresno`

```
`mun_destBecerril de la Sierra`
mun_destCenicientos
`mun_destVillarejo de Salvanés`
`mun_destFresno de Torote`
`mun_destNavas del Rey`
`mun_destÁlamo, El`
`mun_destSan Martín de Valdeiglesias`
mun_destCanencia
`mes2021-08`
`mes2020-03`
`mes2021-07`
`mun_destHorcajuelo de la Sierra`
mun_destCasarrubuelos
`mun_destMolar, El`
mun_destPatones
mun_destLozoya
pais_orig_cod011
`mes2021-09`
mun_destVillamantilla
`mes2022-01`
mun_destBrunete
`mun_destDaganzo de Arriba`
`mun_destTorrejón de la Calzada`
mun_destNavalafuente
`mes2021-12`
mun_destCobeña
`mun_destNavarredonda y San Mamés`
`mun_destMontejo de la Sierra`
mun_destCarabaña
`mun_destMolinos, Los`
`mun_destCabrera, La`
`mun_destGarganta de los Montes`
pais_orig_cod010
mun_destRascafría
mun_destEstremera
`mes2022-03`
`mes2021-11`
mun_destValdepiélagos
`mun_destRobledo de Chavela`
`mun_destHorcajo de la Sierra-Aoslos`
mun_destValdemaqueda
`mes2021-10`
`mun_destRobledillo de la Jara`
`mun_destFuentidueña de Tajo`
`mun_destCamarma de Esteruelas`
`mun_destSevilla la Nueva`
mun_destTorrelaguna
`mun_destFuente el Saz de Jarama`
```

```
`mun_destOrusco de Tajuña`              `mun_destOrusco de Tajuña`
`mun_destValdetorres de Jarama`      `mun_destValdetorres de Jarama`
`mun_destSerna del Monte, La`          `mun_destSerna del Monte, La`
`mun_destBuitrago del Lozoya`          `mun_destBuitrago del Lozoya`
`mes2022-08`                                          `mes2022-08`
`mes2022-10`                                          `mes2022-10`
`mun_destPelayos de la Presa`          `mun_destPelayos de la Presa`
mun_destBustarviejo                              mun_destBustarviejo
mun_destMoralzarzal                              mun_destMoralzarzal
`mun_destCampo Real`                          `mun_destCampo Real`
`mun_destPrádena del Rincón`          `mun_destPrádena del Rincón`
mun_destValdeavero                              mun_destValdeavero
`mun_destVellón, El`                          `mun_destVellón, El`
`mun_destManzanares el Real`          `mun_destManzanares el Real`
mun_destSantorcaz                                mun_destSantorcaz
`mun_destTalamanca de Jarama`          `mun_destTalamanca de Jarama`
`mun_destPuebla de la Sierra`          `mun_destPuebla de la Sierra`
mun_destPedrezuela                              mun_destPedrezuela
mun_destRibatejada                              mun_destRibatejada
`mes2022-04`                                          `mes2022-04`
`mes2020-02`                                          `mes2020-02`
`mun_destPozuelo del Rey`                  `mun_destPozuelo del Rey`
mun_destRedueña                                  mun_destRedueña
mun_destValdelaguna                          mun_destValdelaguna
mun_destNavacerrada                          mun_destNavacerrada
`mes2019-10`                                          `mes2019-10`
`mes2022-09`                                          `mes2022-09`
`mun_destBoalo, El`                              `mun_destBoalo, El`
mun_destVillaconejos                        mun_destVillaconejos
mun_destRobregordo                            mun_destRobregordo
`mun_destGuadalix de la Sierra`    `mun_destGuadalix de la Sierra`
`mun_destVillar del Olmo`                  `mun_destVillar del Olmo`
mun_destCercedilla                            mun_destCercedilla
`mes2022-07`                                          `mes2022-07`
`mun_destValverde de Alcalá`          `mun_destValverde de Alcalá`
`mun_destCubas de la Sagra`            `mun_destCubas de la Sagra`
`mes2019-09`                                          `mes2019-09`
`mun_destMorata de Tajuña`              `mun_destMorata de Tajuña`
`mun_destPinilla del Valle`            `mun_destPinilla del Valle`
`mun_destNuevo Baztán`                        `mun_destNuevo Baztán`
`mun_destPerales de Tajuña`            `mun_destPerales de Tajuña`
mun_destAlpedrete                                mun_destAlpedrete
`mun_destMoraleja de Enmedio`          `mun_destMoraleja de Enmedio`
`mes2019-12`                                          `mes2019-12`
mun_destValdaracete                          mun_destValdaracete
`mun_destHoyo de Manzanares`          `mun_destHoyo de Manzanares`
`mun_destColmenar de Oreja`            `mun_destColmenar de Oreja`
mun_destVenturada                              mun_destVenturada
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mun_destColmenarejo                                              mun_destColmenarejo
`mun_destValdeolmos-Alalpardo`                          `mun_destValdeolmos-Alalpardo`
`mun_destCollado Mediano`                                  `mun_destCollado Mediano`
