

```
options(tinytex.verbose = TRUE)
```

```
set.seed(123456)
```

```
library(car)
library(dplyr)
library(magrittr)
library(ggplot2)
library(forcats)
library(lubridate)
library(RQuantLib)
library(tidyverse)
library(wesanderson)
library(caret)
library(rpart.plot)
library(randomForest)
library(rfm)
library(party)
library(e1071)
library(tree)
library(doby)
library(kableExtra)
library(DT)
library(funModeling)
```

```
##PRE-PROCESSING
```

```
str(df_1_cli_fid)
```

```
## 'data.frame': 370135 obs. of 7 variables:
## $ ID_CLI : int 500 16647 835335 9557 767877 743090 768948 813156 766232 773214 ...
## $ ID_FID : int 814583 781106 816369 746573 741522 776971 742716 791681 739769 752897 ...
## $ ID_NEG : int 32 44 28 9 41 2 31 45 4 5 ...
## $ TYP_CLI_FID: int 1 1 1 1 1 1 1 1 1 1 ...
## $ COD_FID : chr "PREMIUM" "PREMIUM" "PREMIUM" "PREMIUM" ...
## $ STATUS_FID: int 1 1 1 1 1 1 1 1 1 1 ...
## $ DT_ACTIVE : chr "2019-02-23" "2019-02-02" "2019-02-23" "2019-01-11" ...
```

```
summary(df_1_cli_fid)
```

```
##      ID_CLI      ID_FID      ID_NEG      TYP_CLI_FID
## Min.   : 1      Min.   : 3      Min.   : 1.0      Min.   :0.0000
## 1st Qu.:230659  1st Qu.:229067  1st Qu.: 6.0      1st Qu.:1.0000
## Median :462034  Median :458969  Median :23.0     Median :1.0000
## Mean   :462486  Mean   :459425  Mean   :22.1     Mean   :0.9848
## 3rd Qu.:693200  3rd Qu.:688435  3rd Qu.:36.0     3rd Qu.:1.0000
## Max.   :934919  Max.   :928121  Max.   :49.0     Max.   :1.0000
##      COD_FID      STATUS_FID      DT_ACTIVE
## Length:370135      Min.   :0.00      Length:370135
## Class :character    1st Qu.:1.00      Class :character
## Mode  :character    Median :1.00      Mode  :character
##                      Mean   :0.99
```

```

##          3rd Qu.:1.00
##          Max.    :1.00

### START CLEANING df_1 ###

df_1_cli_fid_clean <- df_1_cli_fid

#### CLEANING DUPLICATE VALUES in df_1 ####

## check for duplicates
df_1_cli_fid_clean %>%
  summarise(TOT_ID_CLIs = n_distinct(ID_CLI)
            , TOT_ID_FIDs = n_distinct(ID_FID)
            , TOT_ID_CLIFIDs = n_distinct(paste0(as.character(ID_CLI), "-", as.character(ID_FID)))
            , TOT_ROWS = n())

##   TOT_ID_CLIs TOT_ID_FIDs TOT_ID_CLIFIDs TOT_ROWS
## 1      369472      367925      370135      370135

### NOTE: no duplicates for combination CLI-FID !!!#

#### CLEANING DATA TYPES in df_1 ####

## formatting dates ##
df_1_cli_fid_clean <- df_1_cli_fid_clean %>%
  mutate(DT_ACTIVE = as.Date(DT_ACTIVE))

## formatting boolean as factor ##
df_1_cli_fid_clean <- df_1_cli_fid_clean %>%
  mutate(TYP_CLI_FID = as.factor(TYP_CLI_FID)) %>%
  mutate(STATUS_FID = as.factor(STATUS_FID))

#### CONSISTENCY CHECK on df1: number of fidelity subscriptions per client ####
str(df_1_cli_fid_clean)

## 'data.frame':   370135 obs. of  7 variables:
## $ ID_CLI      : int  500 16647 835335 9557 767877 743090 768948 813156 766232 773214 ...
## $ ID_FID      : int  814583 781106 816369 746573 741522 776971 742716 791681 739769 752897 ...
## $ ID_NEG      : int   32 44 28 9 41 2 31 45 4 5 ...
## $ TYP_CLI_FID : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
## $ COD_FID     : chr  "PREMIUM" "PREMIUM" "PREMIUM" "PREMIUM" ...
## $ STATUS_FID  : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
## $ DT_ACTIVE   : Date, format: "2019-02-23" "2019-02-02" ...

## count the subscriptions for each client
num_fid_x_cli <- df_1_cli_fid_clean %>%
  group_by(ID_CLI) %>%
  summarise(NUM_FIDs = n_distinct(ID_FID)
            , NUM_DATES = n_distinct(DT_ACTIVE)
            )
?n_distinct
tot_id_cli <- n_distinct(num_fid_x_cli$ID_CLI)

```

```
## compute the distribution of number of subscriptions
dist_num_fid_x_cli <- num_fid_x_cli %>%
  group_by(NUM_FIDs, NUM_DATEs) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT_CLIs = TOT_CLIs/tot_id_cli)

dist_num_fid_x_cli
```

```
## # A tibble: 7 x 4
## # Groups:   NUM_FIDs [4]
##   NUM_FIDs NUM_DATEs TOT_CLIs PERCENT_CLIs
##   <int>     <int>   <int>     <dbl>
## 1       1         1   368833    0.998
## 2       2         1     254    0.000687
## 3       2         2     363    0.000982
## 4       3         1       7    0.0000189
## 5       3         2       8    0.0000217
## 6       3         3       5    0.0000135
## 7       4         1       2    0.00000541
```

NOTE: there are clients with multiple fidelity subscriptions

let examine in details clients with multiple subscriptions

```
num_fid_x_cli %>% filter(NUM_FIDs == 3)
```

```
## # A tibble: 20 x 3
##   ID_CLI NUM_FIDs NUM_DATEs
##   <int>   <int>   <int>
## 1  7533       3         3
## 2 11477       3         1
## 3 68556       3         1
## 4 96537       3         1
## 5 223203      3         3
## 6 250133      3         2
## 7 311669      3         1
## 8 320880      3         2
## 9 621814      3         3
## 10 648813     3         3
## 11 662651     3         3
## 12 671097     3         2
## 13 688941     3         2
## 14 722274     3         2
## 15 736520     3         2
## 16 757759     3         2
## 17 792369     3         1
## 18 826640     3         2
## 19 859327     3         1
## 20 879261     3         1
```

```
# each subscription can have different dates
df_1_cli_fid %>% filter(ID_CLI == 621814)
```

```
##   ID_CLI ID_FID ID_NEG TYP_CLI_FID COD_FID STATUS_FID DT_ACTIVE
## 1 621814 578123     1           1 STANDARD           0 2018-10-13
## 2 621814 646483    18           1 STANDARD           0 2018-11-13
## 3 621814 661124    18           1 STANDARD           1 2018-11-20
```

```
# there could be subscriptions at the same dates [possibly for technical reasons]
df_1_cli_fid %>% filter(ID_CLI == 320880)
```

```
##   ID_CLI ID_FID ID_NEG TYP_CLI_FID COD_FID STATUS_FID DT_ACTIVE
## 1 320880 248462     8           1 STANDARD           0 2018-04-25
## 2 320880 250899     8           1 PREMIUM           0 2018-04-26
## 3 320880 250910     8           1 STANDARD           1 2018-04-26
```

```
#### RESHAPING df_1 ####
```

```
## combining information
```

```
# from first subscription --> registration date, store for registration
# from last subscription --> type of fidelity, status
# from subscriptions count --> number of subscriptions made
```

```
df_1_cli_fid_first <- df_1_cli_fid_clean %>%
  group_by(ID_CLI) %>%
  filter(DT_ACTIVE == min(DT_ACTIVE)) %>%
  arrange(ID_FID) %>%
  filter(row_number() == 1) %>%
  ungroup() %>%
  as.data.frame()
```

```
df_1_cli_fid_last <- df_1_cli_fid_clean %>%
  group_by(ID_CLI) %>%
  filter(DT_ACTIVE == max(DT_ACTIVE)) %>%
  arrange(desc(ID_FID)) %>%
  filter(row_number() == 1) %>%
  ungroup() %>%
  as.data.frame()
```

```
df_1_cli_fid_clean <- df_1_cli_fid_last %>%
  select(ID_CLI
    , ID_FID
    , LAST_COD_FID = COD_FID
    , LAST_TYP_CLI_FID = TYP_CLI_FID
    , LAST_STATUS_FID = STATUS_FID
    , LAST_DT_ACTIVE = DT_ACTIVE) %>%
  left_join(df_1_cli_fid_first %>%
    select(ID_CLI
      , FIRST_ID_NEG = ID_NEG
      , FIRST_DT_ACTIVE = DT_ACTIVE)
    , by = 'ID_CLI') %>%
```

```

left_join(num_fid_x_cli %>%
  select(ID_CLI
        , NUM_FIDs) %>%
  mutate(NUM_FIDs = as.factor(NUM_FIDs))
, by = 'ID_CLI')

```

EXPLORE COLUMNS of df_1

variable LAST_COD_FID

compute distribution

```

df1_dist_codfid <- df_1_cli_fid_clean %>%
  group_by(LAST_COD_FID) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))

```

df1_dist_codfid

```

## # A tibble: 4 x 3
##   LAST_COD_FID TOT_CLIs PERCENT
##   <chr>         <int>   <dbl>
## 1 STANDARD      289756  0.784
## 2 PREMIUM       43878  0.119
## 3 STANDARD BIZ   29148  0.0789
## 4 PREMIUM BIZ    6690  0.0181

```

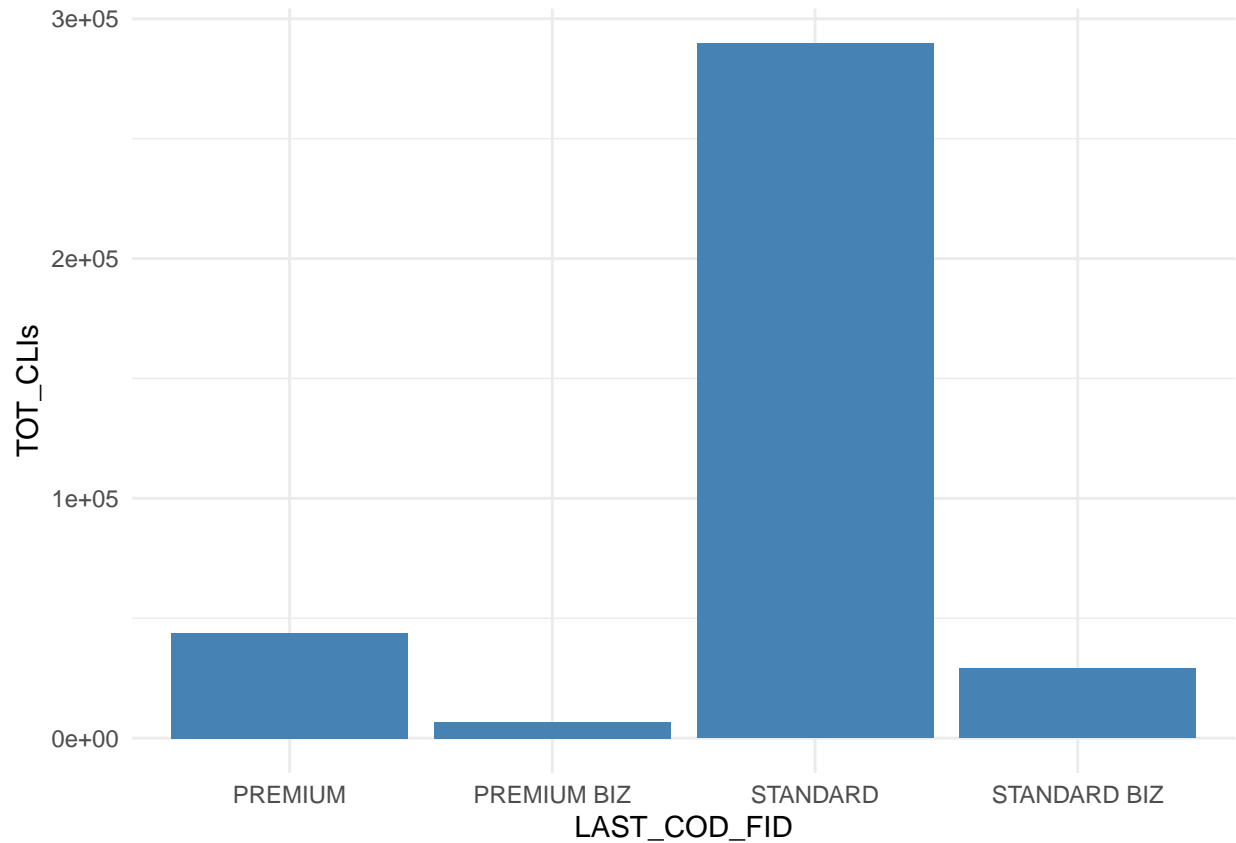
plot distribution

```

plot_df1_dist_codfid <- (
  ggplot(data=df1_dist_codfid
        , aes(x=LAST_COD_FID, y=TOT_CLIs)
  ) +
  geom_bar(stat="identity"
        , fill="steelblue") +
  theme_minimal()
)

```

plot_df1_dist_codfid



```
#### TO DO df_1 ####
# EXPLORE the remaining df_1_cli_fid_clean relevant variables
```

```
### variable NUM_FIDS ###
```

```
## compute distribution
df1_dist_codfid <- df_1_cli_fid_clean %>%
  group_by(NUM_FIDS) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))
```

```
df1_dist_codfid
```

```
## # A tibble: 4 x 3
##   NUM_FIDS TOT_CLIs   PERCENT
##   <fct>      <int>     <dbl>
## 1 1        368833 0.998
## 2 2          617 0.00167
## 3 3           20 0.0000541
## 4 4           2 0.00000541
```

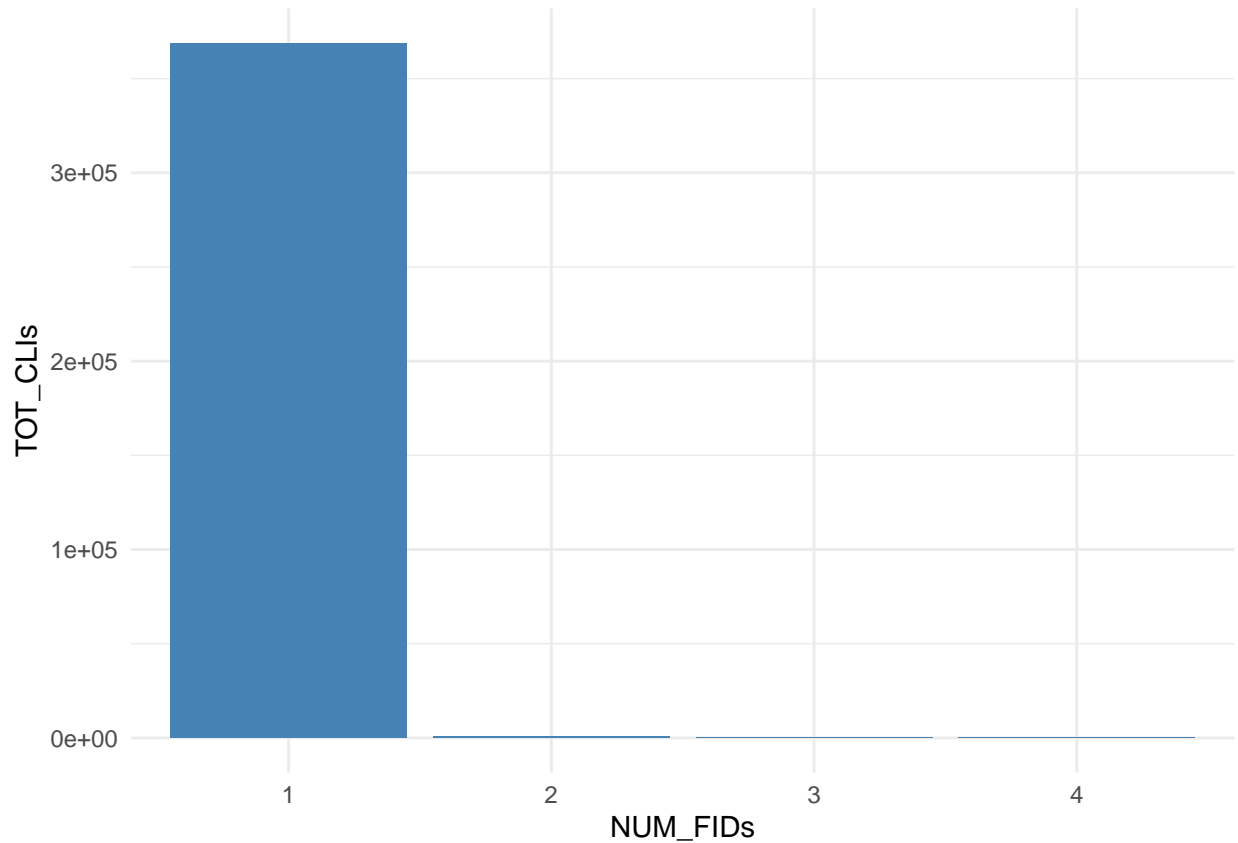
```
## plot distribution
```

```
plot_df1_dist_codfid <- (
```

```

ggplot(data=df1_dist_codfid
      , aes(x=NUM_FIDs, y=TOT_CLIs)
) +
  geom_bar(stat="identity"
          , fill="steelblue") +
  theme_minimal()
)
plot_df1_dist_codfid

```



```

### variable LAST_DT_ACTIVE ###

## compute distribution
df1_dist_codfid <- df_1_cli_fid_clean %>%
  group_by(substring(LAST_DT_ACTIVE,1,4)) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT)) %>%
  rename(Year = `substring(LAST_DT_ACTIVE, 1, 4)`)

df1_dist_codfid

```

```

## # A tibble: 2 x 3
##   Year TOT_CLIs PERCENT
##   <chr>    <int>   <dbl>

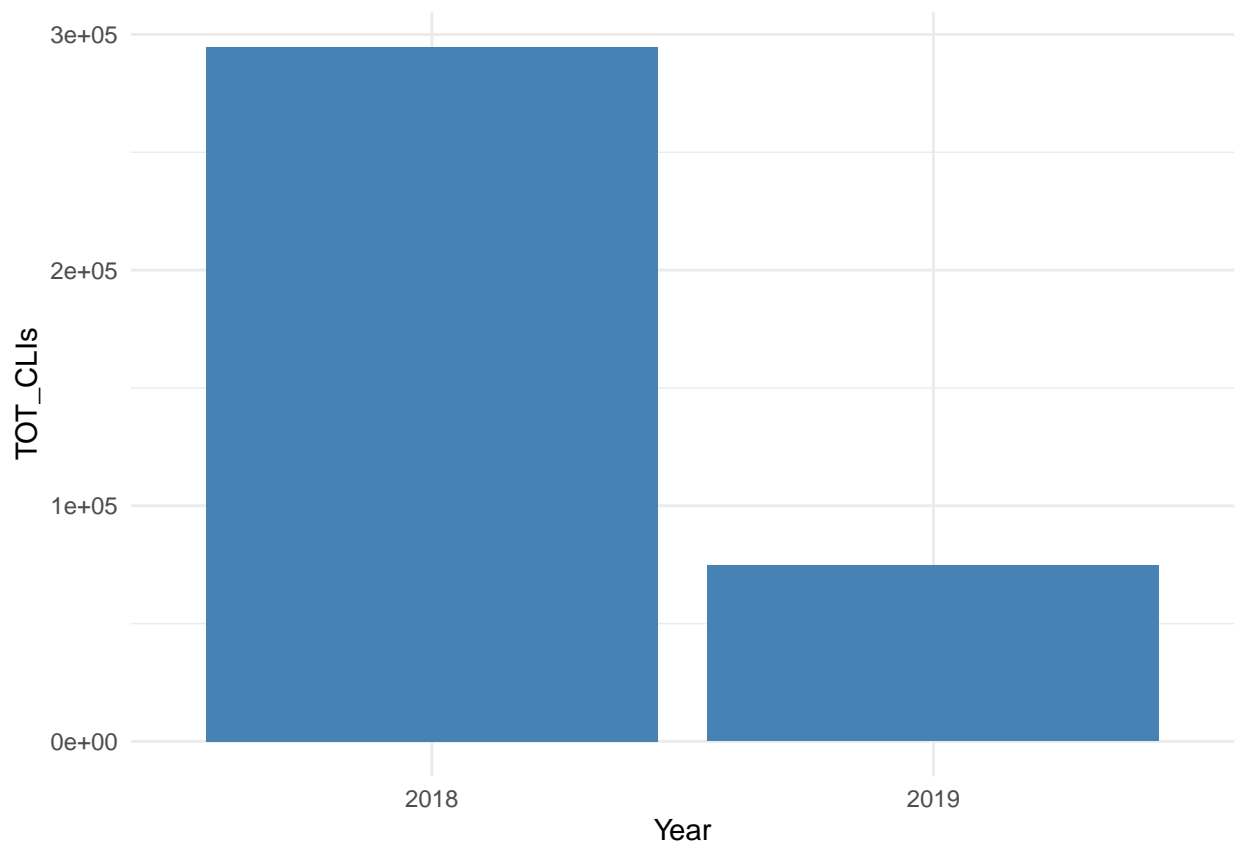
```

```
## 1 2018    294855    0.798
## 2 2019     74617    0.202
```

```
## plot distribution
```

```
plot_df1_dist_codfid <- (
  ggplot(data=df1_dist_codfid
    , aes(x=Year, y=TOT_CLIs)
  ) +
  geom_bar(stat="identity"
    , fill="steelblue") +
  theme_minimal()
)
```

```
plot_df1_dist_codfid
```



```
### variable FIRST_DT_ACTIVE ###
```

```
## compute distribution
```

```
df1_dist_codfid <- df_1_cli_fid_clean %>%
  group_by(substring(FIRST_DT_ACTIVE,1,4)) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT)) %>%
  rename(Year = `substring(FIRST_DT_ACTIVE, 1, 4)`)
```



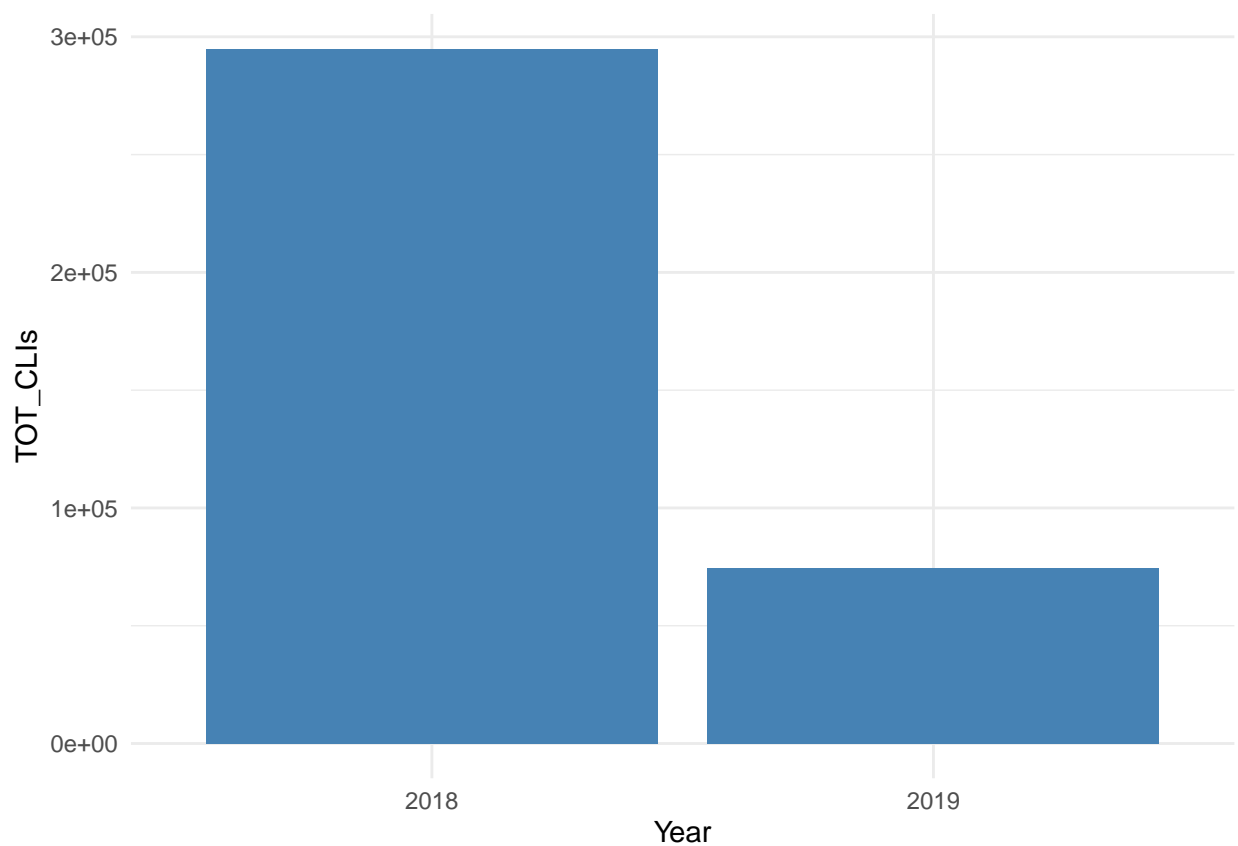
```
df1_dist_codfid
```

```
## # A tibble: 2 x 3
##   Year  TOT_CLIs PERCENT
##   <chr>   <int>   <dbl>
## 1 2018    294954   0.798
## 2 2019     74518   0.202
```

```
## plot distribution
```

```
plot_df1_dist_codfid <- (
  ggplot(data=df1_dist_codfid
    , aes(x=Year, y=TOT_CLIs)
  ) +
  geom_bar(stat="identity"
    , fill="steelblue") +
  theme_minimal()
)
```

```
plot_df1_dist_codfid
```



```
### variable LAST_STATUS_FID ###
```

```
## compute distribution
```

```
df1_dist_codfid <- df_1_cli_fid_clean %>%
  group_by(LAST_STATUS_FID) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))
```