`mun_destVillamanrique de Tajo`                      `mun_destVillamanrique de Tajo`
mun_destValdilecha                                                mun_destValdilecha
`mes2022-05`                                                          `mes2022-05`
`mun_destSerranillos del Valle`                      `mun_destSerranillos del Valle`
mun_destChinchón                                                    mun_destChinchón
`mes2022-06`                                                          `mes2022-06`
mun_destSomosierra                                                mun_destSomosierra
mun_destValdemanco                                                mun_destValdemanco
`mun_destVillanueva de Perales`                      `mun_destVillanueva de Perales`
`mun_destSanta María de la Alameda`            `mun_destSanta María de la Alameda`
`mun_destPezuela de las Torres`                      `mun_destPezuela de las Torres`
mun_destGriñón                                                        mun_destGriñón
is_trainTRUE                                                          is_trainTRUE
mun_destVillamanta                                                mun_destVillamanta
`mes2020-01`                                                          `mes2020-01`
mun_destQuijorna                                                    mun_destQuijorna
mun_destTitulcia                                                    mun_destTitulcia
mun_destNavalagamella                                          mun_destNavalagamella
`mes2019-08`                                                          `mes2019-08`
`mun_destMiraflores de la Sierra`              `mun_destMiraflores de la Sierra`
mun_dest_cod                                                          mun_dest_cod
`mes2019-11`                                                          `mes2019-11`
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pais_orig_cod327                     -3.325783e-10   3.325783e-10
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pais_orig_cod434                     -3.286746e-10   3.286746e-10
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pais_orig_cod204                     -3.284306e-10   3.284306e-10
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pais_orig_cod315                     -3.283113e-10   3.283113e-10
pais_orig_cod417                     -3.281330e-10   3.281330e-10
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pais_orig_cod250                        -3.264578e-10   3.264578e-10
pais_orig_cod231                        -3.264207e-10   3.264207e-10
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pais_orig_cod154                -2.400697e-10   2.400697e-10
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pais_orig_cod112                -1.971578e-10   1.971578e-10
pais_orig_cod116                -1.712692e-10   1.712692e-10
pais_orig_cod351                -1.506967e-10   1.506967e-10
pais_orig_cod220                -1.437673e-10   1.437673e-10
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`mun_destPuentes Viejas`                 9.704435e-11   9.704435e-11
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pais_orig_cod132                        -8.927172e-11   8.927172e-11
pais_orig_cod228                        -8.186802e-11   8.186802e-11
pais_orig_cod343                        -8.156948e-11   8.156948e-11
pais_orig_cod407                        -7.902226e-11   7.902226e-11
pais_orig_cod128                        -7.806729e-11   7.806729e-11
pais_orig_cod020                        -7.499286e-11   7.499286e-11
pais_orig_cod122                        -7.411288e-11   7.411288e-11
pais_orig_cod117                        -7.207759e-11   7.207759e-11
pais_orig_cod107                        -6.972713e-11   6.972713e-11
pais_orig_cod103                        -6.956337e-11   6.956337e-11
pais_orig_cod252                        -6.908930e-11   6.908930e-11
pais_orig_cod040                        -6.777401e-11   6.777401e-11
pais_orig_cod033                        -6.326782e-11   6.326782e-11
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`mun_destAlcalá de Henares`              6.227087e-11   6.227087e-11
pais_orig_cod131                        -6.221112e-11   6.221112e-11
pais_orig_cod102                        -6.173980e-11   6.173980e-11
pais_orig_cod115                        -6.057693e-11   6.057693e-11
pais_orig_cod302                        -6.023196e-11   6.023196e-11
mun_destAlcobendas                       5.977062e-11   5.977062e-11
mun_destGetafe                           5.843262e-11   5.843262e-11
`mun_destTorrejón de Ardoz`              5.840486e-11   5.840486e-11