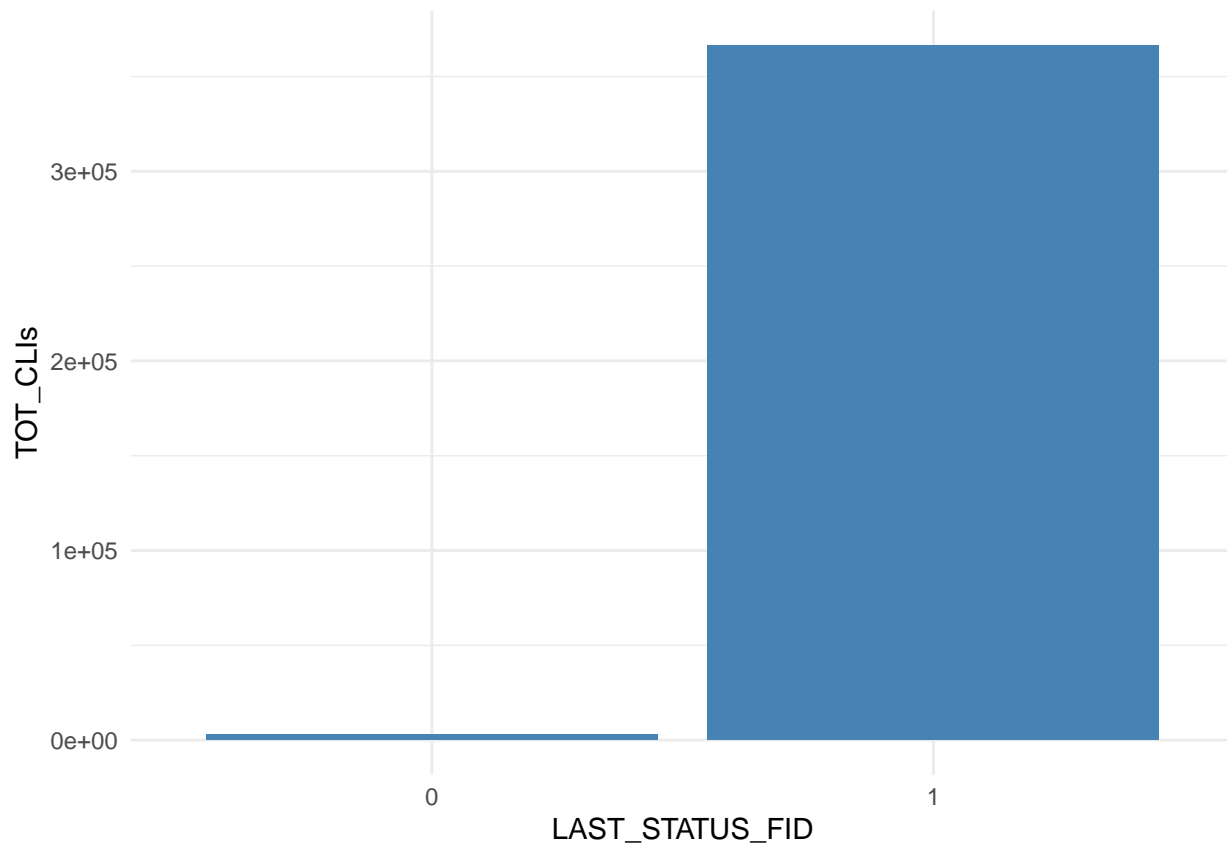
```
df1_dist_codfid
```

```
## # A tibble: 2 x 3
##   LAST_STATUS_FID TOT_CLIs PERCENT
##   <fct>          <int>   <dbl>
## 1 1              366413 0.992
## 2 0              3059  0.00828
```

```
## plot distribution
```

```
plot_df1_dist_codfid <- (
  ggplot(data=df1_dist_codfid
    , aes(x=LAST_STATUS_FID, y=TOT_CLIs)
  ) +
  geom_bar(stat="identity"
    , fill="steelblue") +
  theme_minimal()
)
```

```
plot_df1_dist_codfid
```



```
#### FINAL REVIEW df_1_clean ####
```

```
str(df_1_cli_fid_clean)
```

```
## 'data.frame': 369472 obs. of 9 variables:
## $ ID_CLI : int 199060 613049 648813 914880 342639 816890 898295 178553 918274 111479 ...
## $ ID_FID : int 928121 928118 928116 928115 928112 928110 928106 928101 928100 928099 ...
## $ LAST_COD_FID : chr "PREMIUM BIZ" "PREMIUM" "STANDARD" "STANDARD" ...
## $ LAST_TYP_CLI_FID: Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
## $ LAST_STATUS_FID : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 1 2 ...
## $ LAST_DT_ACTIVE : Date, format: "2019-05-11" "2019-05-11" ...
## $ FIRST_ID_NEG : int 19 21 1 43 26 24 34 10 17 31 ...
## $ FIRST_DT_ACTIVE : Date, format: "2018-02-18" "2019-03-30" ...
## $ NUM_FIDs : Factor w/ 4 levels "1","2","3","4": 2 2 3 2 2 2 2 2 2 2 ...
```

```
summary(df_1_cli_fid_clean)
```

```
##      ID_CLI      ID_FID      LAST_COD_FID      LAST_TYP_CLI_FID
## Min.   : 1      Min.   : 3      Length:369472      0: 5607
## 1st Qu.:230783  1st Qu.:228931      Class :character  1:363865
## Median :462063  Median :458832      Mode  :character
## Mean   :462541  Mean   :459335
## 3rd Qu.:693197  3rd Qu.:688330
## Max.   :934919  Max.   :928121
## LAST_STATUS_FID LAST_DT_ACTIVE      FIRST_ID_NEG FIRST_DT_ACTIVE
```

```
## 0: 3059      Min. :2018-01-01  Min. : 1.0  Min. :2018-01-01
## 1:366413    1st Qu.:2018-04-15  1st Qu.: 6.0  1st Qu.:2018-04-15
##           Median :2018-08-10  Median :23.0  Median :2018-08-09
##           Mean  :2018-08-14  Mean  :22.1  Mean  :2018-08-14
##           3rd Qu.:2018-11-30  3rd Qu.:36.0  3rd Qu.:2018-11-30
##           Max.  :2019-05-11  Max.  :49.0  Max.  :2019-04-30
## NUM_FIDs
## 1:368833
## 2: 617
## 3: 20
## 4: 2
##
##
```

```
#-----
#### FIRST LOOK of df_2 ####

str(df_2_cli_account)
```

```
## 'data.frame': 369472 obs. of 6 variables:
## $ ID_CLI : int 600125 729642 304639 292497 589492 638815 658338 883322 508481 871293 ...
## $ EMAIL_PROVIDER : chr "libero.it" "gmail.com" "yahoo.it" "libero.it" ...
## $ W_PHONE : int NA NA 1 1 NA 1 1 1 1 ...
## $ ID_ADDRESS : int 584621 714144 284176 272563 573304 622947 642716 856157 488177 847360 ...
## $ TYP_CLI_ACCOUNT: int 4 4 4 4 2 2 4 4 4 4 ...
## $ TYP_JOB : chr NA NA NA NA ...
```

```
summary(df_2_cli_account)
```

```
##      ID_CLI      EMAIL_PROVIDER      W_PHONE      ID_ADDRESS
## Min.   :      1  Length:369472  Min.   :1  Min.   :      1
## 1st Qu.:230783  Class :character  1st Qu.:1  1st Qu.:227903
## Median :462063  Mode  :character  Median :1  Median :456720
## Mean   :462541                Mean  :1  Mean   :457283
## 3rd Qu.:693197                3rd Qu.:1  3rd Qu.:686533
## Max.   :934919                Max.   :1  Max.   :900091
##                                     NA's   :27305
## TYP_CLI_ACCOUNT  TYP_JOB
## Min.   :2.000  Length:369472
## 1st Qu.:4.000  Class :character
## Median :4.000  Mode  :character
## Mean   :3.806
## 3rd Qu.:4.000
## Max.   :4.000
##
```

```
#### START CLEANING df_2 ####

df_2_cli_account_clean <- df_2_cli_account

#### CLEANING DUPLICATE VALUES in df_2 ####
```

```

## check for duplicates
df_2_cli_account_clean %>%
  summarise(TOT_ID_CLIs = n_distinct(ID_CLI)
            , TOT_ROWS = n())

##   TOT_ID_CLIs TOT_ROWS
## 1      369472   369472

#### NOTE: no duplicates !!!#

#### CLEANING DATA TYPES in df_2 ####

## format boolean as factor ##
df_2_cli_account_clean <- df_2_cli_account_clean %>%
  mutate(W_PHONE = as.factor(W_PHONE))

## format numerical categories as factor ##
df_2_cli_account_clean <- df_2_cli_account_clean %>%
  mutate(TYP_CLI_ACCOUNT = as.factor(TYP_CLI_ACCOUNT))

#### CLEANING MISSING VALUES in df_2 ####

## MISSING VALUES mapped as natural values ##
df_2_cli_account_clean <- df_2_cli_account_clean %>%
  mutate(W_PHONE = fct_explicit_na(W_PHONE, "0"))

## MISSING VALUES mapped as new level in categorical columns ##
df_2_cli_account_clean <- df_2_cli_account_clean %>%
  mutate(EMAIL_PROVIDER = fct_explicit_na(EMAIL_PROVIDER, "(missing)")) %>%
  mutate(TYP_JOB = fct_explicit_na(TYP_JOB, "(missing)"))

#### CONSISTENCY CHECK ID_CLI in df_1/df_2 ####

cons_idcli_df1_df2 <- df_1_cli_fid_clean %>%
  select(ID_CLI) %>%
  mutate(is_in_df_1 = 1) %>%
  distinct() %>%
  full_join(df_2_cli_account_clean %>%
            select(ID_CLI) %>%
            mutate(is_in_df_2 = 1) %>%
            distinct()
            , by = "ID_CLI"
  ) %>%
  group_by(is_in_df_1, is_in_df_2) %>%
  summarise(NUM_ID_CLIs = n_distinct(ID_CLI)) %>%
  as.data.frame()

cons_idcli_df1_df2

##   is_in_df_1 is_in_df_2 NUM_ID_CLIs
## 1         1         1      369472

```

```
#### NOTE: all ID_CLI in df_1 are also in df_2 and vice-versa !!!#
```

```
#### EXPLORE COLUMNS of df_2 ####
```

```
### Variable EMAIL_PROVIDER ###
```

```
## compute distribution
```

```
df_2_dist_emailprovider <- df_2_cli_account_clean %>%
  group_by(EMAIL_PROVIDER) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT)) %>%
  as.data.frame()
```

```
df_2_dist_emailprovider
```

	EMAIL_PROVIDER	TOT_CLIs	PERCENT
## 1	gmail.com	151508	4.100663e-01
## 2	libero.it	57782	1.563907e-01
## 3	hotmail.it	28698	7.767300e-02
## 4	alice.it	18127	4.906190e-02
## 5	yahoo.it	16538	4.476117e-02
## 6	hotmail.com	10076	2.727135e-02
## 7	virgilio.it	9161	2.479484e-02
## 8	tiscali.it	8733	2.363643e-02
## 9	live.it	7936	2.147930e-02
## 10	(missing)	5889	1.593896e-02
## 11	icloud.com	3735	1.010902e-02
## 12	yahoo.com	3259	8.820695e-03
## 13	gmail.it	2266	6.133076e-03
## 14	tin.it	2183	5.908431e-03
## 15	outlook.it	2039	5.518686e-03
## 16	fastwebnet.it	1749	4.733782e-03
## 17	inwind.it	1514	4.097739e-03
## 18	email.it	1103	2.985341e-03
## 19	me.com	1034	2.798588e-03
## 20	live.com	837	2.265395e-03
## 21	outlook.com	695	1.881063e-03
## 22	msn.com	653	1.767387e-03
## 23	tim.it	462	1.250433e-03
## 24	ymail.com	440	1.190889e-03
## 25	teletu.it	421	1.139464e-03
## 26	nomail.it	396	1.071800e-03
## 27	vodafone.it	386	1.044734e-03
## 28	libero.com	349	9.445912e-04
## 29	pec.it	317	8.579811e-04
## 30	mail.ru	301	8.146761e-04
## 31	lm.it	281	7.605448e-04
## 32	mail.com	246	6.658150e-04
## 33	gmai.com	240	6.495756e-04
## 34	istruzione.it	219	5.927377e-04
## 35	katamail.com	208	5.629655e-04
## 36	yhao.it	204	5.521393e-04

## 37	iol.it	183 4.953014e-04
## 38	telecomitalia.it	160 4.330504e-04
## 39	gamil.com	135 3.653863e-04
## 40	qq.com	126 3.410272e-04
## 41	gdf.it	125 3.383206e-04
## 42	legalmail.it	124 3.356141e-04
## 43	tiscalinet.it	124 3.356141e-04
## 44	l.it	114 3.085484e-04
## 45	poste.it	114 3.085484e-04
## 46	email.com	112 3.031353e-04
## 47	alice.com	105 2.841893e-04
## 48	icloud.it	104 2.814828e-04
## 49	yahoo.fr	97 2.625368e-04
## 50	nomail.com	92 2.490040e-04
## 51	info.it	90 2.435909e-04
## 52	gmail.co	86 2.327646e-04
## 53	bluewin.ch	81 2.192318e-04
## 54	rocketmail.com	74 2.002858e-04
## 55	gimail.com	72 1.948727e-04
## 56	gmil.com	72 1.948727e-04
## 57	gmail.con	71 1.921661e-04
## 58	hotmai.it	68 1.840464e-04
## 59	mac.com	68 1.840464e-04
## 60	aliceposta.it	67 1.813399e-04
## 61	aol.com	66 1.786333e-04
## 62	hotmail.fr	65 1.759267e-04
## 63	gmil.com	64 1.732202e-04
## 64	interfree.it	64 1.732202e-04
## 65	yahoo.co.uk	62 1.678070e-04
## 66	intesasanpaolo.com	61 1.651005e-04
## 67	lib.it	60 1.623939e-04
## 68	aruba.it	58 1.569808e-04
## 69	virgilio.com	57 1.542742e-04
## 70	giustizia.it	52 1.407414e-04
## 71	uniroma1.it	52 1.407414e-04
## 72	tiscali.com	51 1.380348e-04
## 73	fastweb.it	47 1.272086e-04
## 74	yahoo.es	47 1.272086e-04
## 75	googlemail.com	45 1.217954e-04
## 76	gmial.com	44 1.190889e-04
## 77	liber.it	38 1.028495e-04
## 78	vigilfuoco.it	36 9.743634e-05
## 79	aol.it	35 9.472978e-05
## 80	blu.it	35 9.472978e-05
## 81	homail.it	35 9.472978e-05
## 82	ibero.it	35 9.472978e-05
## 83	gnail.com	34 9.202321e-05
## 84	infinito.it	34 9.202321e-05
## 85	libeo.it	34 9.202321e-05
## 86	unicredit.eu	34 9.202321e-05
## 87	yahho.it	34 9.202321e-05
## 88	enel.com	33 8.931665e-05
## 89	eni.com	33 8.931665e-05
## 90	unibo.it	33 8.931665e-05

## 91	mail.it	32 8.661008e-05
## 92	mclink.it	32 8.661008e-05
## 93	posteitaliane.it	32 8.661008e-05
## 94	yandex.ru	32 8.661008e-05
## 95	yhao.com	31 8.390352e-05
## 96	icluod.com	30 8.119695e-05
## 97	poliziadistato.it	30 8.119695e-05
## 98	yao.it	30 8.119695e-05
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## 100	liberi.it	28 7.578382e-05
## 101	163.com	27 7.307726e-05
## 102	nonholemail.it	27 7.307726e-05
## 103	gm.com	26 7.037069e-05
## 104	gamil.com	25 6.766413e-05
## 105	iclaud.com	25 6.766413e-05
## 106	rai.it	25 6.766413e-05
## 107	hmail.com	24 6.495756e-05
## 108	hotmail.co.uk	24 6.495756e-05
## 109	unipa.it	24 6.495756e-05
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## 111	virglio.it	23 6.225100e-05
## 112	yhoo.it	23 6.225100e-05
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## 117	gm.de	22 5.954443e-05
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## 130	homail.com	19 5.142474e-05
## 131	houtlook.it	19 5.142474e-05
## 132	mef.gov.it	19 5.142474e-05
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## 134	tecnocasa.it	19 5.142474e-05
## 135	virgiglio.it	19 5.142474e-05
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## 156	inail.it	15 4.059848e-05
## 157	libero.ir	15 4.059848e-05
## 158	notariato.it	15 4.059848e-05
## 159	protonmail.com	15 4.059848e-05
## 160	unipolsai.it	15 4.059848e-05
## 161	unipv.it	15 4.059848e-05
## 162	uniroma2.it	15 4.059848e-05
## 163	wp.pl	15 4.059848e-05
## 164	alleanza.it	14 3.789191e-05
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## 166	autlook.it	14 3.789191e-05
## 167	comune.milano.it	14 3.789191e-05
## 168	ecloud.com	14 3.789191e-05
## 169	gmaill.com	14 3.789191e-05
## 170	hotamil.it	14 3.789191e-05
## 171	hotmail.de	14 3.789191e-05
## 172	htmail.it	14 3.789191e-05
## 173	lin.it	14 3.789191e-05
## 174	omniway.sm	14 3.789191e-05
## 175	polito.it	14 3.789191e-05
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## 182	g.com	13 3.518535e-05
## 183	gmaill.com	13 3.518535e-05
## 184	gmail.om	13 3.518535e-05
## 185	gmail.ru	13 3.518535e-05
## 186	hotmal.it	13 3.518535e-05
## 187	icoud.com	13 3.518535e-05
## 188	iss.it	13 3.518535e-05
## 189	lbero.it	13 3.518535e-05
## 190	lice.it	13 3.518535e-05
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## 194	ubibanca.it	13 3.518535e-05
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## 201	gail.com	12 3.247878e-05
## 202	gmh.net	12 3.247878e-05
## 203	hotamail.it	12 3.247878e-05
## 204	hotmail.es	12 3.247878e-05
## 205	micso.net	12 3.247878e-05
## 206	mit.gov.it	12 3.247878e-05
## 207	mps.it	12 3.247878e-05
## 208	msm.com	12 3.247878e-05
## 209	quipo.it	12 3.247878e-05
## 210	senzamail.com	12 3.247878e-05
## 211	simail.it	12 3.247878e-05
## 212	supereva.it	12 3.247878e-05
## 213	trenitalia.it	12 3.247878e-05
## 214	unito.it	12 3.247878e-05
## 215	fatwebnet.it	11 2.977222e-05
## 216	free.fr	11 2.977222e-05
## 217	galliera.it	11 2.977222e-05
## 218	generali.com	11 2.977222e-05
## 219	gmail.com	11 2.977222e-05
## 220	hotnail.it	11 2.977222e-05
## 221	hsr.it	11 2.977222e-05
## 222	liberto.it	11 2.977222e-05
## 223	marina.difesa.it	11 2.977222e-05
## 224	otmail.it	11 2.977222e-05
## 225	ticino.com	11 2.977222e-05
## 226	virgili.it	11 2.977222e-05
## 227	viriglio.it	11 2.977222e-05
## 228	yahoo.com.br	11 2.977222e-05
## 229	99.com	10 2.706565e-05
## 230	bresciaonline.it	10 2.706565e-05
## 231	com.it	10 2.706565e-05
## 232	gmaol.com	10 2.706565e-05
## 233	leonardocompany.com	10 2.706565e-05
## 234	li.it	10 2.706565e-05
## 235	libeto.it	10 2.706565e-05
## 236	live.fr	10 2.706565e-05
## 237	live.vo	10 2.706565e-05
## 238	outloock.it	10 2.706565e-05
## 239	sirti.it	10 2.706565e-05
## 240	st.com	10 2.706565e-05
## 241	stradeanas.it	10 2.706565e-05
## 242	virgilo.it	10 2.706565e-05
## 243	vodafon.it	10 2.706565e-05
## 244	yaho.it	10 2.706565e-05
## 245	yahoo.ro	10 2.706565e-05
## 246	archiworld.it	9 2.435909e-05
## 247	azimut.it	9 2.435909e-05
## 248	bricomani.it	9 2.435909e-05
## 249	bt.com	9 2.435909e-05
## 250	cnr.it	9 2.435909e-05
## 251	cri.it	9 2.435909e-05
## 252	fastewebnet.it	9 2.435909e-05

## 253	hitmail.it	9 2.435909e-05
## 254	inbox.ru	9 2.435909e-05
## 255	ingv.it	9 2.435909e-05
## 256	inps.it	9 2.435909e-05
## 257	interia.pl	9 2.435909e-05
## 258	it.ibm.com	9 2.435909e-05
## 259	jahoo.it	9 2.435909e-05
## 260	libera.it	9 2.435909e-05
## 261	liero.it	9 2.435909e-05
## 262	mise.gov.it	9 2.435909e-05
## 263	nonho.it	9 2.435909e-05
## 264	outllok.it	9 2.435909e-05
## 265	regione.sicilia.it	9 2.435909e-05
## 266	tin.com	9 2.435909e-05
## 267	tiscal.it	9 2.435909e-05
## 268	unibg.it	9 2.435909e-05
## 269	unicatt.it	9 2.435909e-05
## 270	yahoo.com.ar	9 2.435909e-05
## 271	comune.roma.it	8 2.165252e-05
## 272	comune.torino.it	8 2.165252e-05
## 273	decathlon.com	8 2.165252e-05
## 274	gma.com	8 2.165252e-05
## 275	gmail.net	8 2.165252e-05
## 276	gmail.org	8 2.165252e-05
## 277	icloud.com	8 2.165252e-05
## 278	icolud.com	8 2.165252e-05
## 279	it.abb.com	8 2.165252e-05
## 280	libeor.it	8 2.165252e-05
## 281	liberp.it	8 2.165252e-05
## 282	outolook.com	8 2.165252e-05
## 283	outolook.it	8 2.165252e-05
## 284	pfafineco.it	8 2.165252e-05
## 285	rcs.it	8 2.165252e-05
## 286	sanita.it	8 2.165252e-05
## 287	sfr.fr	8 2.165252e-05
## 288	tahoo.it	8 2.165252e-05
## 289	terna.it	8 2.165252e-05
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## 291	tiscali.net	8 2.165252e-05
## 292	unicampus.it	8 2.165252e-05
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## 294	unipd.it	8 2.165252e-05
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## 296	uniroma3.it	8 2.165252e-05
## 297	unisa.it	8 2.165252e-05
## 298	wanadoo.fr	8 2.165252e-05
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## 300	aceaspa.it	7 1.894596e-05
## 301	alitalia.com	7 1.894596e-05
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## 304	bancagenerali.it	7 1.894596e-05
## 305	campus.unimib.it	7 1.894596e-05
## 306	comune.genova.it	7 1.894596e-05

## 307	comune.palermo.it	7 1.894596e-05
## 308	crea.gov.it	7 1.894596e-05
## 309	dhl.com	7 1.894596e-05
## 310	edison.it	7 1.894596e-05
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## 312	fcagroup.com	7 1.894596e-05
## 313	gmail.cm	7 1.894596e-05
## 314	gmailc.om	7 1.894596e-05
## 315	gmx.ch	7 1.894596e-05
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## 317	hotmial.it	7 1.894596e-05
## 318	iclou.com	7 1.894596e-05
## 319	italgas.it	7 1.894596e-05
## 320	laposte.net	7 1.894596e-05
## 321	list.ru	7 1.894596e-05
## 322	mclink.net	7 1.894596e-05
## 323	neomedia.it	7 1.894596e-05
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## 341	ansaldoenergia.com	6 1.623939e-05
## 342	autostrade.it	6 1.623939e-05
## 343	bhge.com	6 1.623939e-05
## 344	cgil.lombardia.it	6 1.623939e-05
## 345	coldiretti.it	6 1.623939e-05
## 346	coni.it	6 1.623939e-05
## 347	corteconti.it	6 1.623939e-05
## 348	emailna.co	6 1.623939e-05
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## 351	fao.org	6 1.623939e-05
## 352	fmail.com	6 1.623939e-05
## 353	gmaiol.com	6 1.623939e-05
## 354	gmaul.com	6 1.623939e-05
## 355	google.com	6 1.623939e-05
## 356	gotmail.it	6 1.623939e-05
## 357	hayoo.it	6 1.623939e-05
## 358	hotmail.co	6 1.623939e-05
## 359	hotmail.ir	6 1.623939e-05
## 360	hotmali.it	6 1.623939e-05

## 361	humanitas.it	6 1.623939e-05
## 362	iclod.com	6 1.623939e-05
## 363	iclood.com	6 1.623939e-05
## 364	istat.it	6 1.623939e-05
## 365	iwind.it	6 1.623939e-05
## 366	lgmail.com	6 1.623939e-05
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## 369	livero.it	6 1.623939e-05
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## 374	onet.eu	6 1.623939e-05
## 375	otlook.it	6 1.623939e-05
## 376	oulook.it	6 1.623939e-05
## 377	outlook.fr	6 1.623939e-05
## 378	regione.lombardia.it	6 1.623939e-05
## 379	repubblica.it	6 1.623939e-05
## 380	sogei.it	6 1.623939e-05
## 381	tenaris.com	6 1.623939e-05
## 382	timitim.it	6 1.623939e-05
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## 384	unive.it	6 1.623939e-05
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## 4242	personal_mail_provider_12567	1 2.706565e-06
## 4243	personal_mail_provider_12568	1 2.706565e-06
## 4244	personal_mail_provider_12569	1 2.706565e-06
## 4245	personal_mail_provider_12570	1 2.706565e-06
## 4246	personal_mail_provider_12571	1 2.706565e-06
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## 4739	personal_mail_provider_13064	1 2.706565e-06
## 4740	personal_mail_provider_13065	1 2.706565e-06
## 4741	personal_mail_provider_13066	1 2.706565e-06
## 4742	personal_mail_provider_13067	1 2.706565e-06
## 4743	personal_mail_provider_13068	1 2.706565e-06
## 4744	personal_mail_provider_13069	1 2.706565e-06
## 4745	personal_mail_provider_13070	1 2.706565e-06
## 4746	personal_mail_provider_13071	1 2.706565e-06
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## 4750	personal_mail_provider_13075	1 2.706565e-06
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## 4752	personal_mail_provider_13077	1 2.706565e-06
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## 4757	personal_mail_provider_13082	1 2.706565e-06
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## 4768	personal_mail_provider_13093	1 2.706565e-06
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## 6091	personal_mail_provider_14416	1	2.706565e-06
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## 6137	personal_mail_provider_14462	1	2.706565e-06
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## 6359	personal_mail_provider_14684	1	2.706565e-06
## 6360	personal_mail_provider_14685	1	2.706565e-06
## 6361	personal_mail_provider_14686	1	2.706565e-06
## 6362	personal_mail_provider_14687	1	2.706565e-06
## 6363	personal_mail_provider_14688	1	2.706565e-06
## 6364	personal_mail_provider_14689	1	2.706565e-06
## 6365	personal_mail_provider_14690	1	2.706565e-06
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## 6407	personal_mail_provider_14732	1	2.706565e-06
## 6408	personal_mail_provider_14733	1	2.706565e-06

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## 6625	personal_mail_provider_14950	1	2.706565e-06
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## 6627	personal_mail_provider_14952	1	2.706565e-06
## 6628	personal_mail_provider_14953	1	2.706565e-06
## 6629	personal_mail_provider_14954	1	2.706565e-06
## 6630	personal_mail_provider_14955	1	2.706565e-06
## 6631	personal_mail_provider_14956	1	2.706565e-06
## 6632	personal_mail_provider_14957	1	2.706565e-06
## 6633	personal_mail_provider_14958	1	2.706565e-06
## 6634	personal_mail_provider_14959	1	2.706565e-06
## 6635	personal_mail_provider_14960	1	2.706565e-06
## 6636	personal_mail_provider_14961	1	2.706565e-06
## 6637	personal_mail_provider_14962	1	2.706565e-06
## 6638	personal_mail_provider_14963	1	2.706565e-06
## 6639	personal_mail_provider_14964	1	2.706565e-06
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## 6646	personal_mail_provider_14971	1	2.706565e-06
## 6647	personal_mail_provider_14972	1	2.706565e-06
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## 6655	personal_mail_provider_14980	1	2.706565e-06
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## 6659	personal_mail_provider_14984	1	2.706565e-06
## 6660	personal_mail_provider_14985	1	2.706565e-06
## 6661	personal_mail_provider_14986	1	2.706565e-06
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## 6675	personal_mail_provider_15000	1	2.706565e-06
## 6676	personal_mail_provider_15001	1	2.706565e-06
## 6677	personal_mail_provider_15002	1	2.706565e-06
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## 6899	personal_mail_provider_15224	1	2.706565e-06
## 6900	personal_mail_provider_15225	1	2.706565e-06
## 6901	personal_mail_provider_15226	1	2.706565e-06
## 6902	personal_mail_provider_15227	1	2.706565e-06
## 6903	personal_mail_provider_15228	1	2.706565e-06
## 6904	personal_mail_provider_15229	1	2.706565e-06
## 6905	personal_mail_provider_15230	1	2.706565e-06
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## 6907	personal_mail_provider_15232	1	2.706565e-06
## 6908	personal_mail_provider_15233	1	2.706565e-06
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## 7440	personal_mail_provider_15765	1	2.706565e-06
## 7441	personal_mail_provider_15766	1	2.706565e-06
## 7442	personal_mail_provider_15767	1	2.706565e-06
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## 7461	personal_mail_provider_15786	1	2.706565e-06
## 7462	personal_mail_provider_15787	1	2.706565e-06
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## 7473	personal_mail_provider_15798	1	2.706565e-06
## 7474	personal_mail_provider_15799	1	2.706565e-06
## 7475	personal_mail_provider_15800	1	2.706565e-06
## 7476	personal_mail_provider_15801	1	2.706565e-06
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## 7481	personal_mail_provider_15806	1	2.706565e-06
## 7482	personal_mail_provider_15807	1	2.706565e-06
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## 7488	personal_mail_provider_15813	1	2.706565e-06

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##	8676	personal mail provider 16980	1	2.706565e-06

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## 9969	personal_mail_provider_18156	1 2.706565e-06
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## 9971	personal_mail_provider_18158	1 2.706565e-06
## 9972	personal_mail_provider_18159	1 2.706565e-06

## 9973	personal_mail_provider_1816	1 2.706565e-06
## 9974	personal_mail_provider_18160	1 2.706565e-06
## 9975	personal_mail_provider_18161	1 2.706565e-06
## 9976	personal_mail_provider_18162	1 2.706565e-06
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## 9979	personal_mail_provider_18165	1 2.706565e-06
## 9980	personal_mail_provider_18166	1 2.706565e-06
## 9981	personal_mail_provider_18167	1 2.706565e-06
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## 9986	personal_mail_provider_18171	1 2.706565e-06
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## 10001	personal_mail_provider_18185	1 2.706565e-06
## 10002	personal_mail_provider_18186	1 2.706565e-06
## 10003	personal_mail_provider_18187	1 2.706565e-06
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## 10006	personal_mail_provider_1819	1 2.706565e-06
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## 10010	personal_mail_provider_18193	1 2.706565e-06
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##	10411	personal_mail_provider_18558	1	2.706565e-06
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##	10509	personal_mail_provider_18647	1	2.706565e-06
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##	10512	personal mail provider 1865	1	2.706565e-06

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211

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214

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##	11005	personal_mail_provider_19098	1	2.706565e-06
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## 20503 personal_mail_provider_9990      1 2.706565e-06
## 20504 personal_mail_provider_9991      1 2.706565e-06
## 20505 personal_mail_provider_9992      1 2.706565e-06
## 20506 personal_mail_provider_9993      1 2.706565e-06
## 20507 personal_mail_provider_9994      1 2.706565e-06
## 20508 personal_mail_provider_9995      1 2.706565e-06
## 20509 personal_mail_provider_9996      1 2.706565e-06
## 20510 personal_mail_provider_9997      1 2.706565e-06
## 20511 personal_mail_provider_9998      1 2.706565e-06
## 20512 personal_mail_provider_9999      1 2.706565e-06
```

```
tot_emailproviders <- n_distinct(df_2_dist_emailprovider$EMAIL_PROVIDER)
```

```
tot_emailproviders
```

```
## [1] 20512
```

```
### NOTE: too many different values for EMAIL_PROVIDER to be an useful category !!!#
```

```
#### TO DO df_2 ####
```

```
# COMPUTE THE DISTRIBUTION for the remaining df_2_cli_fid_clean variables
```

```
#### RESHAPING df_2 ####
```

```
## keep the most frequent EMAIL_PROVIDER values and add a common factor level "OTHER" for the remaining
```

```
df_2_dist_emailprovider %>%
  arrange(desc(PERCENT)) %>%
  mutate(PERCENT_COVERED = cumsum(TOT_CLIs)/sum(TOT_CLIs)) %>%
  as.data.frame() %>%
  head(20)
```

##	EMAIL_PROVIDER	TOT_CLIs	PERCENT	PERCENT_COVERED
## 1	gmail.com	151508	0.410066257	0.4100663
## 2	libero.it	57782	0.156390741	0.5664570
## 3	hotmail.it	28698	0.077673004	0.6441300
## 4	alice.it	18127	0.049061905	0.6931919
## 5	yahoo.it	16538	0.044761173	0.7379531
## 6	hotmail.com	10076	0.027271349	0.7652244
## 7	virgilio.it	9161	0.024794842	0.7900193
## 8	tiscali.it	8733	0.023636433	0.8136557
## 9	live.it	7936	0.021479300	0.8351350
## 10	(missing)	5889	0.015938962	0.8510740
## 11	icloud.com	3735	0.010109020	0.8611830
## 12	yahoo.com	3259	0.008820695	0.8700037
## 13	gmail.it	2266	0.006133076	0.8761368
## 14	tin.it	2183	0.005908431	0.8820452
## 15	outlook.it	2039	0.005518686	0.8875639
## 16	fastwebnet.it	1749	0.004733782	0.8922977
## 17	inwind.it	1514	0.004097739	0.8963954
## 18	email.it	1103	0.002985341	0.8993807
## 19	me.com	1034	0.002798588	0.9021793
## 20	live.com	837	0.002265395	0.9044447

```

## always keep the (missing) level for technical reasons
## select levels that cover the 85% of the cases, the remaining 15%
clean_email_providers <- df_2_dist_emailprovider %>%
  arrange(desc(PERCENT)) %>%
  mutate(PERCENT_COVERED = cumsum(TOT_CLIs)/sum(TOT_CLIs)) %>%
  mutate(EMAIL_PROVIDER = as.character(EMAIL_PROVIDER)) %>%
  mutate(AUX = if_else(PERCENT_COVERED < 0.85 | (PERCENT_COVERED > 0.85 & lag(PERCENT_COVERED) < 0.85),
    mutate(EMAIL_PROVIDER_CLEAN = if_else(AUX | EMAIL_PROVIDER == "(missing)", EMAIL_PROVIDER, "others"))
  )

head(clean_email_providers, 20)

```

	EMAIL_PROVIDER	TOT_CLIs	PERCENT	PERCENT_COVERED	AUX	EMAIL_PROVIDER_CLEAN
## 1	gmail.com	151508	0.410066257	0.4100663	1	gmail.com
## 2	libero.it	57782	0.156390741	0.5664570	1	libero.it
## 3	hotmail.it	28698	0.077673004	0.6441300	1	hotmail.it
## 4	alice.it	18127	0.049061905	0.6931919	1	alice.it
## 5	yahoo.it	16538	0.044761173	0.7379531	1	yahoo.it
## 6	hotmail.com	10076	0.027271349	0.7652244	1	hotmail.com
## 7	virgilio.it	9161	0.024794842	0.7900193	1	virgilio.it
## 8	tiscali.it	8733	0.023636433	0.8136557	1	tiscali.it
## 9	live.it	7936	0.021479300	0.8351350	1	live.it
## 10	(missing)	5889	0.015938962	0.8510740	1	(missing)
## 11	icloud.com	3735	0.010109020	0.8611830	0	others
## 12	yahoo.com	3259	0.008820695	0.8700037	0	others
## 13	gmail.it	2266	0.006133076	0.8761368	0	others
## 14	tin.it	2183	0.005908431	0.8820452	0	others
## 15	outlook.it	2039	0.005518686	0.8875639	0	others
## 16	fastwebnet.it	1749	0.004733782	0.8922977	0	others
## 17	inwind.it	1514	0.004097739	0.8963954	0	others
## 18	email.it	1103	0.002985341	0.8993807	0	others
## 19	me.com	1034	0.002798588	0.9021793	0	others
## 20	live.com	837	0.002265395	0.9044447	0	others

```

## add clean EMAIL_PROVIDER ##
df_2_cli_account_clean <- df_2_cli_account_clean %>%
  mutate(EMAIL_PROVIDER = as.character(EMAIL_PROVIDER)) %>%
  left_join(clean_email_providers %>%
    select(EMAIL_PROVIDER, EMAIL_PROVIDER_CLEAN)
    , by = "EMAIL_PROVIDER") %>%
  select(-EMAIL_PROVIDER) %>%
  mutate(EMAIL_PROVIDER_CLEAN = as.factor(EMAIL_PROVIDER_CLEAN))

```

EXPLORE NEW COLUMNS EMAIL_PROVIDER_CLEAN in df_2

```

## compute distribution
df2_dist_emailproviderclean <- df_2_cli_account_clean %>%
  group_by(EMAIL_PROVIDER_CLEAN) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))

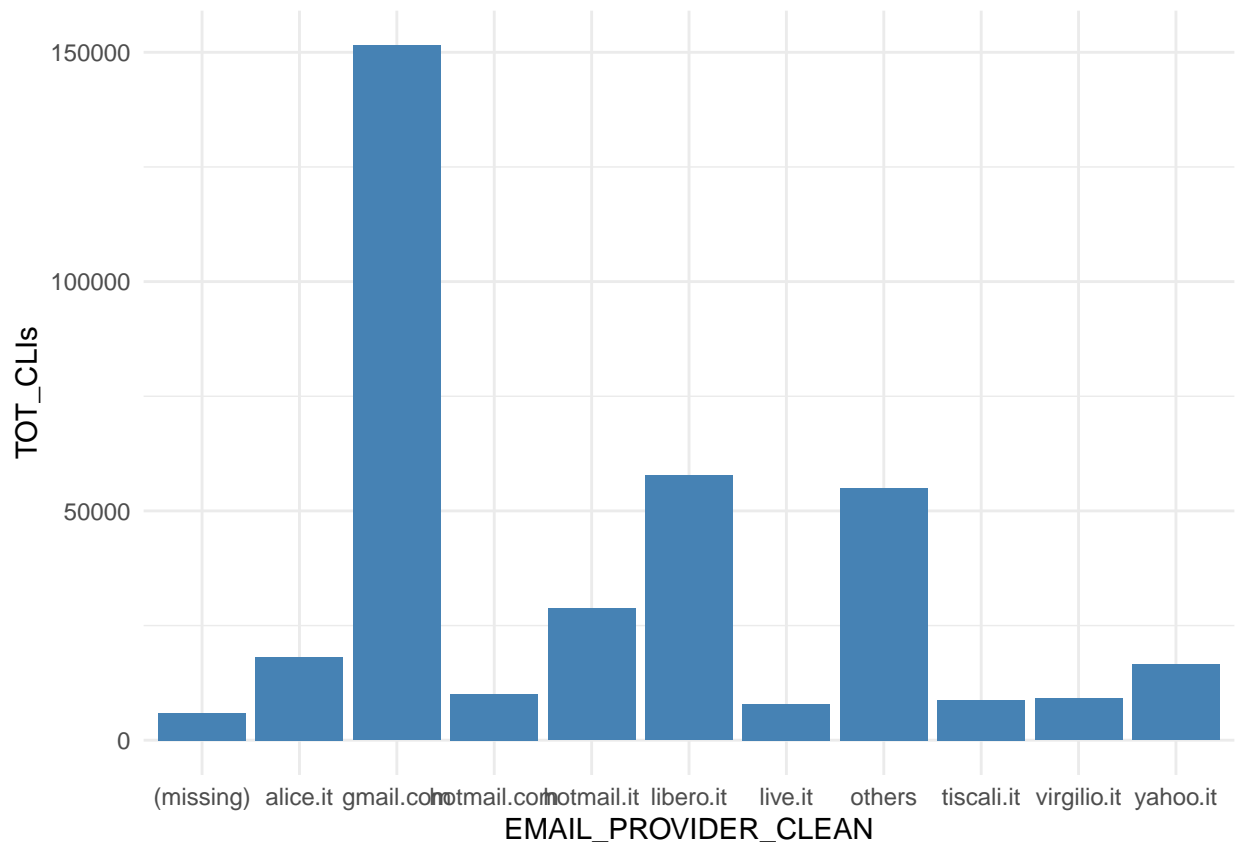
df2_dist_emailproviderclean

```

```
## # A tibble: 11 x 3
##   EMAIL_PROVIDER_CLEAN TOT_CLIs PERCENT
##   <fct>                <int>   <dbl>
## 1 gmail.com            151508 0.410
## 2 libero.it            57782 0.156
## 3 others                55024 0.149
## 4 hotmail.it           28698 0.0777
## 5 alice.it             18127 0.0491
## 6 yahoo.it             16538 0.0448
## 7 hotmail.com          10076 0.0273
## 8 virgilio.it           9161 0.0248
## 9 tiscali.it            8733 0.0236
## 10 live.it              7936 0.0215
## 11 (missing)            5889 0.0159
```

```
## plot distribution
plot_df2_dist_emailproviderclean <- (
  ggplot(data=df2_dist_emailproviderclean
    , aes(x=EMAIL_PROVIDER_CLEAN, y=TOT_CLIs)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df2_dist_emailproviderclean
```



```
#### TO DO df_2 ####
# EXPLORE the remaining df_2_cli_account_clean relevant variables
```

```
### W_PHONE variable
```

```
df2_dist_wphone <- df_2_cli_account_clean %>%
  group_by(W_PHONE) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))
```

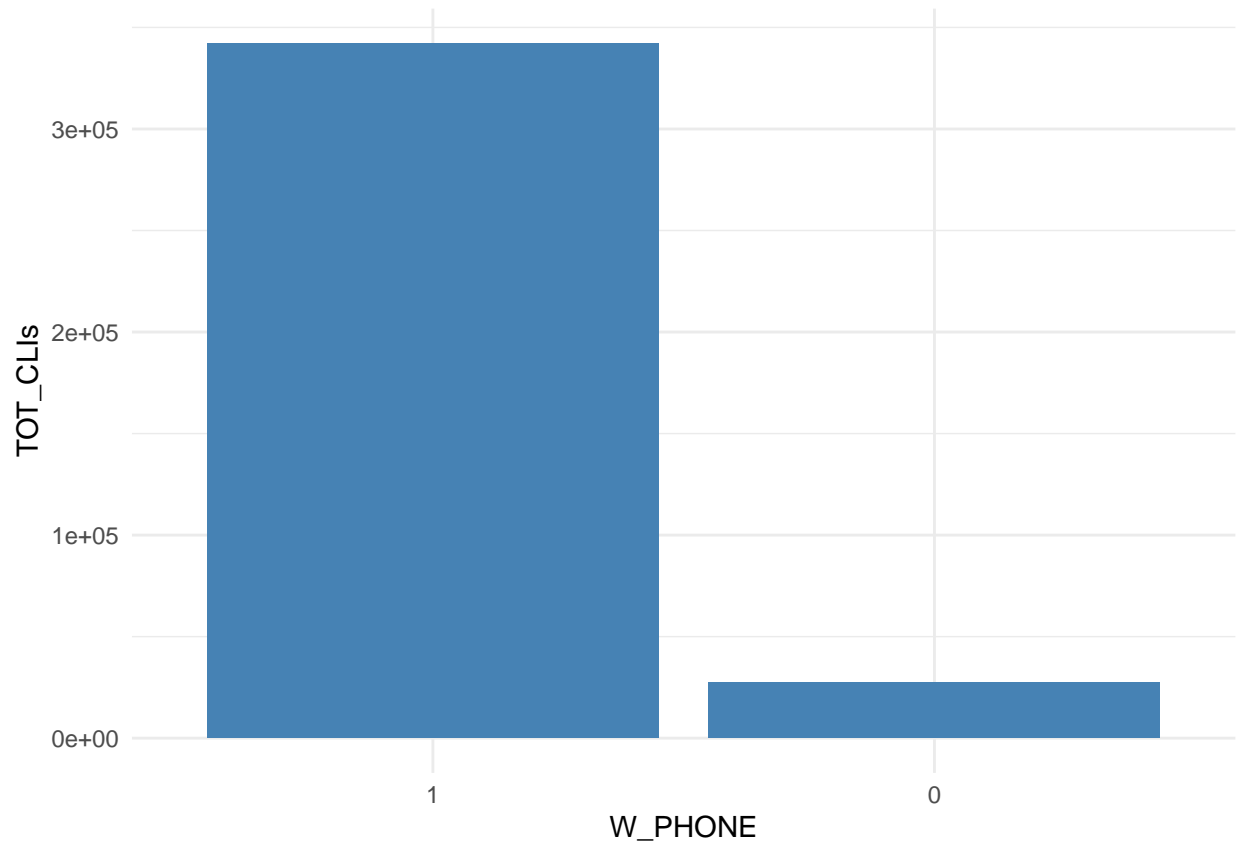
```
df2_dist_wphone
```

```
## # A tibble: 2 x 3
##   W_PHONE TOT_CLIs PERCENT
##   <fct>      <int>   <dbl>
## 1 1          342167  0.926
## 2 0          27305  0.0739
```

```
## plot distribution
```

```
plot_df2_dist_wphone <- (
  ggplot(data=df2_dist_wphone
    , aes(x=W_PHONE, y=TOT_CLIs)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)
```

```
plot_df2_dist_wphone
```



```
### ID_ADDRESS variable forse NO SENSE
```

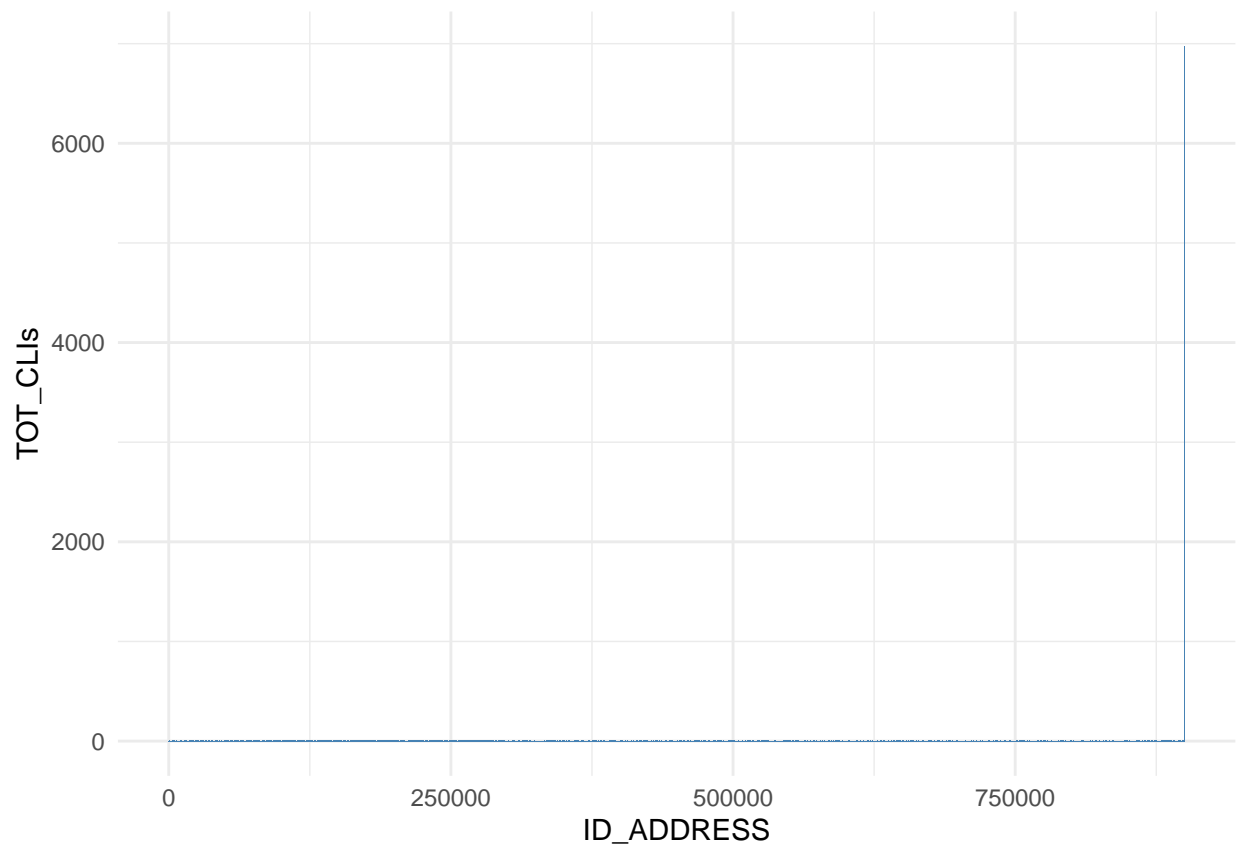
```
df2_dist_IDaddress <- df_2_cli_account_clean %>%
  group_by(ID_ADDRESS) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))
```

```
df2_dist_IDaddress
```

```
## # A tibble: 361,385 x 3
##   ID_ADDRESS TOT_CLIs PERCENT
##   <int>      <int>    <dbl>
## 1    900091     6974 0.0189
## 2     13539         3 0.00000812
## 3    745497         3 0.00000812
## 4        332         2 0.00000541
## 5       3342         2 0.00000541
## 6       3460         2 0.00000541
## 7       3921         2 0.00000541
## 8       4503         2 0.00000541
## 9       4523         2 0.00000541
## 10      4620         2 0.00000541
## # ... with 361,375 more rows
```

```
## plot distribution
plot_df2_dist_IDAddress <- (
  ggplot(data=df2_dist_IDAddress
    , aes(x=ID_ADDRESS, y=TOT_CLIs)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df2_dist_IDAddress
```



```
### TYP_CLI_ACCOUNT variable

df2_dist_TYP_CLI_ACCOUNT <- df_2_cli_account_clean %>%
  group_by(TYP_CLI_ACCOUNT) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))

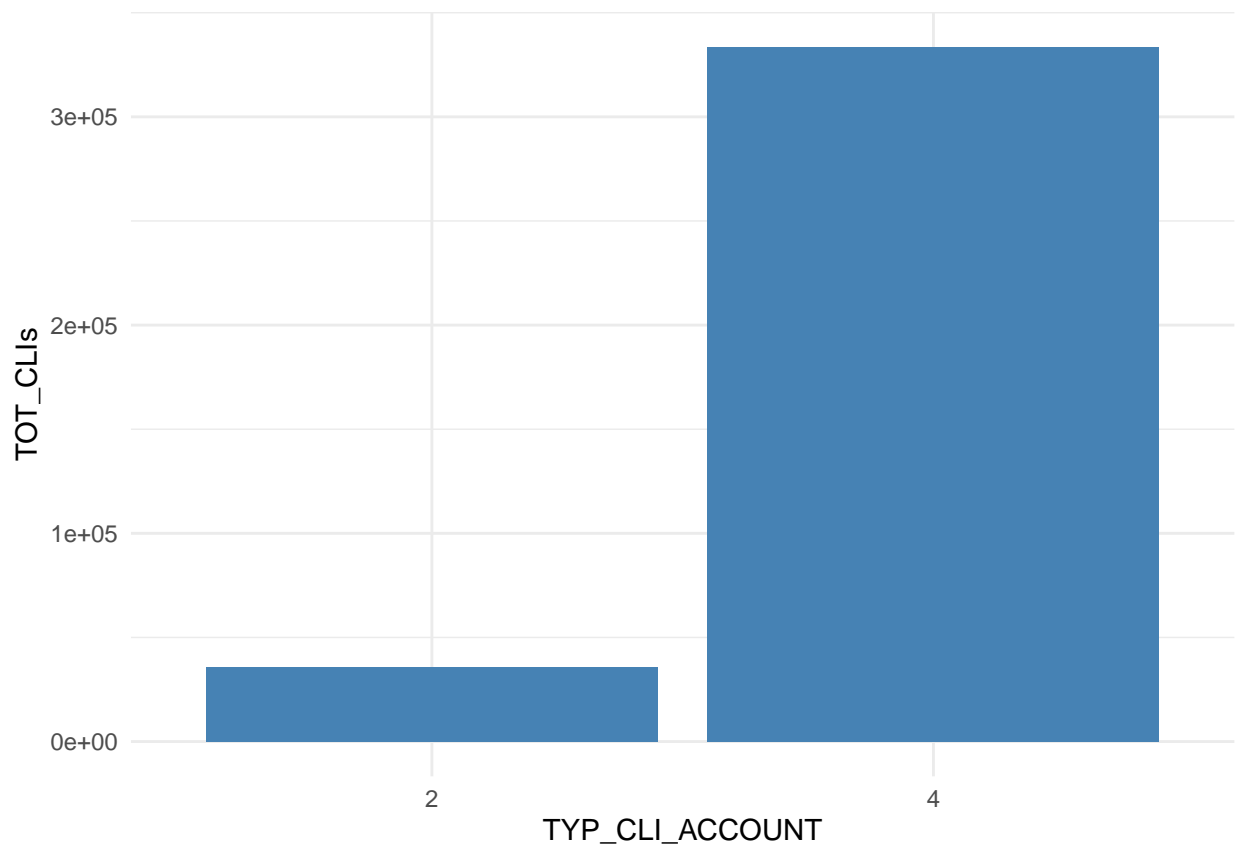
df2_dist_TYP_CLI_ACCOUNT
```

```
## # A tibble: 2 x 3
##   TYP_CLI_ACCOUNT TOT_CLIs PERCENT
##   <fct>           <int>   <dbl>
## 1 4               333656 0.903
```