mun_destValdemoro                        5.597501e-11   5.597501e-11
pais_orig_cod125                        -5.540148e-11   5.540148e-11
`mun_destSan Sebastián de los Reyes`     5.443586e-11   5.443586e-11
`mun_destRozas de Madrid, Las`           5.405785e-11   5.405785e-11
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mun_destMóstoles                         5.279971e-11   5.279971e-11
`mun_destSan Fernando de Henares`        5.261982e-11   5.261982e-11
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mun_destLeganés                          5.245154e-11   5.245154e-11
pais_orig_cod126                        -5.018820e-11   5.018820e-11
mun_destFuenlabrada                      4.975637e-11   4.975637e-11
mun_destParla                            4.959018e-11   4.959018e-11
`mun_destVillaviciosa de Odón`           4.867228e-11   4.867228e-11
mun_destPinto                            4.707179e-11   4.707179e-11
`mun_destRivas-Vaciamadrid`              4.668166e-11   4.668166e-11
`mun_destParacuellos de Jarama`          4.469855e-11   4.469855e-11
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`mun_destDaganzo de Arriba`                1.095039e-11   1.095039e-11
`mun_destTorrejón de la Calzada`           1.077565e-11   1.077565e-11
mun_destNavalafuente                      -1.046934e-11   1.046934e-11
`mes2021-12`                              -1.003402e-11   1.003402e-11
```

```
mun_destCobeña                         -9.678309e-12   9.678309e-12
`mun_destNavarredonda y San Mamés`     -9.675837e-12   9.675837e-12
`mun_destMontejo de la Sierra`         -9.650894e-12   9.650894e-12
mun_destCarabaña                       -9.483817e-12   9.483817e-12
`mun_destMolinos, Los`                 -8.949923e-12   8.949923e-12
`mun_destCabrera, La`                   8.690315e-12   8.690315e-12
`mun_destGarganta de los Montes`       -8.516620e-12   8.516620e-12
pais_orig_cod010                       -8.163102e-12   8.163102e-12
mun_destRascafría                       8.024024e-12   8.024024e-12
mun_destEstremera                      -7.970370e-12   7.970370e-12
`mes2022-03`                           -7.945169e-12   7.945169e-12
`mes2021-11`                           -7.746986e-12   7.746986e-12
mun_destValdepiélagos                  -7.685333e-12   7.685333e-12
`mun_destRobledo de Chavela`            7.642873e-12   7.642873e-12
`mun_destHorcajo de la Sierra-Aoslos`  -7.601932e-12   7.601932e-12
mun_destValdemaqueda                    7.469779e-12   7.469779e-12
`mes2021-10`                           -7.211342e-12   7.211342e-12
`mun_destRobledillo de la Jara`        -7.187116e-12   7.187116e-12
`mun_destFuentidueña de Tajo`          -6.901294e-12   6.901294e-12
`mun_destCamarma de Esteruelas`        -6.856676e-12   6.856676e-12
`mun_destSevilla la Nueva`              6.849053e-12   6.849053e-12
mun_destTorrelaguna                     6.561454e-12   6.561454e-12
`mun_destFuente el Saz de Jarama`      -6.277145e-12   6.277145e-12
`mun_destOrusco de Tajuña`             -6.213144e-12   6.213144e-12
`mun_destValdetorres de Jarama`         6.183162e-12   6.183162e-12
`mun_destSerna del Monte, La`          -5.811545e-12   5.811545e-12
`mun_destBuitrago del Lozoya`          -5.671375e-12   5.671375e-12
`mes2022-08`                           -5.565189e-12   5.565189e-12
`mes2022-10`                            5.546414e-12   5.546414e-12
`mun_destPelayos de la Presa`          -5.467893e-12   5.467893e-12
mun_destBustarviejo                    -5.370556e-12   5.370556e-12
mun_destMoralzarzal                     5.234274e-12   5.234274e-12
`mun_destCampo Real`                   -5.080403e-12   5.080403e-12
`mun_destPrádena del Rincón`           -4.955417e-12   4.955417e-12
mun_destValdeavero                     -4.914225e-12   4.914225e-12
`mun_destVellón, El`                    4.883862e-12   4.883862e-12
`mun_destManzanares el Real`            4.881556e-12   4.881556e-12
mun_destSantorcaz                      -4.805541e-12   4.805541e-12
`mun_destTalamanca de Jarama`           4.772305e-12   4.772305e-12
`mun_destPuebla de la Sierra`          -4.597415e-12   4.597415e-12
mun_destPedrezuela                     -4.242360e-12   4.242360e-12
mun_destRibatejada                     -4.167757e-12   4.167757e-12
`mes2022-04`                           -4.049137e-12   4.049137e-12
`mes2020-02`                           -3.947962e-12   3.947962e-12
`mun_destPozuelo del Rey`              -3.933339e-12   3.933339e-12
mun_destRedueña                        -3.850940e-12   3.850940e-12
mun_destValdelaguna                    -3.760160e-12   3.760160e-12
mun_destNavacerrada                    -3.671256e-12   3.671256e-12
```