```
## 2 2          35816  0.0969
```

```
## plot distribution
plot_df2_dist_TYP_CLI_ACCOUNT <- (
  ggplot(data=df2_dist_TYP_CLI_ACCOUNT
    , aes(x=TYP_CLI_ACCOUNT, y=TOT_CLIs)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df2_dist_TYP_CLI_ACCOUNT
```



```
### TYP_JOB variable

df2_dist_TYP_JOB <- df_2_cli_account_clean %>%
  group_by(TYP_JOB) %>%
  summarise(TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_CLIs/sum(TOT_CLIs)) %>%
  arrange(desc(PERCENT))

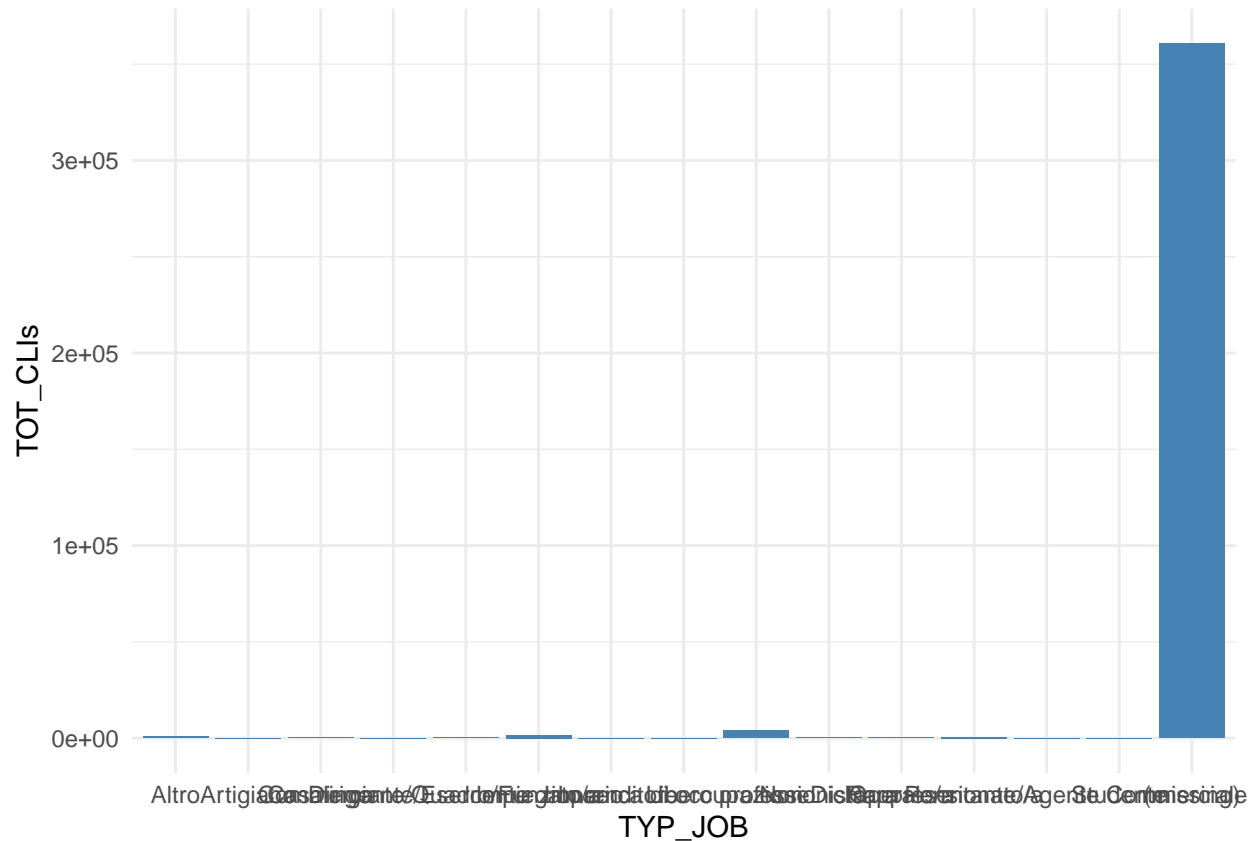
df2_dist_TYP_JOB
```

```
## # A tibble: 15 x 3
##   TYP_JOB          TOT_CLIs  PERCENT
```


##	<fct>	<int>	<dbl>
##	1 (missing)	360810	0.977
##	2 Libero professionista	3970	0.0107
##	3 Impiegato/a	1560	0.00422
##	4 Altro	784	0.00212
##	5 Pensionato/a	641	0.00173
##	6 Operaio/a	482	0.00130
##	7 Dirigente/Quadro/Funzionario	354	0.000958
##	8 Non Dichiarata	218	0.000590
##	9 Casalinga	191	0.000517
##	10 Artigiano	131	0.000355
##	11 Imprenditore	108	0.000292
##	12 In cerca di occupazione	79	0.000214
##	13 Commerciante/Esercente	71	0.000192
##	14 Studente	54	0.000146
##	15 Rappresentante/Agente Commerciale	19	0.0000514

```
## plot distribution
plot_df2_dist_TYP_JOB <- (
  ggplot(data=df2_dist_TYP_JOB
    , aes(x=TYP_JOB, y=TOT_CLIs)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df2_dist_TYP_JOB
```



FINAL REVIEW df_2_clean

```
str(df_2_cli_account_clean)
```

```
## 'data.frame':    369472 obs. of  6 variables:
## $ ID_CLI      : int  600125 729642 304639 292497 589492 638815 658338 883322 508481 871293
## $ W_PHONE     : Factor w/ 2 levels "1","0": 2 2 1 1 2 1 1 1 1 1 ...
## $ ID_ADDRESS  : int  584621 714144 284176 272563 573304 622947 642716 856157 488177 847360
## $ TYP_CLI_ACCOUNT : Factor w/ 2 levels "2","4": 2 2 2 2 1 1 2 2 2 2 ...
## $ TYP_JOB     : Factor w/ 15 levels "Altro","Artigiano",...: 15 15 15 15 15 15 15 15 15 15 .
## $ EMAIL_PROVIDER_CLEAN: Factor w/ 11 levels "(missing)","alice.it",...: 6 3 11 6 3 8 6 6 6 5 ...
```

```
summary(df_2_cli_account_clean)
```

```
##      ID_CLI      W_PHONE      ID_ADDRESS      TYP_CLI_ACCOUNT
##  Min.      :      1      1:342167      Min.      :      1      2: 35816
##  1st Qu.:230783      0: 27305      1st Qu.:227903      4:333656
##  Median :462063                                Median :456720
##  Mean   :462541                                Mean   :457283
##  3rd Qu.:693197                                3rd Qu.:686533
##  Max.   :934919                                Max.   :900091
##
##                                TYP_JOB      EMAIL_PROVIDER_CLEAN
##  (missing)      :360810      gmail.com :151508
##  Libero professionista: 3970      libero.it : 57782
```

```
## Impiegato/a      : 1560  others    : 55024
## Altro           : 784   hotmail.it: 28698
## Pensionato/a    : 641   alice.it  : 18127
## Operaio/a       : 482   yahoo.it  : 16538
## (Other)         : 1225  (Other)   : 41795
```

```
#-----
#### FIRST LOOK of df_3 ####

str(df_3_cli_address)
```

```
## 'data.frame': 1211332 obs. of 4 variables:
## $ ID_ADDRESS: int 1337 1344 1347 1347 1347 1347 1347 1347 1347 1347 ...
## $ CAP : chr "20083" "20024" "20090" "20090" ...
## $ PRV : chr "MI" "MI" "MI" "MI" ...
## $ REGION : chr "LOMBARDIA" "LOMBARDIA" "LOMBARDIA" "LOMBARDIA" ...
```

```
summary(df_3_cli_address)
```

```
## ID_ADDRESS CAP PRV REGION
## Min. : 1 Length:1211332 Length:1211332 Length:1211332
## 1st Qu.:221063 Class :character Class :character Class :character
## Median :437083 Mode :character Mode :character Mode :character
## Mean :443391
## 3rd Qu.:664931
## Max. :900090
```

```
#### START CLEANING df_3 ####

df_3_cli_address_clean <- df_3_cli_address

#### CLEANING DUPLICATE VALUES in df_3 ####

## check for duplicates
df_3_cli_address_clean %>%
  summarise(TOT_ID_ADDRESSES = n_distinct(ID_ADDRESS)
            , TOT_ROWS = n())
```

```
## TOT_ID_ADDRESSES TOT_ROWS
## 1 361330 1211332
```

```
### NOTE: there are duplicates !!!#

df_3_cli_address_clean <- df_3_cli_address_clean %>%
  distinct()

#### CLEANING DATA TYPES in df_3 ####

## format string as factors ##
df_3_cli_address_clean <- df_3_cli_address_clean %>%
  mutate(CAP = as.character(CAP))
```

```
#### CLEANING MISSING VALUES in df_3 ####
```

```
df_3_cli_address_clean %>%
  group_by(w_CAP = !is.na(CAP)
           , w_PRV = !is.na(PRV)
           , w_REGION = !is.na(REGION)) %>%
  summarise(TOT_ADDs = n_distinct(ID_ADDRESS))
```

```
## # A tibble: 4 x 4
## # Groups:   w_CAP, w_PRV [3]
##   w_CAP w_PRV w_REGION TOT_ADDs
##   <lgl> <lgl> <lgl>      <int>
## 1 FALSE FALSE FALSE         121
## 2 TRUE  FALSE FALSE        23148
## 3 TRUE  TRUE  FALSE         595
## 4 TRUE  TRUE  TRUE        337466
```

```
## let examine in details some of these missing cases
```

```
df_3_cli_address_clean %>% filter(is.na(PRV) & !is.na(REGION))
```

```
## [1] ID_ADDRESS CAP          PRV          REGION
## <0 rows> (or 0-length row.names)
```

```
## MISSING VALUES rows are removed ##
```

```
df_3_cli_address_clean <- df_3_cli_address_clean %>%
  filter(!is.na(CAP) & !is.na(PRV) & !is.na(REGION))
```

```
#### CONSISTENCY CHECK ID_ADDRESS in df_2/df_3 ####
```

```
cons_idaddress_df2_df3 <- df_2_cli_account_clean %>%
  select(ID_ADDRESS) %>%
  mutate(is_in_df_2 = 1) %>%
  distinct() %>%
  full_join(df_3_cli_address_clean %>%
            select(ID_ADDRESS) %>%
            mutate(is_in_df_3 = 1) %>%
            distinct()
            , by = "ID_ADDRESS"
  ) %>%
  group_by(is_in_df_2, is_in_df_3) %>%
  summarise(NUM_ID_ADDRESSES = n_distinct(ID_ADDRESS)) %>%
  as.data.frame()
```

```
cons_idaddress_df2_df3
```

```
##   is_in_df_2 is_in_df_3 NUM_ID_ADDRESSES
## 1           1           1           337466
## 2           1          NA           23919
```

```
#### NOTE: there are ID_ADDRESSES actually not mapped in df_3 !!!#
#### this issue should be taken into account in joining these two tables !!!#
```

```
#### EXPLORE COLUMNS of df_3 ####
```

```
#### TO DO df_3 ####
```

```
# EXPLORE the df_3_cli_address_clean relevant variables
```

```
# COMPUTE THE DISTRIBUTION OF REGION
```

```
## compute distribution
```

```
df_3_cli_address_clean_region_distrib <- df_3_cli_address_clean %>%
  group_by(REGION) %>%
  summarise(TOT_IDS = n_distinct(ID_ADDRESS)) %>%
  mutate(PERCENT = TOT_IDS/sum(TOT_IDS)) %>%
  arrange(desc(PERCENT))
```

```
df_3_cli_address_clean_region_distrib
```

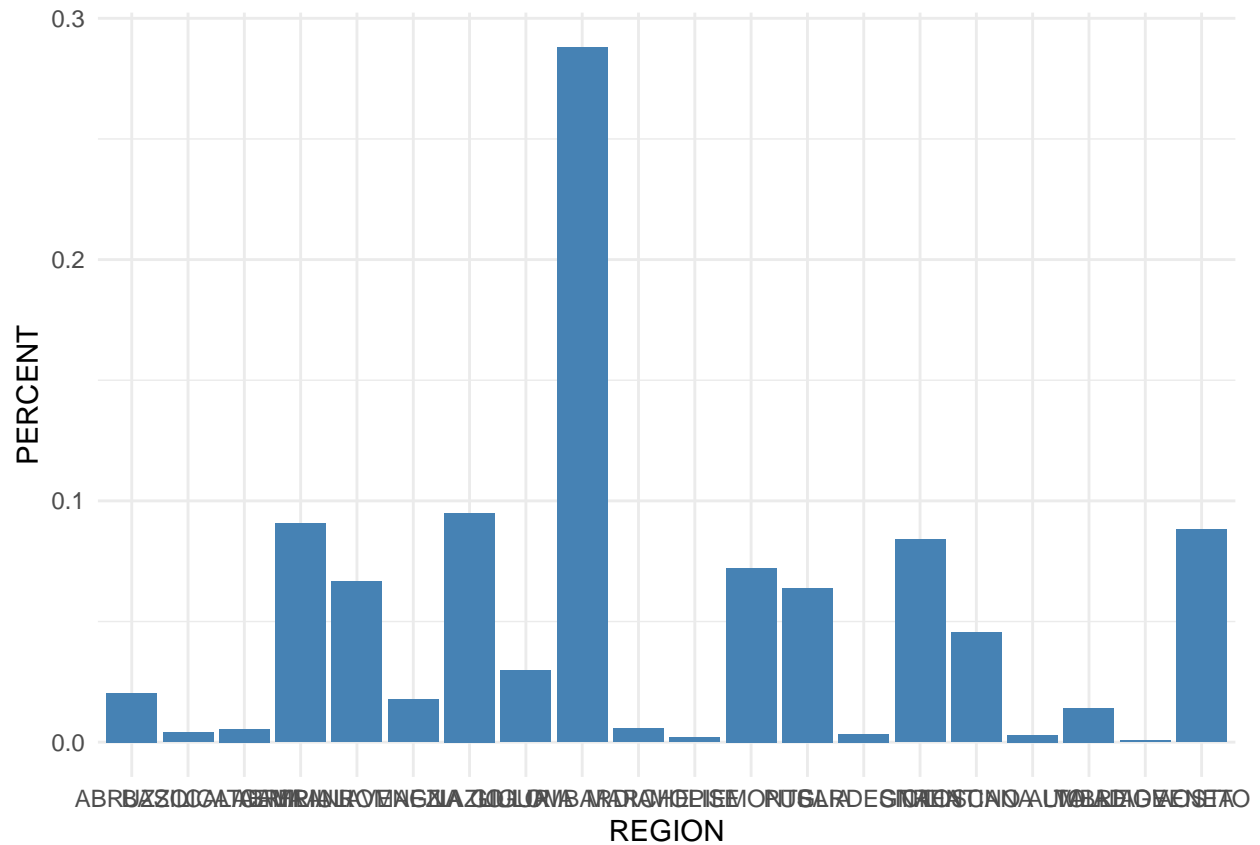
```
## # A tibble: 20 x 3
```

	REGION	TOT_IDS	PERCENT
	<chr>	<int>	<dbl>
## 1	LOMBARDIA	97181	0.288
## 2	LAZIO	32058	0.0950
## 3	CAMPANIA	30570	0.0906
## 4	VENETO	29696	0.0880
## 5	SICILIA	28329	0.0839
## 6	PIEMONTE	24377	0.0722
## 7	EMILIA ROMAGNA	22515	0.0667
## 8	PUGLIA	21582	0.0640
## 9	TOSCANA	15369	0.0455
## 10	LIGURIA	9994	0.0296
## 11	ABRUZZO	6856	0.0203
## 12	FRIULI VENEZIA GIULIA	5969	0.0177
## 13	UMBRIA	4771	0.0141
## 14	MARCHE	1931	0.00572
## 15	CALABRIA	1837	0.00544
## 16	BASILICATA	1382	0.00410
## 17	SARDEGNA	1124	0.00333
## 18	TRENTINO ALTO ADIGE	982	0.00291
## 19	MOLISE	668	0.00198
## 20	VALLE D'AOSTA	277	0.000821

```
## plot distribution
```

```
plot_df_3_cli_address_clean_region_distrib <- (
  ggplot(data=df_3_cli_address_clean_region_distrib
    , aes(x=REGION, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)
```

```
plot_df_3_cli_address_clean_region_distrib
```



```
# COMPUTE THE DISTRIBUTION OF PRV
```

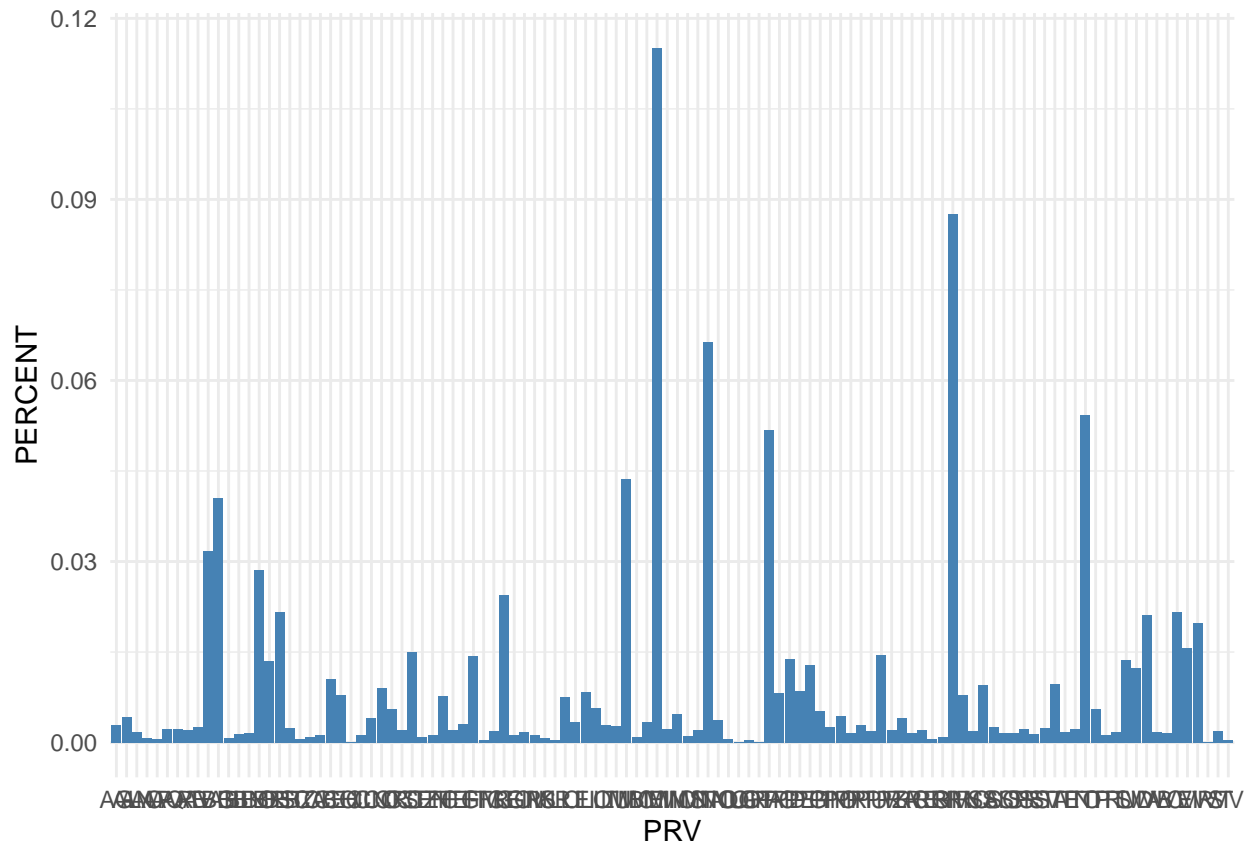
```
## compute distribution
df_3_cli_address_clean_prv_distrib <- df_3_cli_address_clean %>%
  group_by(PRV) %>%
  summarise(TOT_IDs = n_distinct(ID_ADDRESS)) %>%
  mutate(PERCENT = TOT_IDs/sum(TOT_IDs)) %>%
  arrange(desc(PERCENT))

df_3_cli_address_clean_prv_distrib
```

```
## # A tibble: 110 x 3
##   PRV   TOT_IDs PERCENT
##   <chr>   <int>   <dbl>
## 1 MI     38850  0.115
## 2 RM     29529  0.0875
## 3 NA     22374  0.0663
## 4 TO     18322  0.0543
## 5 PA     17448  0.0517
## 6 MB     14751  0.0437
## 7 BG     13659  0.0405
## 8 BA     10698  0.0317
## 9 BO       9634  0.0285
## 10 GE      8234  0.0244
## # ... with 100 more rows
```

```
## plot distribution
plot_df_3_cli_address_clean_prv_distrib <- (
  ggplot(data=df_3_cli_address_clean_prv_distrib
    , aes(x=PRV, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df_3_cli_address_clean_prv_distrib
```



COMPUTE THE DISTRIBUTION OF CAPs - NOT MEANINGFUL AS IT CALCULATES THE PERCENTAGE OF PEOPLE LIVING IN

```
## compute distribution
df_3_cli_address_clean_cap_distrib <- df_3_cli_address_clean %>%
  group_by(CAP) %>%
  summarise(TOT_IDS = n_distinct(ID_ADDRESS)) %>%
  mutate(PERCENT = TOT_IDS/sum(TOT_IDS)) %>%
  arrange(desc(PERCENT))

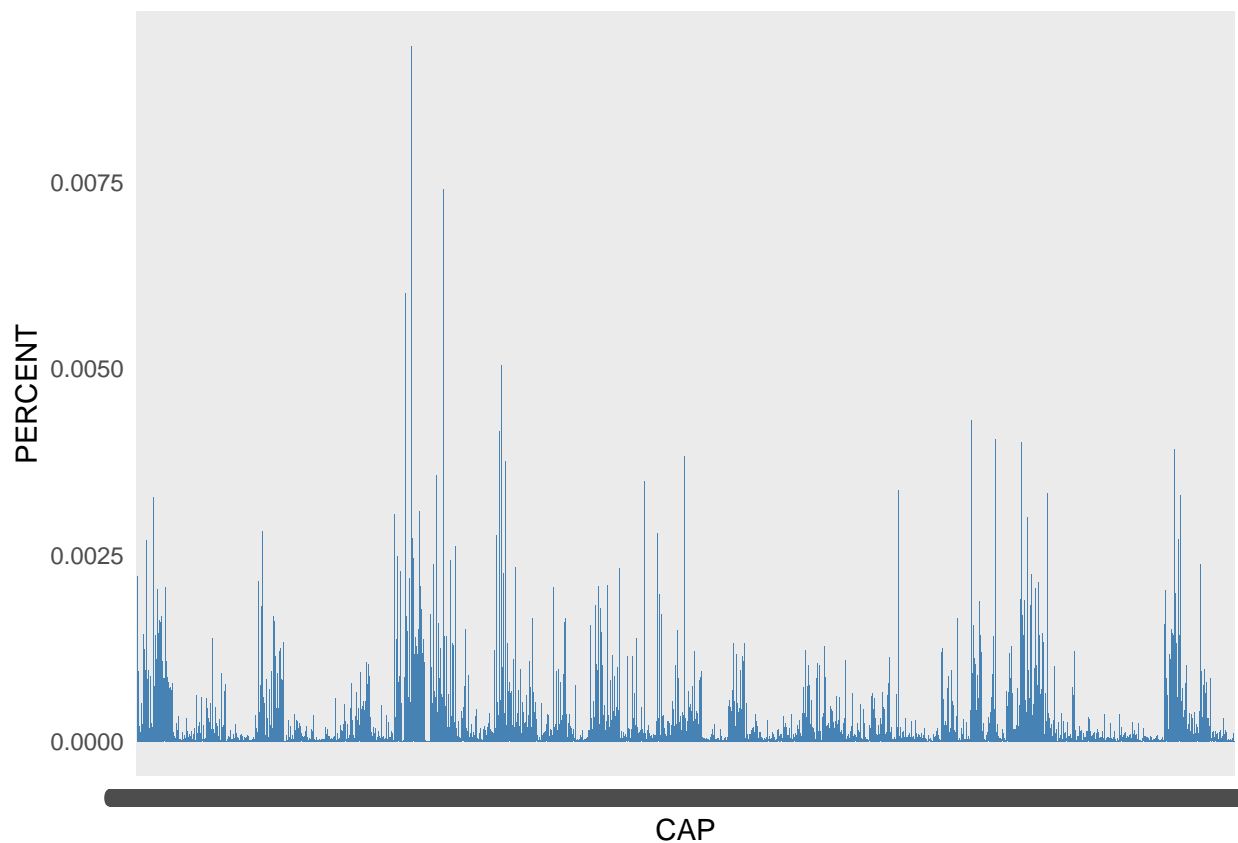
df_3_cli_address_clean_cap_distrib
```

```
## # A tibble: 4,784 x 3
##   CAP   TOT_IDS PERCENT
##   <chr>   <int>   <dbl>
```

```
## 1 20090      3146 0.00932
## 2 20900      2499 0.00741
## 3 20060      2030 0.00602
## 4 24040      1703 0.00505
## 5 70010      1453 0.00431
## 6 24030      1403 0.00416
## 7 72100      1367 0.00405
## 8 80014      1352 0.00401
## 9 90100      1323 0.00392
## 10 36100     1292 0.00383
## # ... with 4,774 more rows
```

```
## plot distribution
plot_df_3_cli_address_clean_cap_distrib <- (
  ggplot(data=df_3_cli_address_clean_cap_distrib
    , aes(x=CAP, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df_3_cli_address_clean_cap_distrib
```



```
#### FINAL REVIEW df_3_clean ####
str(df_3_cli_address_clean)
```



```
## 'data.frame': 337468 obs. of 4 variables:
## $ ID_ADDRESS: int 1337 1344 1347 1352 1353 1355 1361 1379 1384 1387 ...
## $ CAP : chr "20083" "20024" "20090" "20123" ...
## $ PRV : chr "MI" "MI" "MI" "MI" ...
## $ REGION : chr "LOMBARDIA" "LOMBARDIA" "LOMBARDIA" "LOMBARDIA" ...
```

```
summary(df_3_cli_address_clean)
```

```
## ID_ADDRESS CAP PRV REGION
## Min. : 1 Length:337468 Length:337468 Length:337468
## 1st Qu.:219149 Class :character Class :character Class :character
## Median :441844 Mode :character Mode :character Mode :character
## Mean :444313
## 3rd Qu.:667976
## Max. :900090
```

```
#### FIRST LOOK of df_4 ####
```

```
str(df_4_cli_privacy)
```

```
## 'data.frame': 369472 obs. of 4 variables:
## $ ID_CLI : int 4691 3434 3533 9866 5799 4660 8441 502 13290 6448 ...
## $ FLAG_PRIVACY_1 : int 1 0 1 1 1 0 0 1 1 1 ...
## $ FLAG_PRIVACY_2 : int 1 1 1 1 1 1 1 1 1 1 ...
## $ FLAG_DIRECT_MKT: int 1 0 1 1 1 0 0 1 1 1 ...
```

```
summary(df_4_cli_privacy)
```

```
## ID_CLI FLAG_PRIVACY_1 FLAG_PRIVACY_2 FLAG_DIRECT_MKT
## Min. : 1 Min. :0.0000 Min. :0.0000 Min. :0.0000
## 1st Qu.:230783 1st Qu.:0.0000 1st Qu.:1.0000 1st Qu.:0.0000
## Median :462063 Median :1.0000 Median :1.0000 Median :1.0000
## Mean :462541 Mean :0.6557 Mean :0.9356 Mean :0.6707
## 3rd Qu.:693197 3rd Qu.:1.0000 3rd Qu.:1.0000 3rd Qu.:1.0000
## Max. :934919 Max. :1.0000 Max. :1.0000 Max. :1.0000
```

```
#### START CLEANING df_4 ####
```

```
df_4_cli_privacy_clean <- df_4_cli_privacy
```

```
#### CLEANING DUPLICATE VALUES in df_4 ####
```

```
## check for duplicates
```

```
df_4_cli_privacy_clean %>%
  summarise(TOT_ID_CLIs = n_distinct(ID_CLI)
            , TOT_ROWS = n())
```

```
## TOT_ID_CLIs TOT_ROWS
## 1 369472 369472
```

```
#### NOTE: no duplicates !!!#
```

```
#### CLEANING DATA TYPES in df_4 ####
```

```
## formatting boolean as factor ##
```

```
df_4_cli_privacy_clean <- df_4_cli_privacy_clean %>%  
  mutate(FLAG_PRIVACY_1 = as.factor(FLAG_PRIVACY_1)) %>%  
  mutate(FLAG_PRIVACY_2 = as.factor(FLAG_PRIVACY_2)) %>%  
  mutate(FLAG_DIRECT_MKT = as.factor(FLAG_DIRECT_MKT))
```

```
#### CONSISTENCY CHECK ID_CLI in df_1/df_4 ####
```

```
cons_idcli_df1_df4 <- df_1_cli_fid_clean %>%  
  select(ID_CLI) %>%  
  mutate(is_in_df_1 = 1) %>%  
  distinct() %>%  
  full_join(df_4_cli_privacy_clean %>%  
    select(ID_CLI) %>%  
    mutate(is_in_df_4 = 1) %>%  
    distinct()  
  , by = "ID_CLI"  
  ) %>%  
  group_by(is_in_df_1, is_in_df_4) %>%  
  summarise(NUM_ID_CLIs = n_distinct(ID_CLI)) %>%  
  as.data.frame()
```

```
cons_idcli_df1_df4
```

```
##   is_in_df_1 is_in_df_4 NUM_ID_CLIs  
## 1           1           1       369472
```

```
#### NOTE: all ID_CLI in df_1 are also in df_4 and vice-versa !!!#
```

```
#### EXPLORE COLUMNS of df_4 ####
```

```
#### TO DO df_4 ####
```

```
# EXPLORE the df_4_cli_privacy_clean relevant variables
```

```
# COMPUTE THE DISTRIBUTION OF FLAG_PRIVACY_1
```

```
## compute distribution
```

```
df_4_cli_privacy_clean_flag1_distrib <- df_4_cli_privacy_clean %>%  
  group_by(FLAG_PRIVACY_1) %>%  
  summarise(TOT_IDs = n_distinct(ID_CLI)) %>%  
  mutate(PERCENT = TOT_IDs/sum(TOT_IDs)) %>%  
  arrange(desc(PERCENT))
```

```
df_4_cli_privacy_clean_flag1_distrib
```

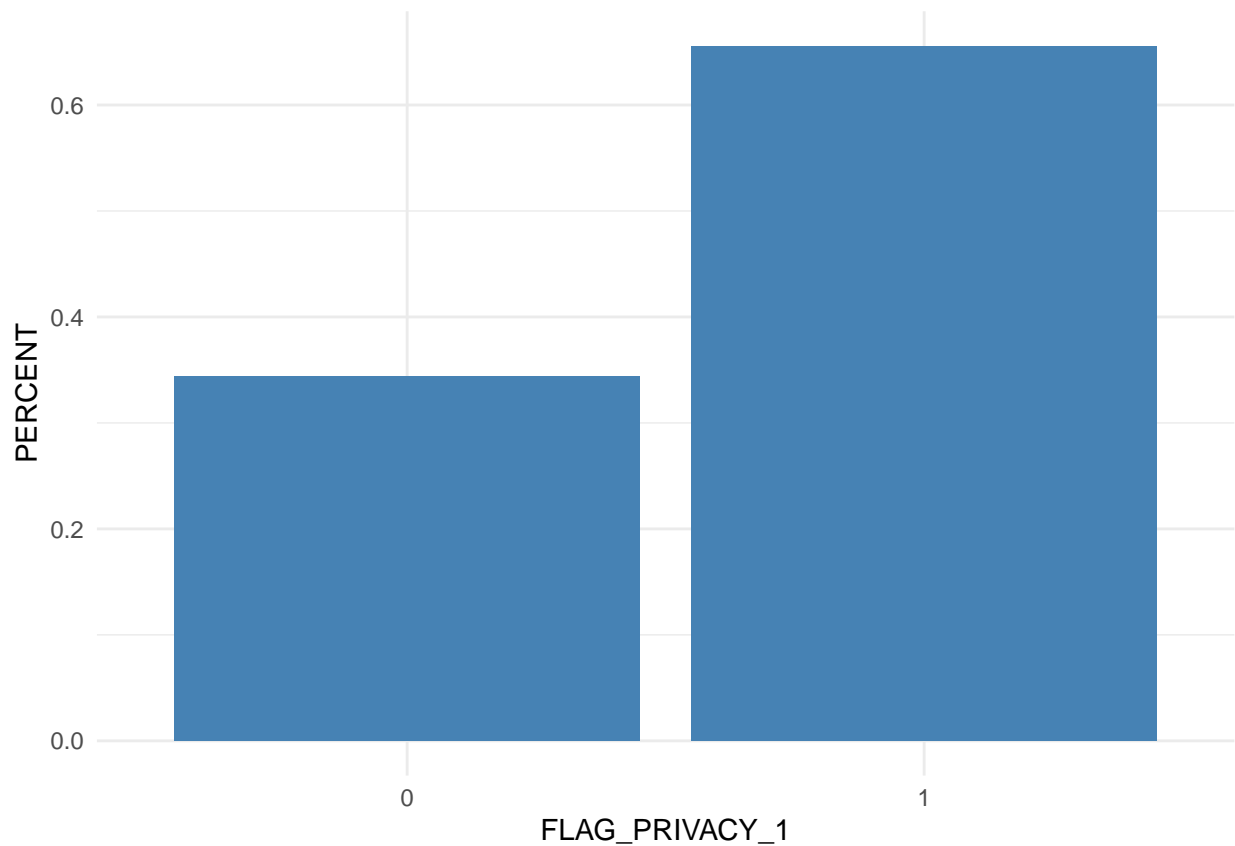
```
## # A tibble: 2 x 3
```

```
##   FLAG_PRIVACY_1 TOT_IDs PERCENT  
##   <fct>          <int>   <dbl>  
## 1 1             242251  0.656
```

```
## 2 0          127221    0.344
```

```
## plot distribution
plot_df_4_cli_privacy_clean_flag1_distrib <- (
  ggplot(data=df_4_cli_privacy_clean_flag1_distrib
    , aes(x=FLAG_PRIVACY_1, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df_4_cli_privacy_clean_flag1_distrib
```



```
# COMPUTE THE DISTRIBUTION OF FLAG_PRIVACY_2

## compute distribution
df_4_cli_privacy_clean_flag2_distrib <- df_4_cli_privacy_clean %>%
  group_by(FLAG_PRIVACY_2) %>%
  summarise(TOT_IDS = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_IDS/sum(TOT_IDS)) %>%
  arrange(desc(PERCENT))

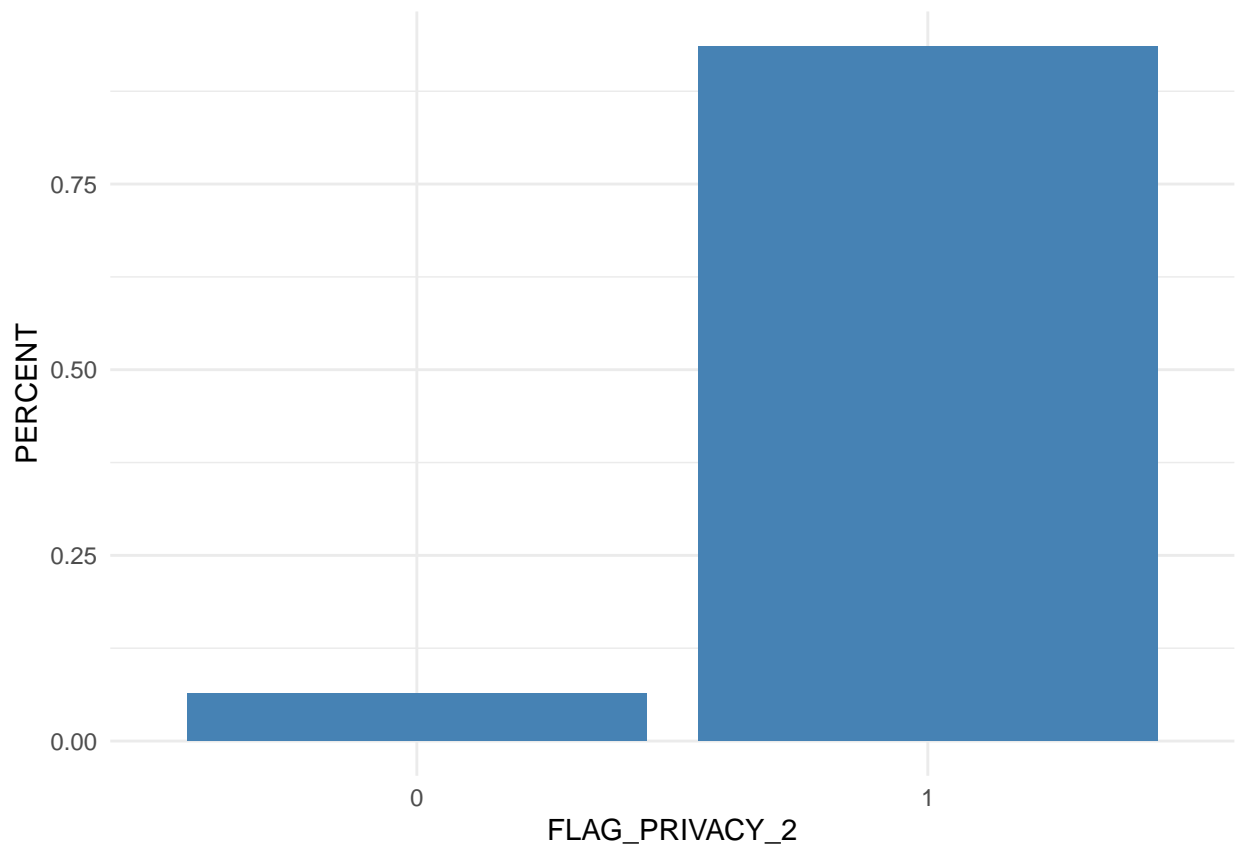
df_4_cli_privacy_clean_flag2_distrib
```

```
## # A tibble: 2 x 3
```

```
## FLAG_PRIVACY_2 TOT_IDs PERCENT
## <fct>          <int>   <dbl>
## 1 1            345682  0.936
## 2 0            23790  0.0644
```

```
## plot distribution
plot_df_4_cli_privacy_clean_flag2_distrib <- (
  ggplot(data=df_4_cli_privacy_clean_flag2_distrib
    , aes(x=FLAG_PRIVACY_2, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df_4_cli_privacy_clean_flag2_distrib
```



```
# COMPUTE THE DISTRIBUTION OF FLAG_DIRECT_MKT

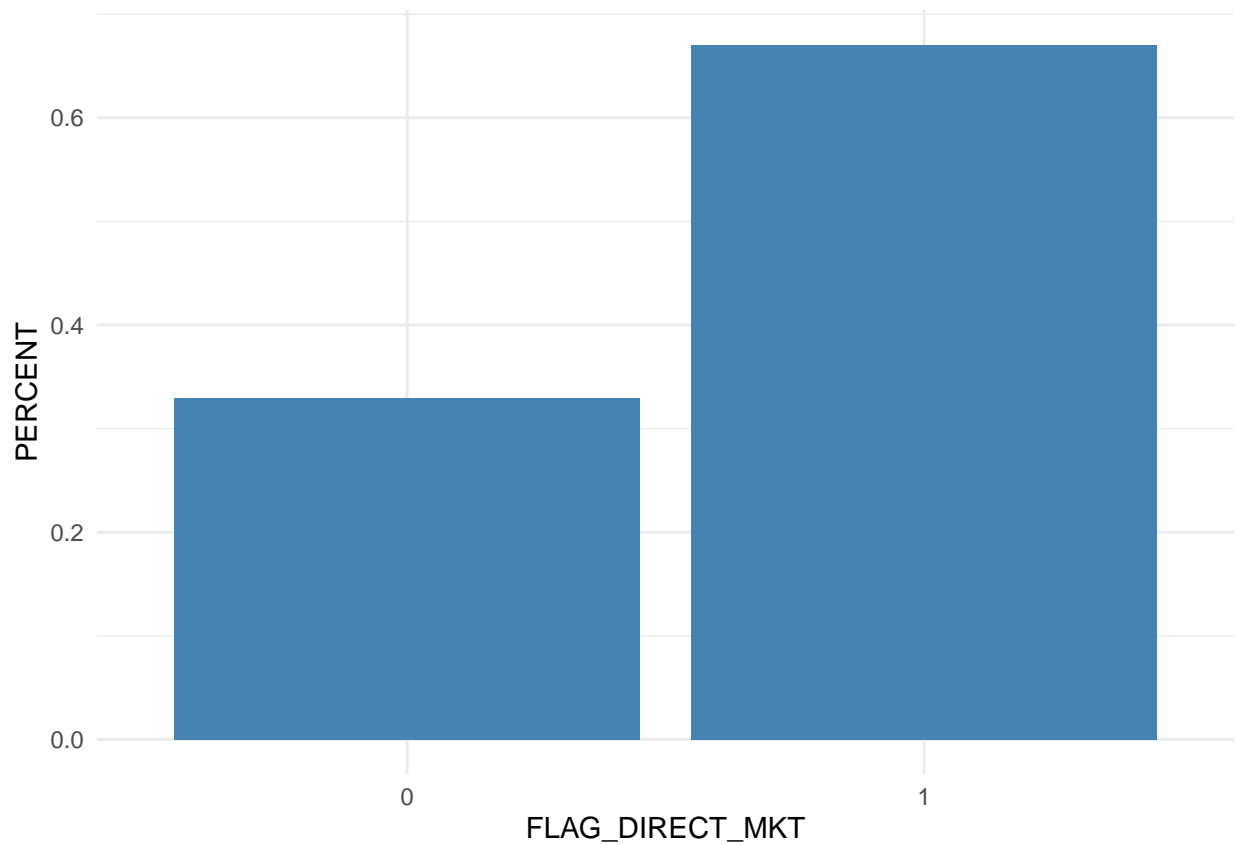
## compute distribution
df_4_cli_privacy_clean_flag_mkt_distrib <- df_4_cli_privacy_clean %>%
  group_by(FLAG_DIRECT_MKT) %>%
  summarise(TOT_IDs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT = TOT_IDs/sum(TOT_IDs)) %>%
  arrange(desc(PERCENT))

df_4_cli_privacy_clean_flag_mkt_distrib
```

```
## # A tibble: 2 x 3
##   FLAG_DIRECT_MKT TOT_IDs PERCENT
##   <fct>          <int>   <dbl>
## 1 1              247790  0.671
## 2 0              121682  0.329
```

```
## plot distribution
plot_df_4_cli_privacy_clean_flag_mkt_distrib <- (
  ggplot(data=df_4_cli_privacy_clean_flag_mkt_distrib
    , aes(x=FLAG_DIRECT_MKT, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)

plot_df_4_cli_privacy_clean_flag_mkt_distrib
```



```
#### FINAL REVIEW df_4_clean ####
```

```
str(df_4_cli_privacy_clean)
```

```
## 'data.frame':   369472 obs. of  4 variables:
##  $ ID_CLI       : int  4691 3434 3533 9866 5799 4660 8441 502 13290 6448 ...
##  $ FLAG_PRIVACY_1 : Factor w/ 2 levels "0","1": 2 1 2 2 2 1 1 2 2 2 ...
##  $ FLAG_PRIVACY_2 : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
##  $ FLAG_DIRECT_MKT: Factor w/ 2 levels "0","1": 2 1 2 2 2 1 1 2 2 2 ...
```

```
summary(df_4_cli_privacy_clean)
```

```
##      ID_CLI      FLAG_PRIVACY_1 FLAG_PRIVACY_2 FLAG_DIRECT_MKT
## Min.      :      1      0:127221      0: 23790      0:121682
## 1st Qu.:230783      1:242251      1:345682      1:247790
## Median :462063
## Mean      :462541
## 3rd Qu.:693197
## Max.      :934919
```

```
#### FIRST LOOK of df_5 ####
```

```
str(df_5_camp_cat)
```

```
## 'data.frame':      848 obs. of  3 variables:
## $ ID_CAMP      : int  757 759 760 761 762 763 764 765 767 769 ...
## $ TYP_CAMP      : chr  "PERSONALIZED" "PERSONALIZED" "PERSONALIZED" "PERSONALIZED" ...
## $ CHANNEL_CAMP : chr  "EMAIL" "EMAIL" "EMAIL" "EMAIL" ...
```

```
summary(df_5_camp_cat)
```

```
##      ID_CAMP      TYP_CAMP      CHANNEL_CAMP
## Min.      :   5.0      Length:848      Length:848
## 1st Qu.: 327.8      Class :character      Class :character
## Median : 561.5      Mode  :character      Mode   :character
## Mean      : 559.6
## 3rd Qu.: 812.2
## Max.      :1052.0
```

```
#### START CLEANING df_5 ####
```

```
df_5_camp_cat_clean <- df_5_camp_cat
```

```
#### CLEANING LOW VARIANCE in df_5 ####
```

```
df_5_camp_cat_clean <- df_5_camp_cat_clean %>%
  select(-CHANNEL_CAMP)
```

```
#### EXPLORE COLUMNS of df_5 ####
```

```
#### TO DO df_5 ####
```

```
# EXPLORE the df_5_camp_cat_clean relevant variables
```

```
# COMPUTE THE DISTRIBUTION OF TYP_CAMP
```

```
## compute distribution
```

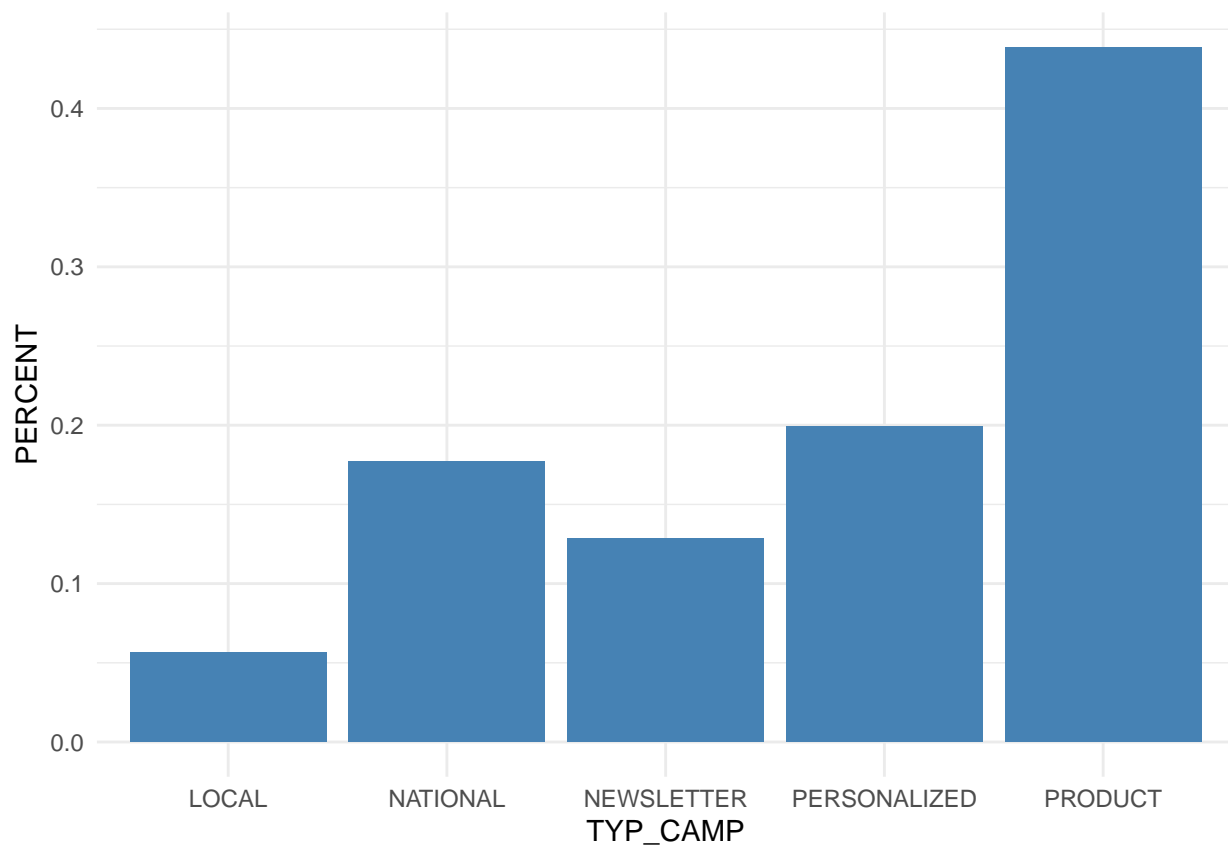
```
df_5_camp_cat_clean_TYP_CAMP <- df_5_camp_cat_clean %>%
  group_by(TYP_CAMP) %>%
  summarise(TOT_IDS = n_distinct(ID_CAMP)) %>%
  mutate(PERCENT = TOT_IDS/sum(TOT_IDS)) %>%
  arrange(desc(PERCENT))
```

```
df_5_camp_cat_clean_TYP_CAMP
```

```
## # A tibble: 5 x 3
##   TYP_CAMP    TOT_IDs PERCENT
##   <chr>      <int>   <dbl>
## 1 PRODUCT        372  0.439
## 2 PERSONALIZED   169  0.199
## 3 NATIONAL       150  0.177
## 4 NEWSLETTER     109  0.129
## 5 LOCAL          48  0.0566
```

```
## plot distribution
plot_df_5_camp_cat_clean_TYP_CAMP <- (
  ggplot(data=df_5_camp_cat_clean_TYP_CAMP
    , aes(x=TYP_CAMP, y=PERCENT)) +
    geom_bar(stat="identity"
      , fill="steelblue") +
    theme_minimal()
)
```

```
plot_df_5_camp_cat_clean_TYP_CAMP
```



```
#### FINAL REVIEW df_5_clean ####
```

```
str(df_5_camp_cat_clean)
```

```
## 'data.frame': 848 obs. of 2 variables:
```

```
## $ ID_CAMP : int 757 759 760 761 762 763 764 765 767 769 ...
## $ TYP_CAMP: chr "PERSONALIZED" "PERSONALIZED" "PERSONALIZED" "PERSONALIZED" ...
```

```
summary(df_5_camp_cat_clean)
```

```
##      ID_CAMP      TYP_CAMP
## Min.   : 5.0   Length:848
## 1st Qu.: 327.8 Class :character
## Median : 561.5 Mode  :character
## Mean   : 559.6
## 3rd Qu.: 812.2
## Max.   :1052.0
```

```
#-----
```

```
#### FIRST LOOK of df_6 ####
```

```
str(df_6_camp_event)
```

```
## 'data.frame': 2060360 obs. of 6 variables:
## $ ID_EVENT : int 11548588 11548640 11548572 11548515 11548609 11548497 11548441 11548490 1154862...
## $ ID_CLI : int 411925 313259 327299 627427 265258 693938 610832 515395 59640 515395 ...
## $ ID_CAMP : int 948 949 941 923 950 955 946 829 951 951 ...
## $ ID_DELIVERY: int 8996 8997 8817 8263 8998 9115 8970 8876 9032 9032 ...
## $ TYP_EVENT : chr "V" "V" "V" "V" ...
## $ EVENT_DATE : chr "2019-01-01T01:42:24" "2019-01-01T02:54:04" "2019-01-01T01:23:29" "2019-01-01T0...
```