`mes2019-10`	3.646700e-12	3.646700e-12
`mes2022-09`	3.592261e-12	3.592261e-12
`mun_destBoalo, El`	-3.321890e-12	3.321890e-12
mun_destVillaconejos	-3.110783e-12	3.110783e-12
mun_destRobregordo	-3.061159e-12	3.061159e-12
`mun_destGuadalix de la Sierra`	-2.983675e-12	2.983675e-12
`mun_destVillar del Olmo`	2.962229e-12	2.962229e-12
mun_destCercedilla	-2.932081e-12	2.932081e-12
`mes2022-07`	-2.887412e-12	2.887412e-12
`mun_destValverde de Alcalá`	-2.866136e-12	2.866136e-12
`mun_destCubas de la Sagra`	-2.855204e-12	2.855204e-12
`mes2019-09`	2.613004e-12	2.613004e-12
`mun_destMorata de Tajuña`	-2.585392e-12	2.585392e-12
`mun_destPinilla del Valle`	-2.487361e-12	2.487361e-12
`mun_destNuevo Baztán`	-2.394053e-12	2.394053e-12
`mun_destPerales de Tajuña`	2.390958e-12	2.390958e-12
mun_destAlpedrete	-2.347034e-12	2.347034e-12
`mun_destMoraleja de Enmedio`	2.342877e-12	2.342877e-12
`mes2019-12`	-2.336594e-12	2.336594e-12
mun_destValdaracete	-2.294792e-12	2.294792e-12
`mun_destHoyo de Manzanares`	-2.044179e-12	2.044179e-12
`mun_destColmenar de Oreja`	-2.010737e-12	2.010737e-12
mun_destVenturada	1.978063e-12	1.978063e-12
mun_destColmenarejo	1.884649e-12	1.884649e-12
`mun_destValdeolmos-Alalpardo`	1.852173e-12	1.852173e-12
`mun_destCollado Mediano`	1.752889e-12	1.752889e-12
`mun_destVillamanrique de Tajo`	1.749953e-12	1.749953e-12
mun_destValdilecha	1.626710e-12	1.626710e-12
`mes2022-05`	-1.579670e-12	1.579670e-12
`mun_destSerranillos del Valle`	-1.450392e-12	1.450392e-12
mun_destChinchón	1.303831e-12	1.303831e-12
`mes2022-06`	-1.168309e-12	1.168309e-12
mun_destSomosierra	-1.095525e-12	1.095525e-12
mun_destValdemanco	-1.036021e-12	1.036021e-12
`mun_destVillanueva de Perales`	9.528964e-13	9.528964e-13
`mun_destSanta María de la Alameda`	8.806456e-13	8.806456e-13
`mun_destPezuela de las Torres`	7.144495e-13	7.144495e-13
mun_destGriñón	-6.766469e-13	6.766469e-13
is_trainTRUE	-5.764220e-13	5.764220e-13
mun_destVillamanta	5.625878e-13	5.625878e-13
`mes2020-01`	-4.845745e-13	4.845745e-13
mun_destQuijorna	-3.124802e-13	3.124802e-13
mun_destTitulcia	-2.425471e-13	2.425471e-13
mun_destNavalagamella	-2.204755e-13	2.204755e-13
`mes2019-08`	-1.594867e-13	1.594867e-13
`mun_destMiraflores de la Sierra`	-1.515459e-13	1.515459e-13
mun_dest_cod	-1.176547e-13	1.176547e-13
`mes2019-11`	-1.135663e-13	1.135663e-13

```
mun_destTielmes                          1.098755e-13    1.098755e-13
```