```
summary(df_6_camp_event)
```

```
##      ID_EVENT      ID_CLI      ID_CAMP      ID_DELIVERY
## Min.   :11548441 Min.   : 1 Min.   : 148.0 Min.   : 7680
## 1st Qu.:13526812 1st Qu.:208129 1st Qu.: 970.0 1st Qu.:10066
## Median :14867410 Median :398084 Median : 991.0 Median :10585
## Mean   :14757544 Mean   :413793 Mean   : 928.9 Mean   :10534
## 3rd Qu.:16284762 3rd Qu.:618440 3rd Qu.:1024.0 3rd Qu.:11151
## Max.   :17650340 Max.   :931973 Max.   :1048.0 Max.   :11509
##      TYP_EVENT      EVENT_DATE
## Length:2060360 Length:2060360
## Class :character Class :character
## Mode :character Mode :character
##
##
##
```

```
#### START CLEANING df_6 ####
```

```
df_6_camp_event_clean <- df_6_camp_event
```

```
#### CLEANING DATA TYPES in df_6 ####
```



```
## formatting dates and times ##
df_6_camp_event_clean <- df_6_camp_event_clean %>%
  mutate(EVENT_DATETIME = as.POSIXct(EVENT_DATE, format="%Y-%m-%dT%H:%M:%S")) %>%
  mutate(EVENT_HOUR = hour(EVENT_DATETIME)) %>%
  mutate(EVENT_DATE = as.Date(EVENT_DATETIME))
```

```
#### CONSISTENCY CHECK ID_CLI in df_1/df_6 ####
```

```
cons_idcli_df1_df6 <- df_1_cli_fid_clean %>%
  select(ID_CLI) %>%
  distinct() %>%
  mutate(is_in_df_1 = 1) %>%
  distinct() %>%
  full_join(df_6_camp_event_clean %>%
    select(ID_CLI) %>%
    distinct() %>%
    mutate(is_in_df_6 = 1) %>%
    distinct()
    , by = "ID_CLI"
  ) %>%
  group_by(is_in_df_1, is_in_df_6) %>%
  summarise(NUM_ID_CLIs = n_distinct(ID_CLI)) %>%
  as.data.frame()
```

```
cons_idcli_df1_df6
```

```
##   is_in_df_1 is_in_df_6 NUM_ID_CLIs
## 1           1           1      202023
## 2           1          NA      167449
```

```
### NOTE: all ID_CLI in df_6 are mapped in df_1, but not all ID_CLI in df_1 are mapped in df_6 !!!
```

```
#### CONSISTENCY CHECK ID_CAMP in df_5/df_6 ####
```

```
cons_idcamp_df5_df6 <- df_5_camp_cat_clean %>%
  select(ID_CAMP) %>%
  distinct() %>%
  mutate(is_in_df_5 = 1) %>%
  distinct() %>%
  full_join(df_6_camp_event_clean %>%
    select(ID_CAMP) %>%
    distinct() %>%
    mutate(is_in_df_6 = 1) %>%
    distinct()
    , by = "ID_CAMP"
  ) %>%
  group_by(is_in_df_5, is_in_df_6) %>%
  summarise(NUM_ID_CAMPs = n_distinct(ID_CAMP)) %>%
  as.data.frame()
```

```
cons_idcamp_df5_df6
```

```
##   is_in_df_5 is_in_df_6 NUM_ID_CAMPs
```

```
## 1      1      1      149
## 2      1      NA     699
```

NOTE: all ID_CAMP in df_6 are mapped in df_5, but not all ID_CAMP in df_5 are mapped in df_6 !!!#

RESHAPING df_6

remapping TYPE_EVENT values "E" [ERROR] and "B" [BOUNCE] into a level "F" [FAILURE]

```
df_6_camp_event_clean <- df_6_camp_event_clean %>%
  mutate(TYP_EVENT = as.factor(if_else(TYP_EVENT == "E" | TYP_EVENT == "B", "F", as.character(TYP_EVENT)))
```

adding type from df_5

```
df_6_camp_event_clean <- df_6_camp_event_clean %>%
  left_join(df_5_camp_cat_clean
            , by = "ID_CAMP")
```

organize the data adding to each sending event the corresponding opens/clicks/fails

sends

```
df_sends <- df_6_camp_event_clean %>%
  filter(TYP_EVENT == "S") %>%
  select(-TYP_EVENT) %>%
  select(ID_EVENT_S = ID_EVENT, ID_CLI, ID_CAMP, TYP_CAMP, ID_DELIVERY, SEND_DATE = EVENT_DATE) %>% as.data.frame()
```

opens

there could be multiple opens of the same communication

1- count the open events

2- consider explicitly only the first open

```
df_opens_prep <- df_6_camp_event_clean %>%
  filter(TYP_EVENT == "V") %>%
  select(-TYP_EVENT) %>%
  select(ID_EVENT_0 = ID_EVENT
         , ID_CLI
         , ID_CAMP
         , TYP_CAMP
         , ID_DELIVERY
         , OPEN_DATETIME = EVENT_DATETIME
         , OPEN_DATE = EVENT_DATE)
```

```
total_opens <- df_opens_prep %>%
  group_by(ID_CLI
            , ID_CAMP
            , ID_DELIVERY) %>%
  summarise(NUM_OPENS = n_distinct(ID_EVENT_0))
```

```
df_opens <- df_opens_prep %>%
  left_join(total_opens
            , by = c("ID_CLI", "ID_CAMP", "ID_DELIVERY")) %>%
  group_by(ID_CLI
            , ID_CAMP
            , ID_DELIVERY) %>%
  filter(OPEN_DATETIME == min(OPEN_DATETIME)) %>%
  filter(row_number() == 1) %>%
```

```

ungroup() %>%
as.data.frame()

# clicks
# there could be multiple clicks of the same communication
# 1- count the click events
# 2- consider explicitly only the first click

df_clicks_prep <- df_6_camp_event_clean %>%
  filter(TYP_EVENT == "C") %>%
  select(-TYP_EVENT) %>%
  select(ID_EVENT_C = ID_EVENT
         , ID_CLI
         , ID_CAMP
         , TYP_CAMP
         , ID_DELIVERY
         , CLICK_DATETIME = EVENT_DATETIME
         , CLICK_DATE = EVENT_DATE)

total_clicks <- df_clicks_prep %>%
  group_by(ID_CLI
           , ID_CAMP
           , ID_DELIVERY) %>%
  summarise(NUM_CLICKS = n_distinct(ID_EVENT_C))

df_clicks <- df_clicks_prep %>%
  left_join(total_clicks
            , by = c("ID_CLI", "ID_CAMP", "ID_DELIVERY")) %>%
  group_by(ID_CLI
           , ID_CAMP
           , ID_DELIVERY) %>%
  filter(CLICK_DATETIME == min(CLICK_DATETIME)) %>%
  filter(row_number() == 1) %>%
  ungroup() %>%
  as.data.frame()

# fails
df_fails <- df_6_camp_event_clean %>%
  filter(TYP_EVENT == "F") %>%
  select(-TYP_EVENT) %>%
  select(ID_EVENT_F = ID_EVENT
         , ID_CLI
         , ID_CAMP
         , TYP_CAMP
         , ID_DELIVERY
         , FAIL_DATETIME = EVENT_DATETIME
         , FAIL_DATE = EVENT_DATE) %>%
  group_by(ID_CLI, ID_CAMP, ID_DELIVERY) %>%
  filter(FAIL_DATETIME == min(FAIL_DATETIME)) %>%
  filter(row_number() == 1) %>%
  ungroup() %>%
  as.data.frame()

```

```

# combine sends opens clicks and fails
df_6_camp_event_clean_final <- df_sends %>%
  left_join(df_opens
    , by = c("ID_CLI", "ID_CAMP", "ID_DELIVERY", "TYP_CAMP")
  ) %>%
  filter(is.na(OPEN_DATE) | SEND_DATE <= OPEN_DATE) %>%
  left_join(df_clicks
    , by = c("ID_CLI", "ID_CAMP", "ID_DELIVERY", "TYP_CAMP")
  ) %>%
  filter(is.na(CLICK_DATE) | OPEN_DATE <= CLICK_DATE) %>%
  left_join(df_fails
    , by = c("ID_CLI", "ID_CAMP", "ID_DELIVERY", "TYP_CAMP")
  ) %>%
  filter(is.na(FAIL_DATE) | SEND_DATE <= FAIL_DATE) %>%
  mutate(OPENED = !is.na(ID_EVENT_O)) %>%
  mutate(CLICKED = !is.na(ID_EVENT_C)) %>%
  mutate(FAILED = !is.na(ID_EVENT_F)) %>%
  mutate(DAYS_TO_OPEN = as.integer(OPEN_DATE - SEND_DATE)) %>%
  select(ID_EVENT_S
    , ID_CLI
    , ID_CAMP
    , TYP_CAMP
    , ID_DELIVERY
    , SEND_DATE

    , OPENED
    , OPEN_DATE
    , DAYS_TO_OPEN
    , NUM_OPENS

    , CLICKED
    , CLICK_DATE
    , NUM_CLICKS

    , FAILED
  )

```

```
#### EXPLORE VARIABLES in df_6 ####
```

```
### GENERAL OVERVIEW ###
```

```
## compute aggregate
```

```

df6_overview <- df_6_camp_event_clean_final %>%
  summarise(MIN_DATE = min(SEND_DATE)
    , MAX_DATE = max(SEND_DATE)
    , TOT_EVENTS = n_distinct(ID_EVENT_S)
    , TOT_CLIs = n_distinct(ID_CLI))

```

```
df6_overview
```

```

##      MIN_DATE  MAX_DATE TOT_EVENTS TOT_CLIs
## 1 2019-01-03 2019-04-30   1556646   190427

```

```
### GENERAL OVERVIEW by TYP_CAMP ###
```

```
## compute aggregate
```

```
df6_overviewbytyp <- df_6_camp_event_clean_final %>%  
  group_by(TYP_CAMP) %>%  
  summarise(MIN_DATE = min(SEND_DATE)  
            , MAX_DATE = max(SEND_DATE)  
            , TOT_EVENTS = n_distinct(ID_EVENT_S)  
            , TOT_CLIs = n_distinct(ID_CLI))
```

```
df6_overviewbytyp
```

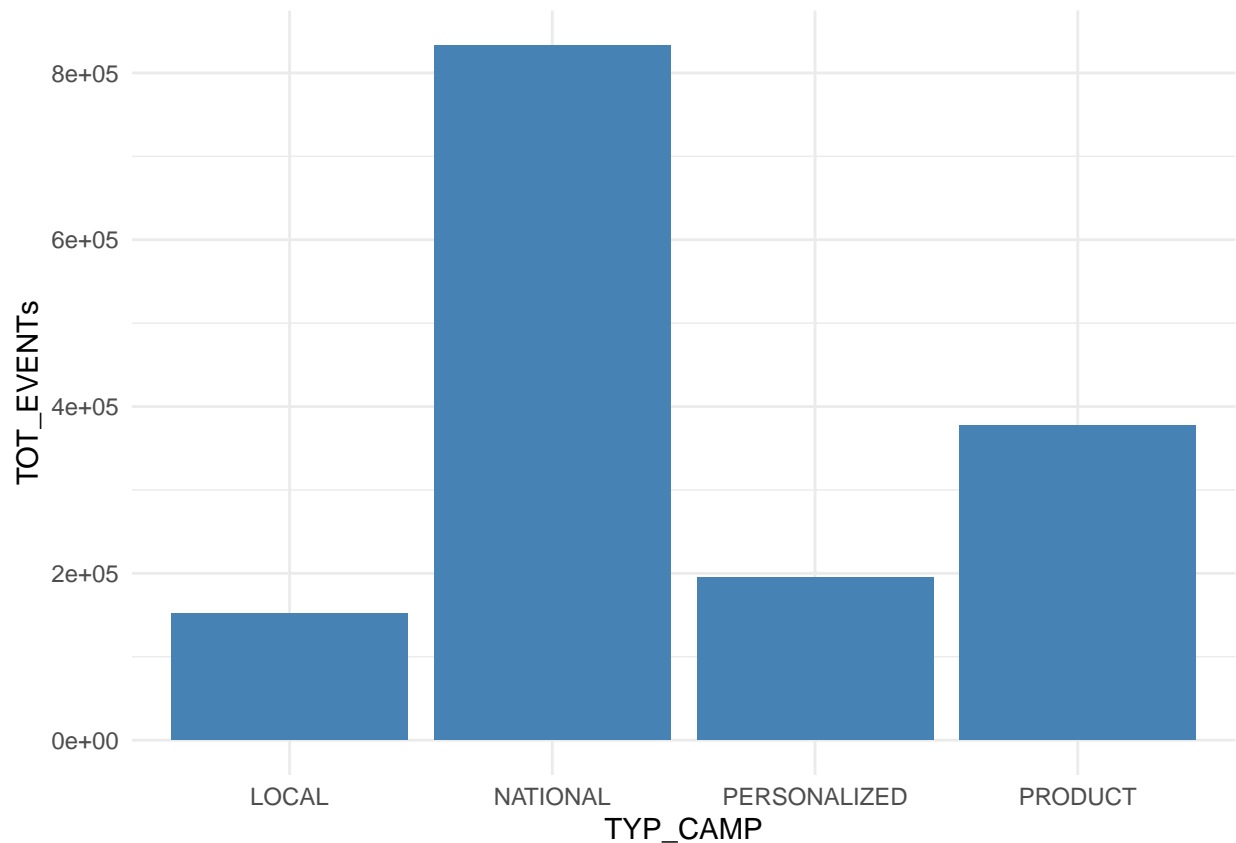
```
## # A tibble: 4 x 5
```

```
##   TYP_CAMP   MIN_DATE   MAX_DATE   TOT_EVENTS TOT_CLIs  
##   <chr>      <date>     <date>         <int>    <int>  
## 1 LOCAL      2019-02-02  2019-04-02     151719    87894  
## 2 NATIONAL   2019-01-07  2019-04-23     833085   177153  
## 3 PERSONALIZED 2019-01-03  2019-04-30     194840   133908  
## 4 PRODUCT    2019-01-03  2019-04-25     377002    69724
```

```
## plot aggregate
```

```
plot_df6_overviewbytyp <- (  
  ggplot(data=df6_overviewbytyp  
        , aes(x=TYP_CAMP, y=TOT_EVENTS)) +  
    geom_bar(stat="identity", fill="steelblue") +  
    theme_minimal()  
)
```

```
plot_df6_overviewbytyp
```



```
### Variable OPENED ###
```

```
## compute aggregate
```

```
df6_dist_opened <- df_6_camp_event_clean_final %>%
  group_by(OPENED) %>%
  summarise(TOT_EVENTS = n_distinct(ID_EVENT_S)
            , TOT_CLIs = n_distinct(ID_CLi)) %>%
  mutate(TYP_CAMP = 'ALL') %>%
  mutate(PERCENT_EVENTS = TOT_EVENTS/df6_overview$TOT_EVENTS
        , PERCENT_CLIs = TOT_CLIs/df6_overview$TOT_CLIs)
```

```
df6_dist_opened
```

```
## # A tibble: 2 x 6
```

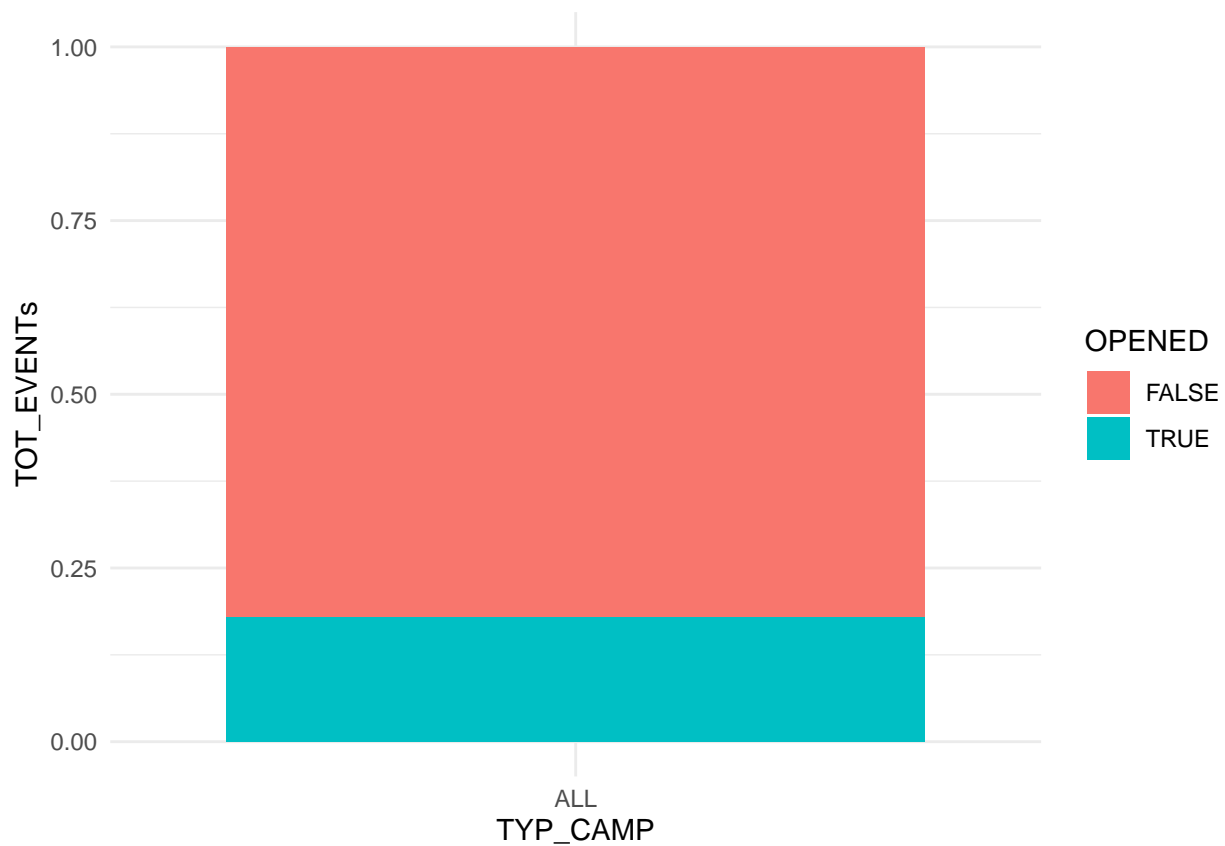
```
##   OPENED TOT_EVENTS TOT_CLIs TYP_CAMP PERCENT_EVENTS PERCENT_CLIs
##   <lgl>      <int>    <int> <chr>      <dbl>      <dbl>
## 1 FALSE    1278264    178378 ALL         0.821      0.937
## 2 TRUE      278382     83420 ALL         0.179      0.438
```

```
## plot aggregate
```

```
plot_df6_dist_opened <- (
  ggplot(data=df6_dist_opened
        , aes(fill=OPENED, x=TYP_CAMP, y=TOT_EVENTS)) +
  geom_bar(stat="identity", position="fill") +
  theme_minimal())
```

```
)
```

```
plot_df6_dist_opened
```



```
### Variable OPENED by TYP_CAMP ###
```

```
## compute aggregate
```

```
df6_dist_openedbytyp <- df_6_camp_event_clean_final %>%
```

```
  group_by(TYP_CAMP, OPENED) %>%
```

```
  summarise(TOT_EVENTS = n_distinct(ID_EVENT_S)  
            , TOT_CLIs = n_distinct(ID_CLI)) %>%
```

```
  left_join(df6_overviewbytyp %>%
```

```
    select(TYP_CAMP  
           , ALL_TOT_EVENTS = TOT_EVENTS  
           , ALL_TOT_CLIs = TOT_CLIs)  
    , by='TYP_CAMP') %>%
```

```
  mutate(PERCENT_EVENTS = TOT_EVENTS/ALL_TOT_EVENTS  
         , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%
```

```
  select(TYP_CAMP  
         , OPENED  
         , TOT_EVENTS  
         , TOT_CLIs  
         , PERCENT_EVENTS  
         , PERCENT_CLIs
```

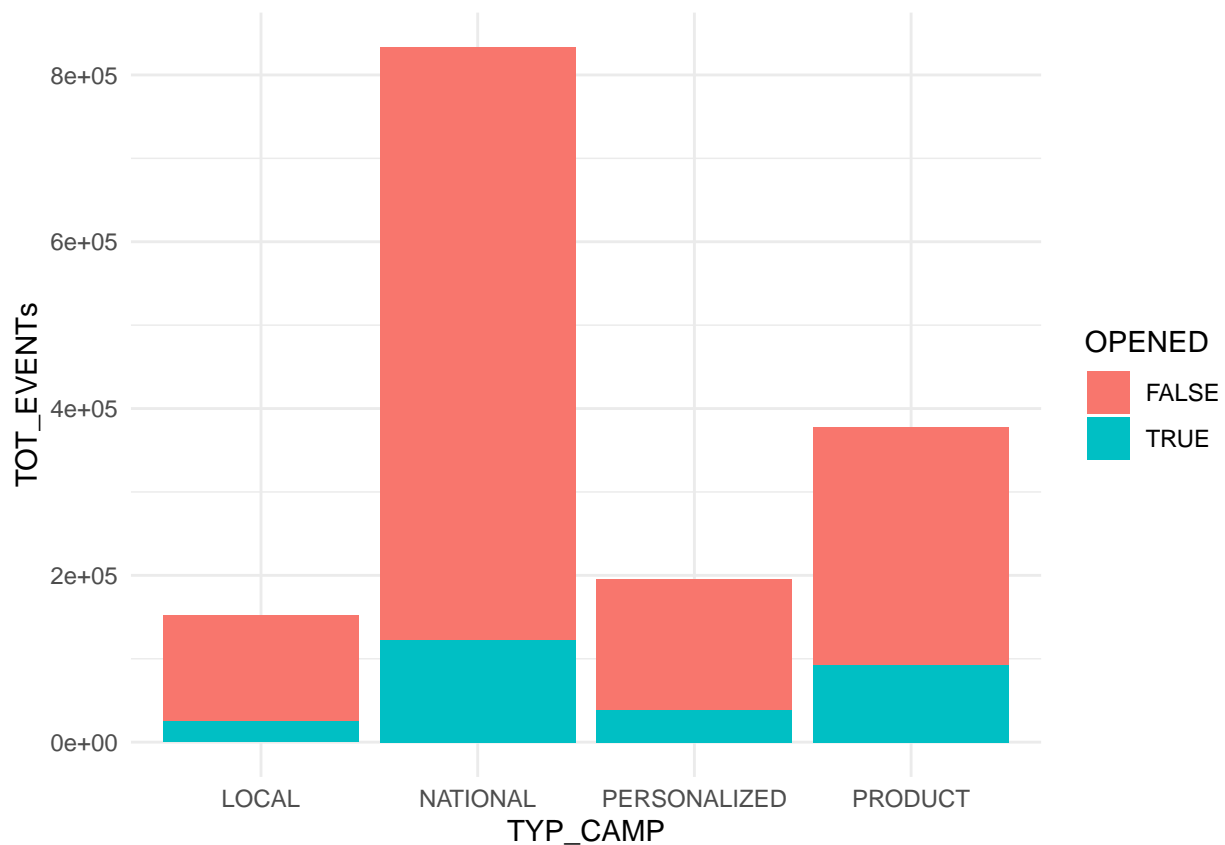
```
)
```

```
df6_dist_openedbytyp
```

```
## # A tibble: 8 x 6
## # Groups:   TYP_CAMP [4]
##   TYP_CAMP   OPENED TOT_EVENTS TOT_CLIs PERCENT_EVENTS PERCENT_CLIs
##   <chr>     <lgl>      <int>    <int>      <dbl>      <dbl>
## 1 LOCAL     FALSE      126700   76835      0.835      0.874
## 2 LOCAL     TRUE        25019   18029      0.165      0.205
## 3 NATIONAL FALSE      710721  162049      0.853      0.915
## 4 NATIONAL TRUE      122364   62964      0.147      0.355
## 5 PERSONALIZED FALSE    156431  111942      0.803      0.836
## 6 PERSONALIZED TRUE      38409   31327      0.197      0.234
## 7 PRODUCT   FALSE    284412   62356      0.754      0.894
## 8 PRODUCT   TRUE      92590   29605      0.246      0.425
```

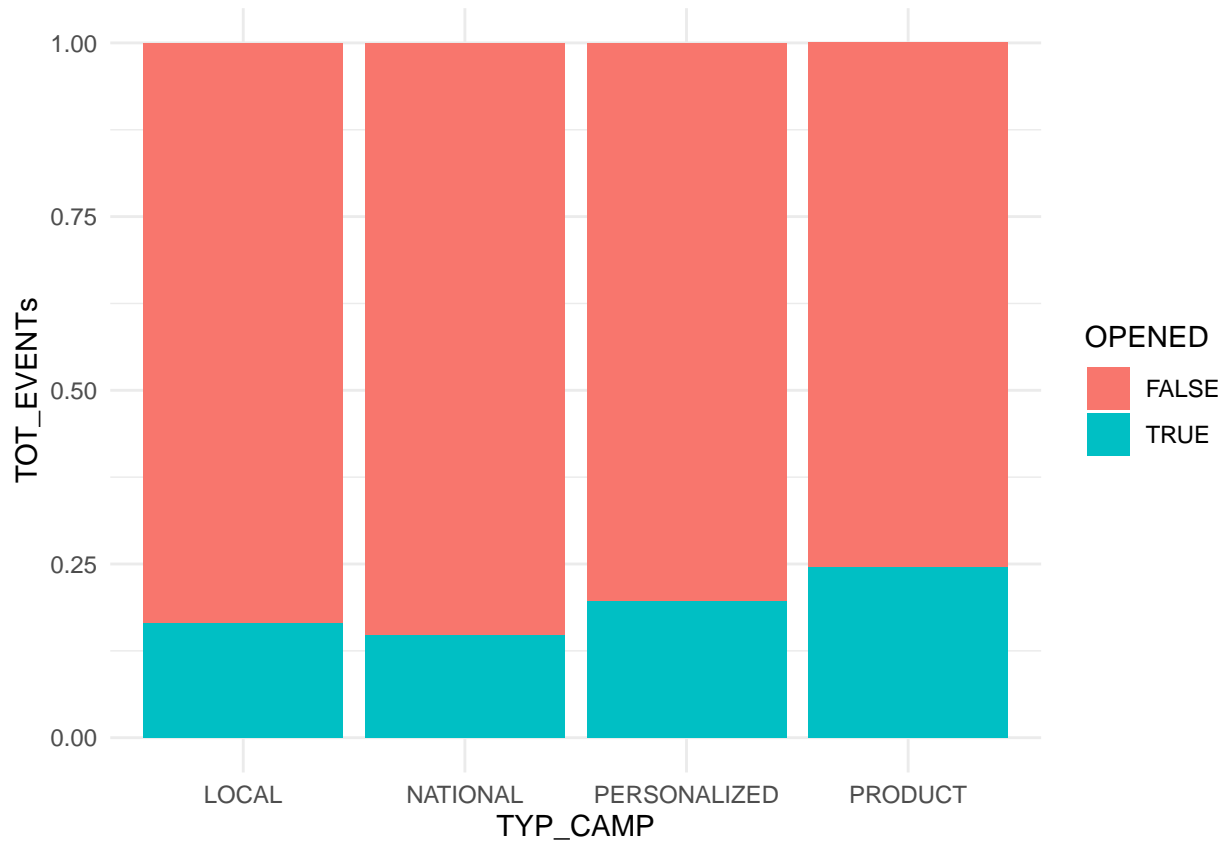
```
## plot aggregate
plot_df6_dist_openedbytyp <- (
  ggplot(data=df6_dist_openedbytyp
    , aes(fill=OPENED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(stat="identity") +
    theme_minimal()
)

plot_df6_dist_openedbytyp
```




```
## plot aggregate percent
plot_df6_dist_openedbytyp_percent <- (
  ggplot(data=df6_dist_openedbytyp
    , aes(fill=OPENED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(position="fill", stat="identity") +
    theme_minimal()
)

plot_df6_dist_openedbytyp_percent
```



```
### Variable DAYS_TO_OPEN

## compute aggregate
df6_dist_daystooopen <- df_6_camp_event_clean_final %>%
  filter(OPENED) %>%
  group_by(ID_CLi) %>%
  summarise(AVG_DAYS_TO_OPEN = floor(mean(DAYS_TO_OPEN))) %>%
  ungroup() %>%
  group_by(AVG_DAYS_TO_OPEN) %>%
  summarise(TOT_CLIIs = n_distinct(ID_CLi))