0.6.2 Logistic Regression Feature importance

No aplica

0.7 Decision Tree Feature Importance

0.7.1 CART Regression Feature Importance

```
[15]: # 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] 4.27540375 0.92840868 0.91951914 0.77648123 0.21746804 0.21746804 0.02441950
[8] 0.01244799
```

0.7.2 CART Classification Feature Importance

No aplica

0.7.3 Random Forest Regression Feature Importance

ATENCIÓN: Este proceso es costoso en recursos.

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

     # load the necessary packages
```

```r
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
mun_dest_cod    mun_dest_cod 346461864.76
CMUN                    CMUN 282898525.92
mun_dest            mun_dest 212597478.48
pais_orig_cod  pais_orig_cod 166564554.68
turistas            turistas 119379733.50
pais_orig          pais_orig  32186340.64
mes                      mes   3750848.44
is_train            is_train     77949.02
```

[10]:
```r
rf_model$importance
```

	%IncMSE	IncNodePurity
mes	3750848.44	1.142556e+11
pais_orig_cod	166564554.68	6.109093e+11
pais_orig	32186340.64	2.365744e+11
A matrix: 8 × 2 of type dbl mun_dest_cod	346461864.76	1.922399e+11
mun_dest	212597478.48	2.086304e+11
turistas	119379733.50	4.089973e+12
CMUN	282898525.92	1.714569e+11
is_train	77949.02	8.536193e+09

0.7.4 Random Forest Classification Feature Importance

No aplica

0.8 Permutation Feature Importance

0.8.1 Permutation Feature Importance for Regression

```r
[11]: # 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)
```

Loading required package: ranger

Attaching package: 'ranger'

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

    importance


```
                  Feature  Importance
mun_dest_cod    mun_dest_cod 271146955.1
CMUN                    CMUN 258862935.3
mun_dest            mun_dest 215161355.5
pais_orig_cod  pais_orig_cod 197744889.8
turistas            turistas 119085138.0
pais_orig          pais_orig  37156365.6
mes                      mes   3818209.9
is_train            is_train    187336.7
```

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

```
[ ]:
```

```
[ ]:
```

```
[ ]:
```