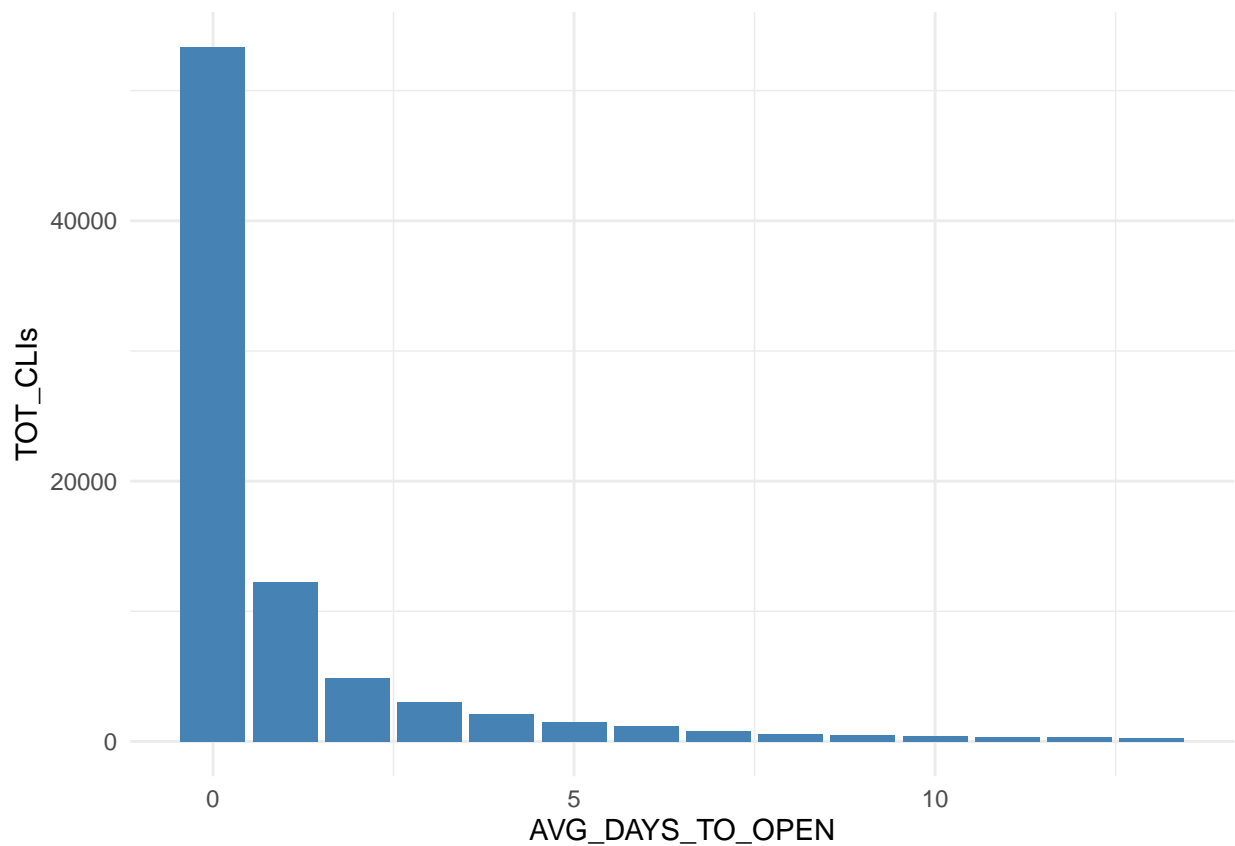
df6_dist_daystooopen
```

```
## # A tibble: 59 x 2
##   AVG_DAYS_TO_OPEN TOT_CLIIs
```

```
##           <dbl>    <int>
##  1             0    53379
##  2             1    12221
##  3             2     4849
##  4             3     3036
##  5             4     2131
##  6             5     1467
##  7             6     1158
##  8             7      786
##  9             8      573
## 10            9      469
## # ... with 49 more rows
```

```
## plot aggregate
plot_df6_dist_daystopen <- (
  ggplot(data=df6_dist_daystopen %>%
    filter(AVG_DAYS_TO_OPEN < 14)
    , aes(x=AVG_DAYS_TO_OPEN, y=TOT_CLIs)) +
  geom_bar(stat="identity", fill="steelblue") +
  theme_minimal()
)

plot_df6_dist_daystopen
```



```

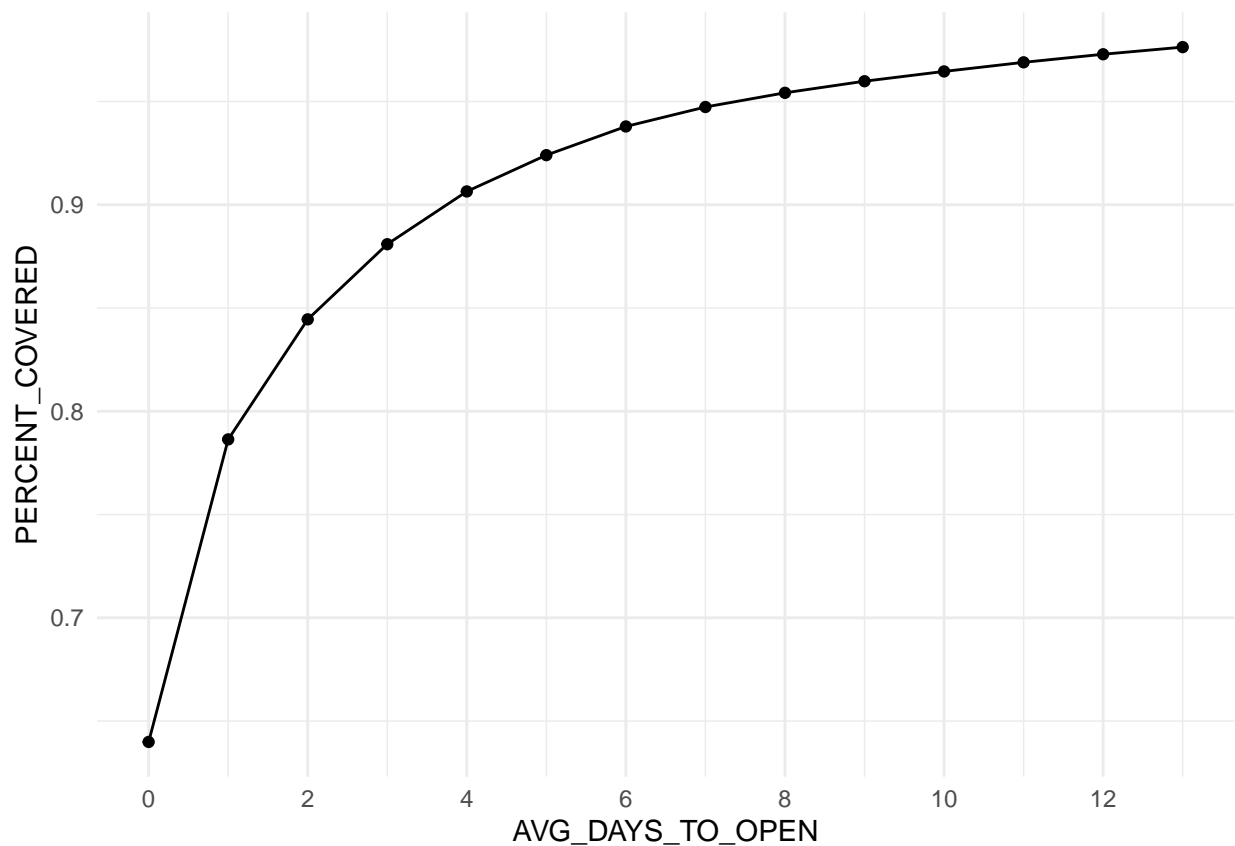
### DAYS_TO_OPEN vs CUMULATE PERCENT ###

## compute aggregate
df6_dist_daystoopen_vs_cumulate <- df6_dist_daystoopen %>%
  arrange(AVG_DAYS_TO_OPEN) %>%
  mutate(PERCENT_COVERED = cumsum(TOT_CLIs)/sum(TOT_CLIs))

## plot aggregate
plot_df6_dist_daystoopen_vs_cumulate <- (
  ggplot(data=df6_dist_daystoopen_vs_cumulate %>%
    filter(AVG_DAYS_TO_OPEN < 14)
    , aes(x=AVG_DAYS_TO_OPEN, y=PERCENT_COVERED)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks=seq(0,14,2), minor_breaks=0:14) +
  theme_minimal()
)

plot_df6_dist_daystoopen_vs_cumulate

```



```

#### TO DO df_6 ####
# EXPLORE the following relevant variables in df_6_camp_event_clean_final:

# - CLICKED/CLICKED by TYP_CAMP
## compute aggregate

```

```

df6_dist_clickedbytyp <- df_6_camp_event_clean_final %>%
  group_by(TYP_CAMP, CLICKED) %>%
  summarise(TOT_EVENTS = n_distinct(ID_EVENT_S)
            , TOT_CLIs = n_distinct(ID_CLI)) %>%
  left_join(df6_overviewbytyp %>%
            select(TYP_CAMP
                  , ALL_TOT_EVENTS = TOT_EVENTS
                  , ALL_TOT_CLIs = TOT_CLIs)
            , by='TYP_CAMP') %>%
  mutate(PERCENT_EVENTS = TOT_EVENTS/ALL_TOT_EVENTS
        , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%
  select(TYP_CAMP
        , CLICKED
        , TOT_EVENTS
        , TOT_CLIs
        , PERCENT_EVENTS
        , PERCENT_CLIs
        )

df6_dist_clickedbytyp

```

```

## # A tibble: 8 x 6
## # Groups:   TYP_CAMP [4]
##   TYP_CAMP    CLICKED TOT_EVENTS TOT_CLIs PERCENT_EVENTS PERCENT_CLIs
##   <chr>      <lgl>      <int>   <int>         <dbl>         <dbl>
## 1 LOCAL      FALSE      150374   87332         0.991         0.994
## 2 LOCAL      TRUE        1345    1280         0.00887       0.0146
## 3 NATIONAL   FALSE      815796  175939        0.979         0.993
## 4 NATIONAL   TRUE       17289   14216        0.0208        0.0802
## 5 PERSONALIZED FALSE     192741  133043        0.989         0.994
## 6 PERSONALIZED TRUE       2099    2016         0.0108        0.0151
## 7 PRODUCT    FALSE     362551   69373        0.962         0.995
## 8 PRODUCT    TRUE      14451    8800         0.0383        0.126

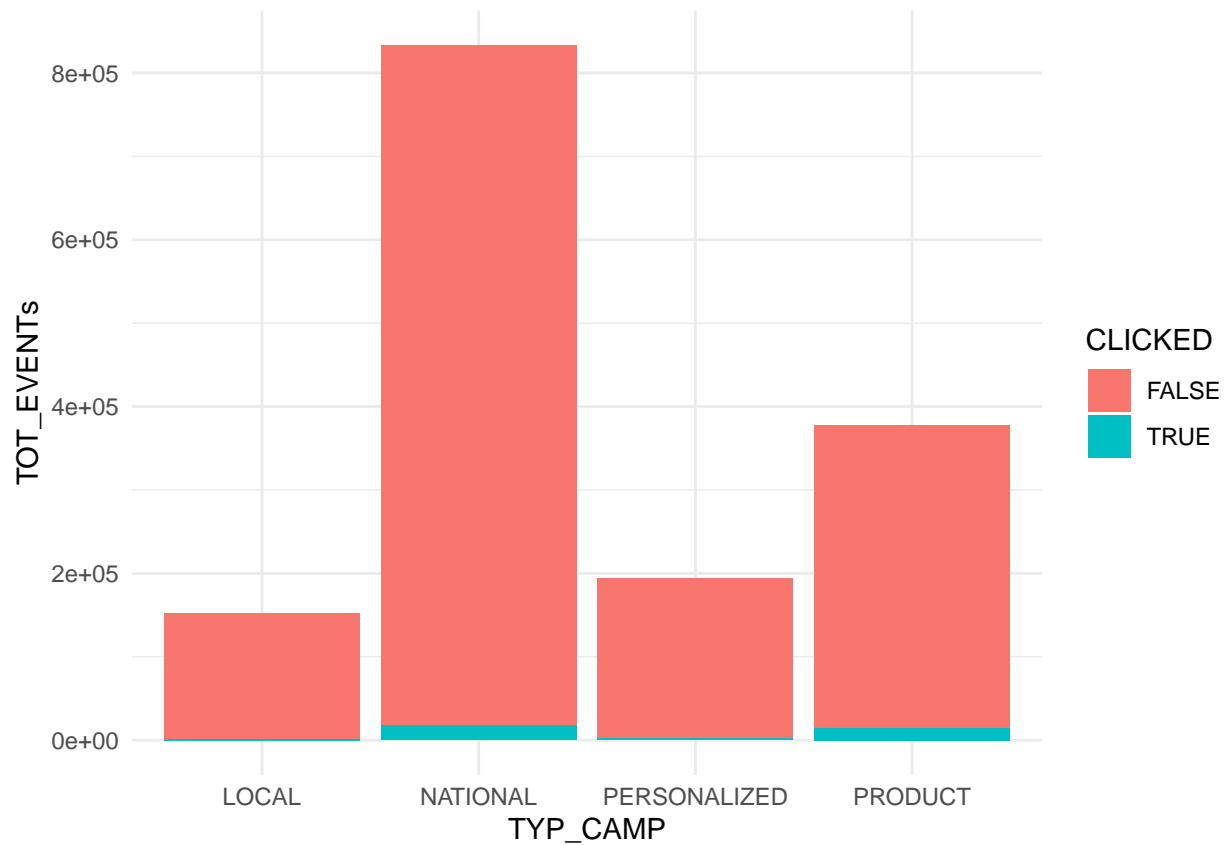
```

```

## plot aggregate
plot_df6_dist_clickedbytyp <- (
  ggplot(data=df6_dist_clickedbytyp
        , aes(fill=CLICKED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(stat="identity") +
    theme_minimal()
)

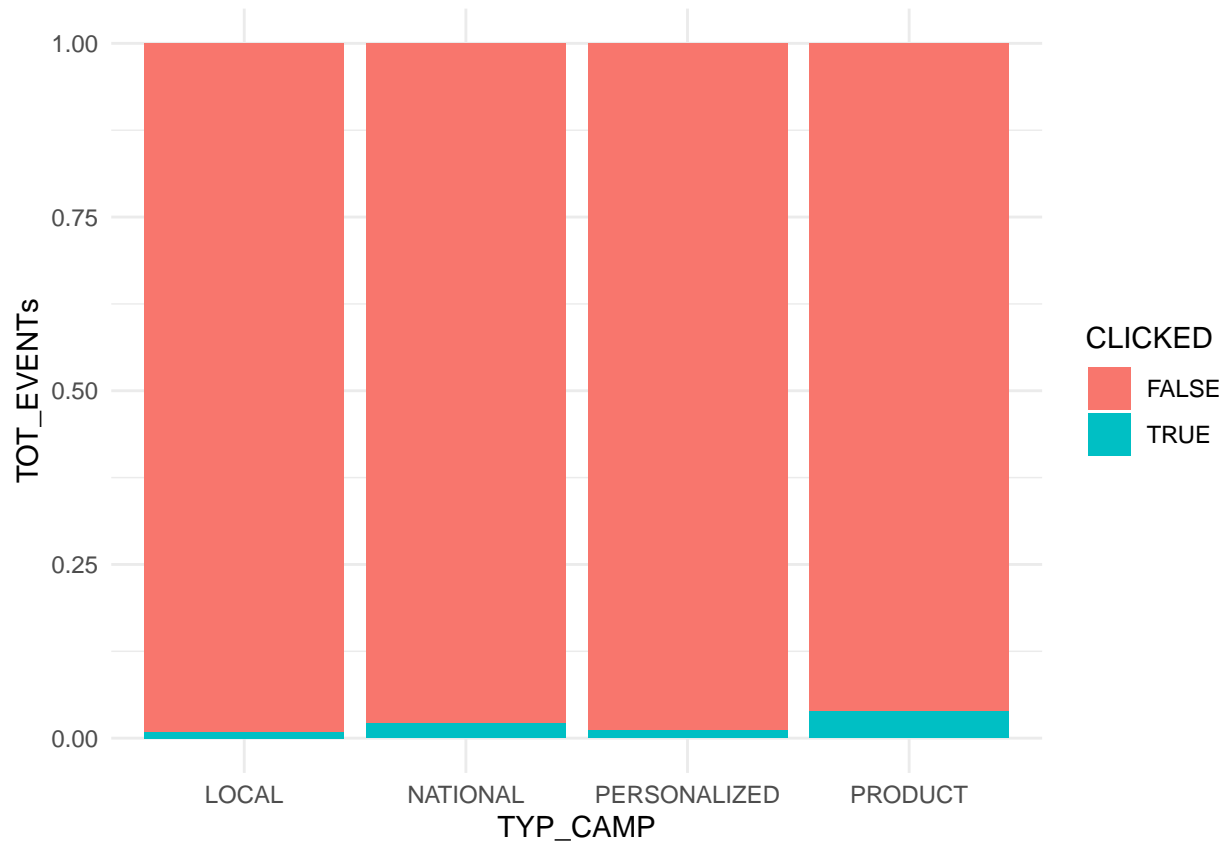
plot_df6_dist_clickedbytyp

```



```
## plot aggregate percent
plot_df6_dist_clickedbytyp_percent <- (
  ggplot(data=df6_dist_clickedbytyp
    , aes(fill=CLICKED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(position="fill", stat="identity") +
    theme_minimal()
)

plot_df6_dist_clickedbytyp_percent
```



```
# - FAILED/FAILED by TYP_CAP

## compute aggregate
df6_dist_failedbytyp <- df_6_camp_event_clean_final %>%
  group_by(TYP_CAMP, FAILED) %>%
  summarise(TOT_EVENTS = n_distinct(ID_EVENT_S)
            , TOT_CLIs = n_distinct(ID_CLi)) %>%
  left_join(df6_overviewbytyp %>%
            select(TYP_CAMP
                  , ALL_TOT_EVENTS = TOT_EVENTS
                  , ALL_TOT_CLIs = TOT_CLIs)
            , by='TYP_CAMP') %>%
  mutate(PERCENT_EVENTS = TOT_EVENTS/ALL_TOT_EVENTS
        , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%
  select(TYP_CAMP
        , FAILED
        , TOT_EVENTS
        , TOT_CLIs
        , PERCENT_EVENTS
        , PERCENT_CLIs
        )

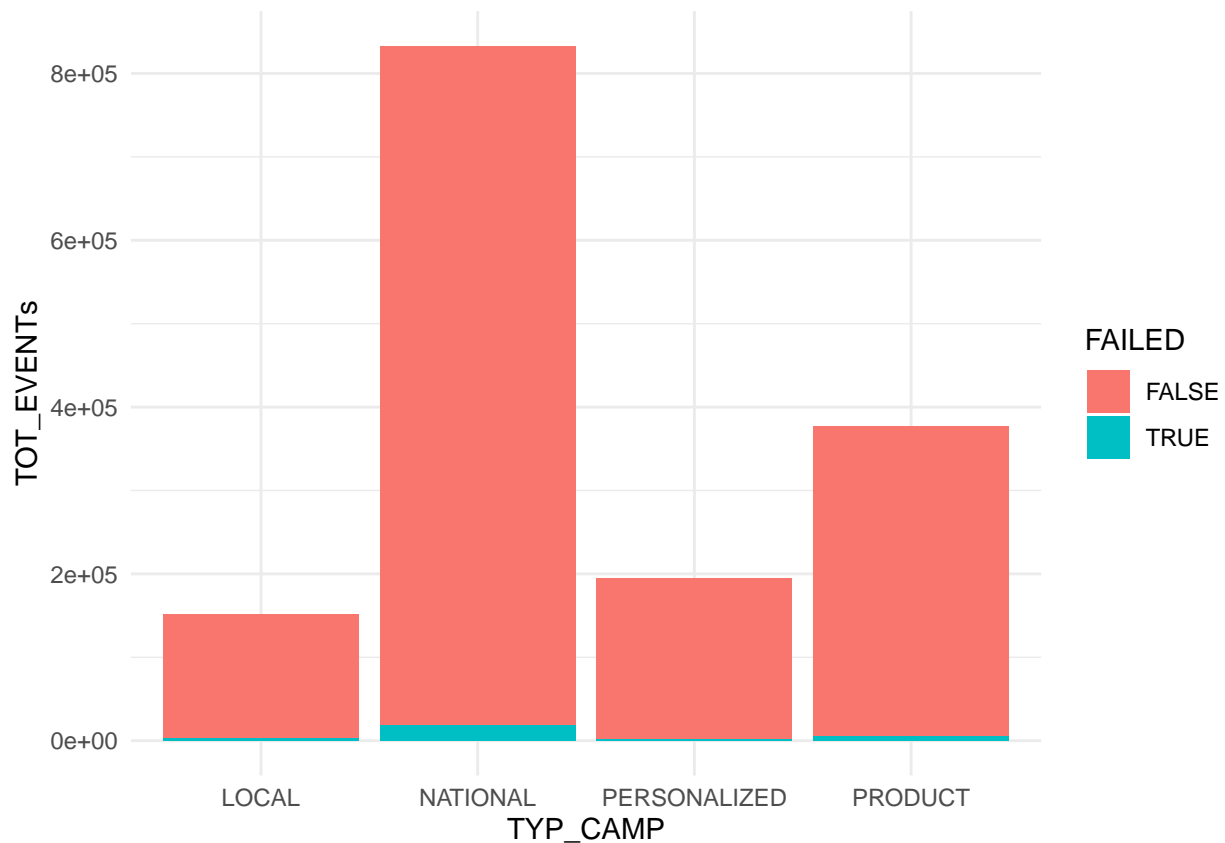
df6_dist_failedbytyp
```

```
## # A tibble: 8 x 6
```

```
## # Groups:   TYP_CAMP [4]
##   TYP_CAMP   FAILED TOT_EVENTS TOT_CLIs PERCENT_EVENTS PERCENT_CLIs
##   <chr>      <lgl>      <int>    <int>         <dbl>         <dbl>
## 1 LOCAL      FALSE      149189   86540         0.983         0.985
## 2 LOCAL      TRUE         2530    1653         0.0167        0.0188
## 3 NATIONAL   FALSE      814897  174425        0.978         0.985
## 4 NATIONAL   TRUE        18188   7045         0.0218        0.0398
## 5 PERSONALIZED FALSE     192844  132774        0.990         0.992
## 6 PERSONALIZED TRUE         1996    1690         0.0102        0.0126
## 7 PRODUCT    FALSE     371788  68960         0.986         0.989
## 8 PRODUCT    TRUE         5214    1729         0.0138        0.0248
```

```
## plot aggregate
plot_df6_dist_failedbytyp <- (
  ggplot(data=df6_dist_failedbytyp
    , aes(fill=FAILED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(stat="identity") +
    theme_minimal()
)

plot_df6_dist_failedbytyp
```



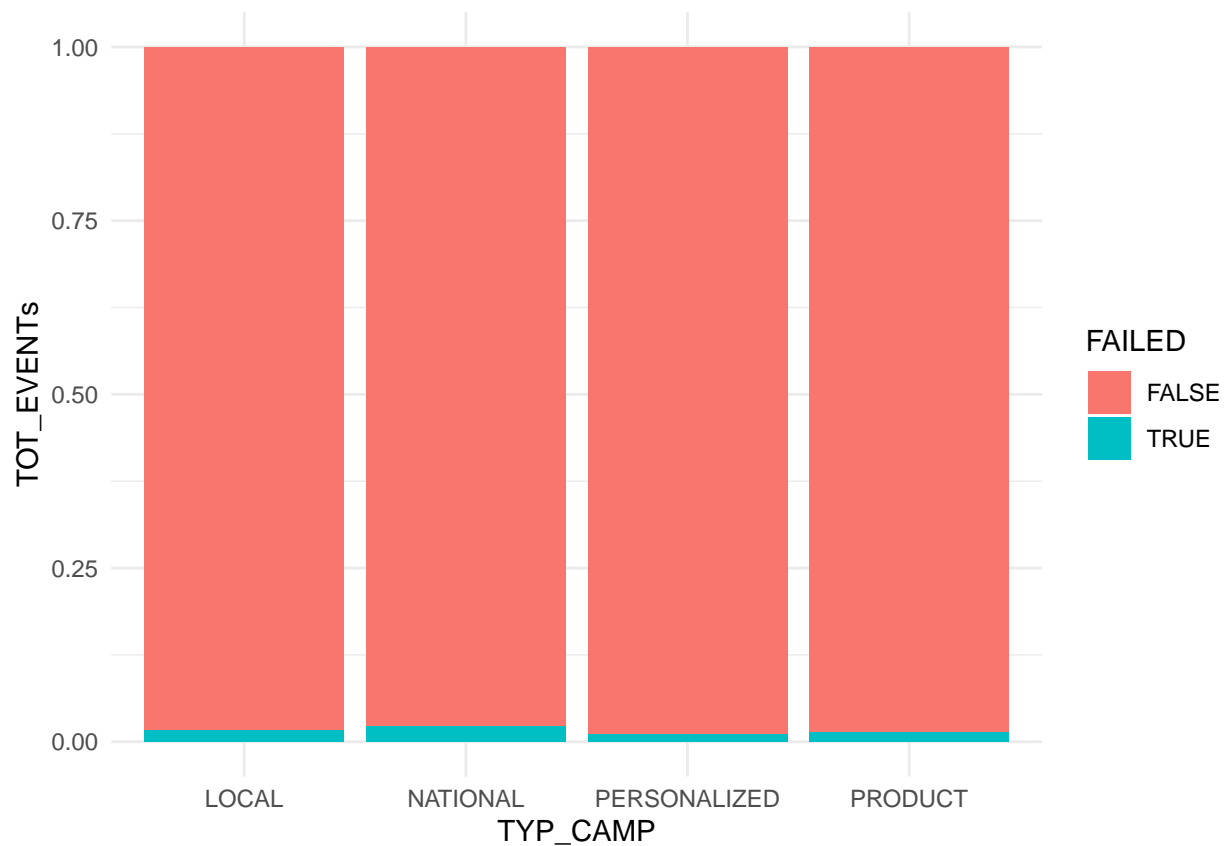
```
## plot aggregate percent
plot_df6_dist_failedbytyp_percent <- (
  ggplot(data=df6_dist_failedbytyp
```

```

    , aes(fill=FAILED, x=TYP_CAMP, y=TOT_EVENTS)) +
    geom_bar(position="fill", stat="identity") +
    theme_minimal()
)

```

plot_df6_dist_failedbytyp_percent



```

# - NUM_OPENS

# compute aggregate
df6_dist_num_opens <- df_6_camp_event_clean_final %>%
  filter(OPENED) %>%
  group_by(ID_CLI) %>%
  summarise(AVG_OPENS = floor(mean(NUM_OPENS))) %>%
  ungroup() %>%
  group_by(AVG_OPENS) %>%
  summarise(TOT_CLIIs = n_distinct(ID_CLI))

```

df6_dist_num_opens

```

## # A tibble: 32 x 2
##   AVG_OPENS TOT_CLIIs
##   <dbl>      <int>
## 1         1    73265
## 2         2     7075

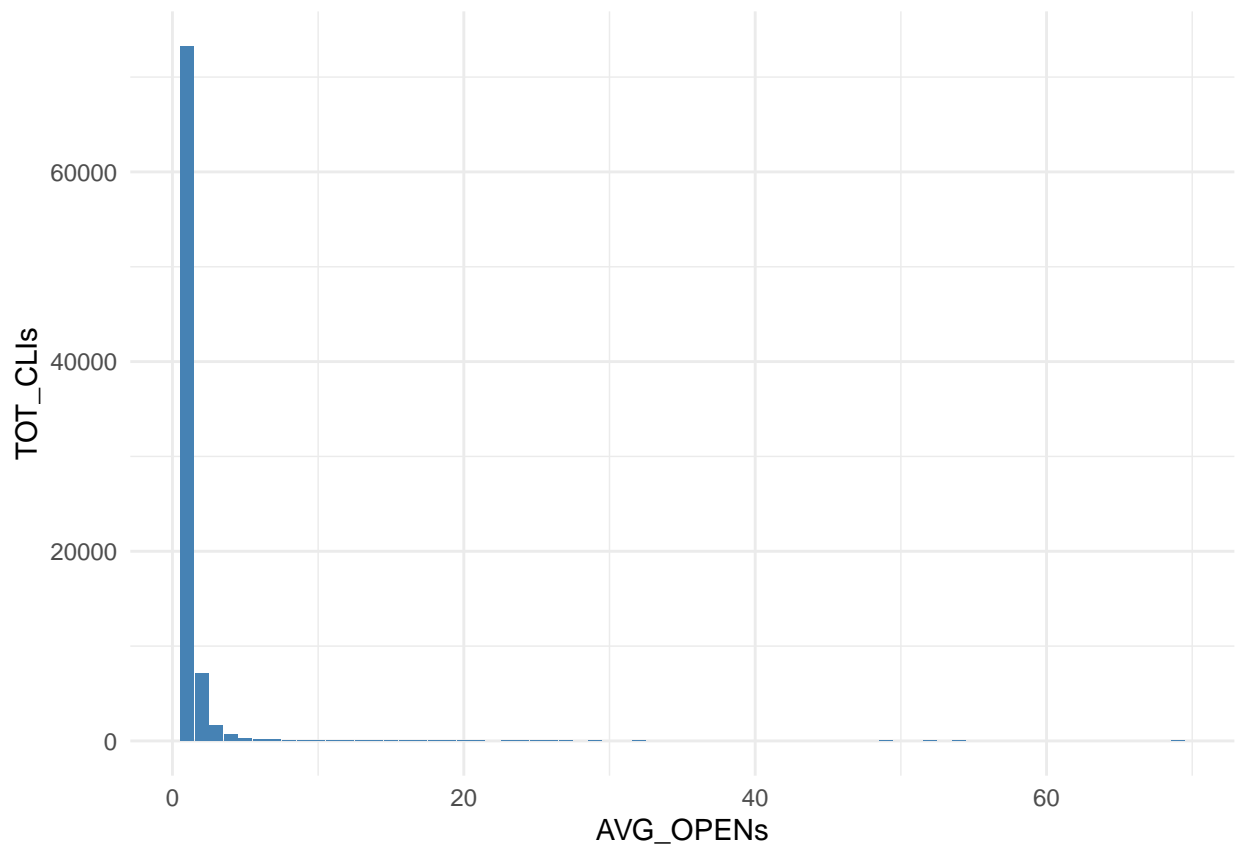
```



```
## 3      3      1685
## 4      4      643
## 5      5      290
## 6      6      156
## 7      7      110
## 8      8       71
## 9      9       30
## 10     10       23
## # ... with 22 more rows
```

```
## plot
plot_df6_dist_num_opens <- (
  ggplot(data=df6_dist_num_opens
    , aes(x=AVG_OPENS, y=TOT_CLIs)) +
    geom_bar(stat="identity", fill="steelblue") +
    theme_minimal()
)

plot_df6_dist_num_opens
```



```
# - NUM_CLICKs

# compute aggregate
df6_num_clicks <- df_6_camp_event_clean_final %>%
  filter(CLICKED) %>%
```

```

group_by(ID_CLI) %>%
summarise(AVG_CLICKs = floor(sum(NUM_CLICKs))) %>%
ungroup()
df6_dist_num_clicks <- df6_num_clicks %>%
group_by(AVG_CLICKs) %>%
summarise(TOT_CLIs = n_distinct(ID_CLI))

df6_dist_num_clicks

```

```

## # A tibble: 35 x 2
##   AVG_CLICKs TOT_CLIs
##   <dbl>     <int>
## 1         1    12705
## 2         2     4523
## 3         3     2133
## 4         4     1170
## 5         5      674
## 6         6      400
## 7         7      289
## 8         8      177
## 9         9      110
## 10        10       86
## # ... with 25 more rows

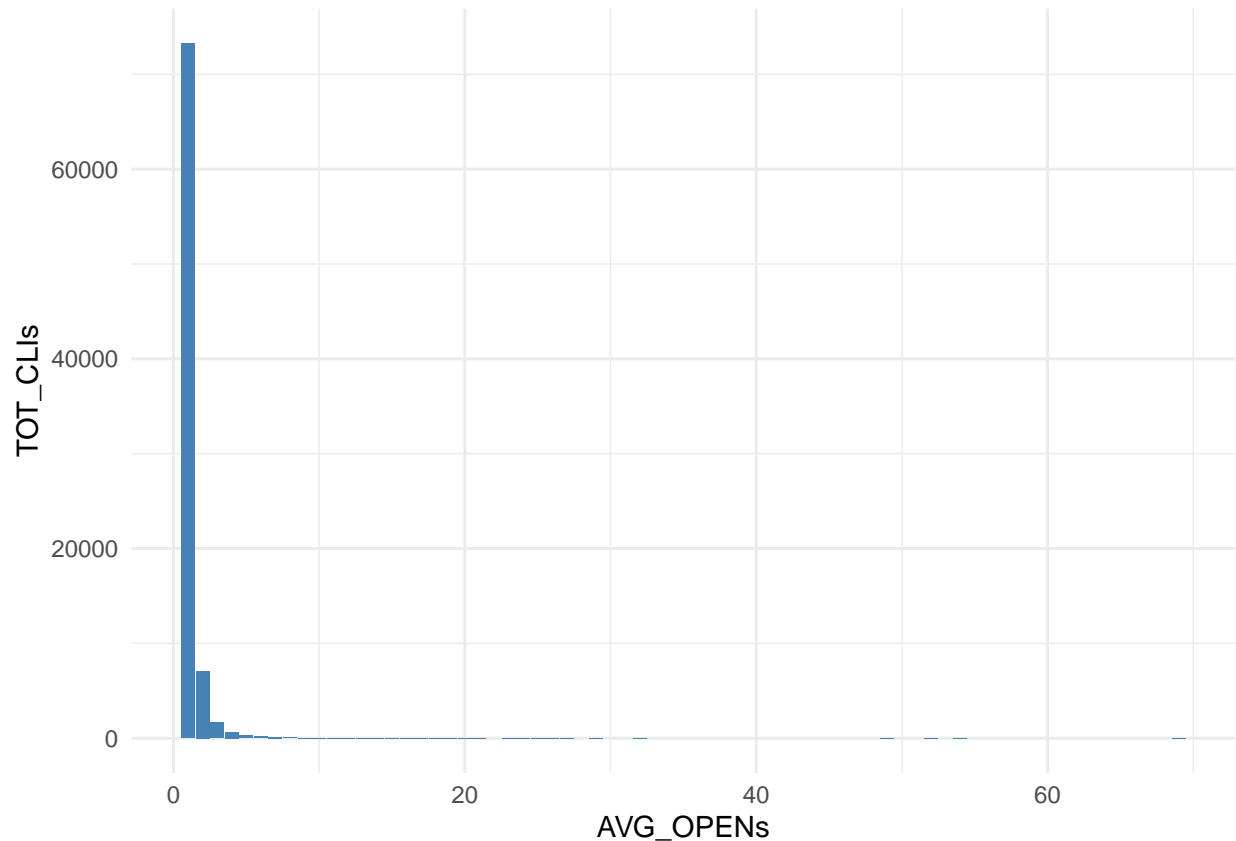
```

```

## plot
plot_df6_dist_num_clicks <- (
  ggplot(data=df6_dist_num_clicks
    , aes(x=AVG_CLICKs, y=TOT_CLIs)) +
    geom_bar(stat="identity", fill="steelblue") +
    theme_minimal()
)

plot_df6_dist_num_opens

```



```
#### FINAL REVIEW df_6_clean ####
```

```
str(df_6_camp_event_clean_final)
```

```
## 'data.frame': 1556646 obs. of 14 variables:
## $ ID_EVENT_S : int 11596999 11566080 11582299 11602861 11588065 11608037 11567230 11609502 115873
## $ ID_CLI : int 553990 284487 339347 267826 108905 733825 149363 192004 281522 375829 ...
## $ ID_CAMP : int 959 957 958 960 959 960 957 960 959 959 ...
## $ TYP_CAMP : chr "PRODUCT" "PRODUCT" "PRODUCT" "PRODUCT" ...
## $ ID_DELIVERY : int 9282 9280 9281 9283 9282 9283 9280 9283 9282 9282 ...
## $ SEND_DATE : Date, format: "2019-01-03" "2019-01-03" ...
## $ OPENED : logi FALSE FALSE FALSE TRUE FALSE TRUE ...
## $ OPEN_DATE : Date, format: NA NA ...
## $ DAYS_TO_OPEN: int NA NA NA 0 NA 0 1 NA NA NA ...
## $ NUM_OPENS : int NA NA NA 6 NA 3 1 NA NA NA ...
## $ CLICKED : logi FALSE FALSE FALSE TRUE FALSE TRUE ...
## $ CLICK_DATE : Date, format: NA NA ...
## $ NUM_CLICKS : int NA NA NA 4 NA 1 NA NA NA NA ...
## $ FAILED : logi FALSE FALSE TRUE FALSE FALSE FALSE ...
```

```
summary(df_6_camp_event_clean_final)
```

```
## ID_EVENT_S ID_CLI ID_CAMP TYP_CAMP
## Min. :11556410 Min. : 1 Min. : 148.0 Length:1556646
## 1st Qu.:13533374 1st Qu.:203686 1st Qu.: 972.0 Class :character
```

```
## Median :14738016 Median :386219 Median : 991.0 Mode :character
## Mean :14710011 Mean :404298 Mean : 926.9
## 3rd Qu.:16262705 3rd Qu.:602601 3rd Qu.:1024.0
## Max. :17649382 Max. :931973 Max. :1048.0
##
## ID_DELIVERY SEND_DATE OPENED OPEN_DATE
## Min. : 9280 Min. :2019-01-03 Mode :logical Min. :2019-01-03
## 1st Qu.:10220 1st Qu.:2019-02-13 FALSE:1278264 1st Qu.:2019-02-13
## Median :10585 Median :2019-02-28 TRUE :278382 Median :2019-03-03
## Mean :10542 Mean :2019-03-03 Mean :2019-03-05
## 3rd Qu.:11151 3rd Qu.:2019-04-04 3rd Qu.:2019-04-04
## Max. :11509 Max. :2019-04-30 Max. :2019-04-30
## NA's :1278264
## DAYS_TO_OPEN NUM_OPENS CLICKED CLICK_DATE
## Min. : 0.0 Min. : 1.0 Mode :logical Min. :2019-01-03
## 1st Qu.: 0.0 1st Qu.: 1.0 FALSE:1521462 1st Qu.:2019-01-31
## Median : 0.0 Median : 1.0 TRUE :35184 Median :2019-03-03
## Mean : 1.5 Mean : 1.4 Mean :2019-03-04
## 3rd Qu.: 1.0 3rd Qu.: 1.0 3rd Qu.:2019-04-05
## Max. :59.0 Max. :82.0 Max. :2019-04-30
## NA's :1278264 NA's :1278264 NA's :1521462
## NUM_CLICKS FAILED
## Min. : 1.0 Mode :logical
## 1st Qu.: 1.0 FALSE:1528718
## Median : 1.0 TRUE :27928
## Mean : 1.4
## 3rd Qu.: 1.0
## Max. :41.0
## NA's :1521462
```

```
#### FIRST LOOK of df_7 ####
```

```
str(df_7_tic)
```

```
## 'data.frame': 4263220 obs. of 9 variables:
## $ ID_SCONTRINO : chr "51299709701/05/18718488513770" "51299709701/05/18718488513770" "51399406901/05/18718488513770" ...
## $ ID_CLI : int 318714 318714 324419 332611 325589 325589 56975 323722 323722 320632 ...
## $ ID_NEG : int 48 48 47 36 35 35 20 27 27 48 ...
## $ ID_ARTICOLO : int 34216854 34216854 36167733 32404540 35811412 35811741 36167733 34326222 34326222 34326222 ...
## $ COD_REPARTO : int 2 2 9 13 9 9 9 12 12 9 ...
## $ DIREZIONE : int 1 1 1 1 1 1 1 1 1 1 ...
## $ IMPORTO_LORDO: num 22.8 22.8 1290 134 399 ...
## $ SCONTO : num 0.05 0 491 34.1 0 0 491 0 0 10.9 ...
## $ DATETIME : chr "2018-05-01T071848" "2018-05-01T071848" "2018-05-01T071848" "2018-05-01T071848" ...
```

```
summary(df_7_tic)
```

```
## ID_SCONTRINO ID_CLI ID_NEG ID_ARTICOLO
## Length:4263220 Min. : 5 Min. : 2.00 Min. : 16921
## Class :character 1st Qu.:211201 1st Qu.:14.00 1st Qu.:34141800
## Mode :character Median :411821 Median :27.00 Median :35558446
## Mean :411433 Mean :25.93 Mean :38022591
## 3rd Qu.:601672 3rd Qu.:38.00 3rd Qu.:36144465
```

```
##           Max.      :934729    Max.      :49.00    Max.      :82231481
## COD_REPARTO DIREZIONE IMPORTO_LORDO SCONTO
## Min.      : 1.000    Min.      :-1.0000   Min.      :-17465.00   Min.      :-2472.000
## 1st Qu.: 3.000    1st Qu.: 1.0000   1st Qu.:      2.67    1st Qu.:      0.000
## Median : 7.000    Median : 1.0000   Median :      7.50    Median :      0.000
## Mean      : 7.393    Mean      : 0.8866   Mean      :     32.65   Mean      :      2.329
## 3rd Qu.:11.000    3rd Qu.: 1.0000   3rd Qu.:     22.00    3rd Qu.:      0.000
## Max.      :14.000    Max.      : 1.0000   Max.      : 17465.00   Max.      : 4853.590
## DATETIME
## Length:4263220
## Class :character
## Mode :character
##
##
##
```

```
#### START CLEANING df_7 ####
```

```
tickets_clean <- df_7_tic
```

```
#### CLEANING DATA TYPES in df_7 ####
```

```
## formatting dates and times ##
```

```
tickets_clean <- tickets_clean %>%
  mutate(TIC_DATETIME = as.POSIXct(DATETIME,
                                    format = "%Y-%m-%dT%H%M%S")) %>% ## Date Time
  mutate(TIC_HOUR = hour(TIC_DATETIME)) %>% ## In Hours
  mutate(TIC_DATE = as.Date(TIC_DATETIME)) %>% ## In Date
  select(-DATETIME) %>% ## Removed DATETIME
  mutate(DIREZIONE = as.factor(DIREZIONE)) %>% ## Factorization
  mutate(COD_REPARTO = as.factor(COD_REPARTO)) %>% ## Factorization
```

```
#### CONSISTENCY CHECK ID_CLI in df_1/df_7 ####
```

```
cons_idcli_df1_df7 <- df_1_cli_fid_clean %>%
  select(ID_CLI) %>%
  distinct() %>%
  mutate(is_in_df_1 = 1) %>%
  distinct() %>%
  full_join(tickets_clean %>%
    select(ID_CLI) %>%
    distinct() %>%
    mutate(is_in_df_7 = 1) %>%
    distinct()
    , by = "ID_CLI"
  ) %>%
  group_by(is_in_df_1, is_in_df_7) %>%
  summarise(NUM_ID_CLI = n_distinct(ID_CLI)) %>%
  as.data.frame()
```

```
cons_idcli_df1_df7
```

```
##   is_in_df_1 is_in_df_7 NUM_ID_CLIs
## 1         1         1      212124
## 2         1        NA      157348
```

NOTE: all ID_CLI in df_7 are mapped in df_1, but not all ID_CLI in df_1 are mapped in df_7 !!!#

RESHAPING df_7

```
tickets_clean <- tickets_clean %>%
  ## adding day characterization ##
  mutate(TIC_DATE_WEEKDAY = wday(TIC_DATE)) %>%
  mutate(TIC_DATE_HOLIDAY = isHoliday("Italy", TIC_DATE)) %>%
  mutate(TIC_DATE_TYP = case_when(
    (TIC_DATE_WEEKDAY %in% c(6,7)) ~ "weekend"
    , (TIC_DATE_HOLIDAY == TRUE) ~ "holiday"
    , (TIC_DATE_WEEKDAY < 7) ~ "weekday"
    , TRUE ~ "other"
  )
)
```

EXPLORE VARIABLES in df_7

GENERAL OVERVIEW

```
## compute aggregate
df7_overview <- tickets_clean %>%
  summarise(MIN_DATE = min(TIC_DATE)
    , MAX_DATE = max(TIC_DATE)
    , TOT_TICs = n_distinct(ID_SCONTRINO)
    , TOT_CLIs = n_distinct(ID_CLI))

df7_overview
```

```
##   MIN_DATE  MAX_DATE TOT_TICs TOT_CLIs
## 1 2018-05-01 2019-04-30   998035   212124
```

Variable DIREZIONE

```
## compute aggregate
df7_dist_direction <- tickets_clean %>%
  group_by(DIREZIONE) %>%
  summarise(TOT_TICs = n_distinct(ID_SCONTRINO)
    , TOT_CLIs = n_distinct(ID_CLI)) %>%
  mutate(PERCENT_TICs = TOT_TICs/df7_overview$TOT_TICs
    , PERCENT_CLIs = TOT_CLIs/df7_overview$TOT_CLIs)

df7_dist_direction
```

```
## # A tibble: 2 x 5
```

```
##   DIREZIONE TOT_TICs TOT_CLIs PERCENT_TICs PERCENT_CLIs
```

```
##   <fct>         <int>    <int>         <dbl>         <dbl>
## 1 -1           90189    46622         0.0904         0.220
## 2 1            907846    212124        0.910          1
```

```
### Variable TIC_HOURS ###
```

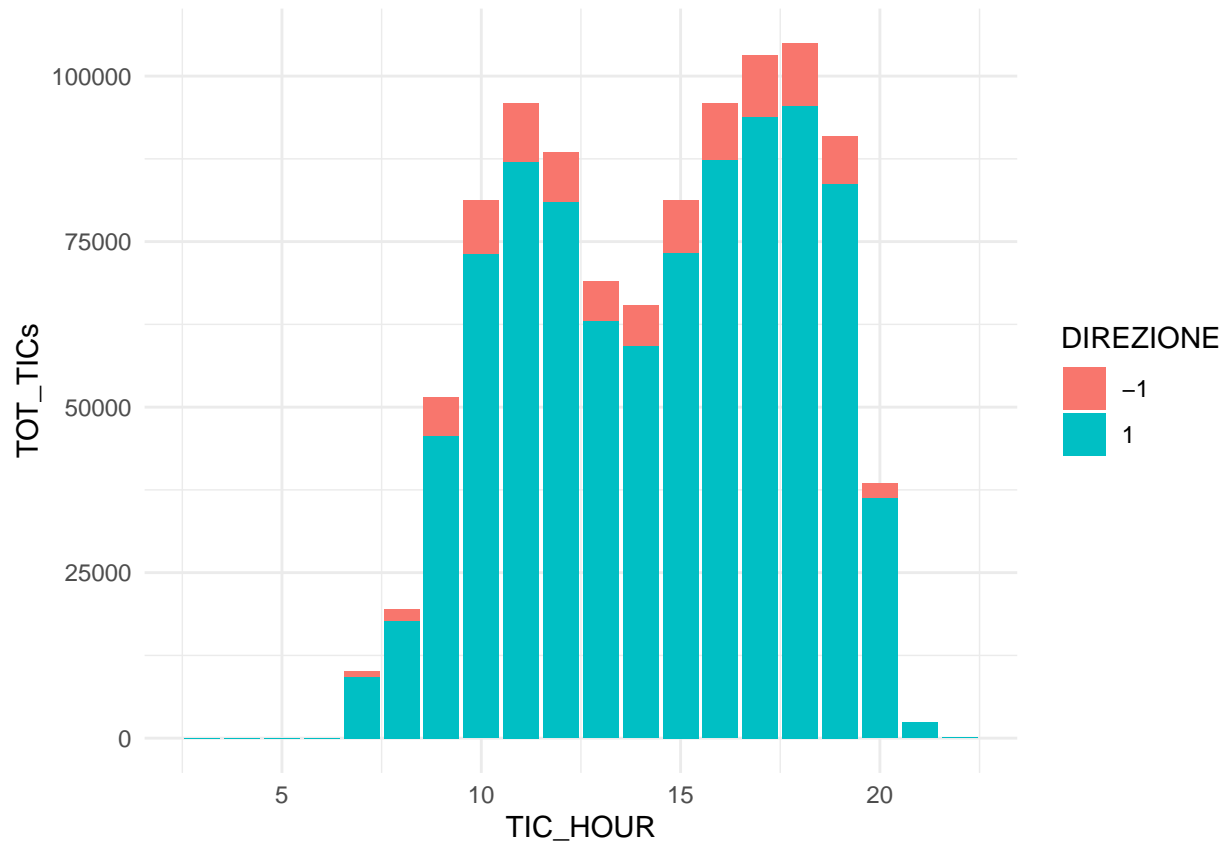
```
## compute aggregate
df7_dist_hour <- tickets_clean %>%
  group_by(TIC_HOUR, DIREZIONE) %>%
  summarise(TOT_TICs = n_distinct(ID_SCONTRINO)
            , TOT_CLIs = n_distinct(ID_CLI)) %>%
  left_join(df7_dist_direction %>%
            select(DIREZIONE
                  , ALL_TOT_TICs = TOT_TICs
                  , ALL_TOT_CLIs = TOT_CLIs)
            , by = 'DIREZIONE'
  ) %>%
  mutate(PERCENT_TICs = TOT_TICs/ALL_TOT_TICs
        , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%
  select(-ALL_TOT_TICs, -ALL_TOT_CLIs)

df7_dist_hour
```

```
## # A tibble: 36 x 6
## # Groups:   TIC_HOUR [20]
##   TIC_HOUR DIREZIONE TOT_TICs TOT_CLIs PERCENT_TICs PERCENT_CLIs
##   <int> <fct>         <int>    <int>         <dbl>         <dbl>
## 1      3 1           2        2    0.00000220    0.00000943
## 2      4 1           4        4    0.00000441    0.0000189
## 3      5 1           2        2    0.00000220    0.00000943
## 4      6 1          32       32    0.0000352     0.000151
## 5      7 -1         759      638    0.00842       0.0137
## 6      7 1         9249     6309    0.0102        0.0297
## 7      8 -1        1767     1468    0.0196        0.0315
## 8      8 1        17678     11624    0.0195        0.0548
## 9      9 -1         5888     4681    0.0653        0.100
## 10     9 1        45619     29290    0.0502        0.138
## # ... with 26 more rows
```

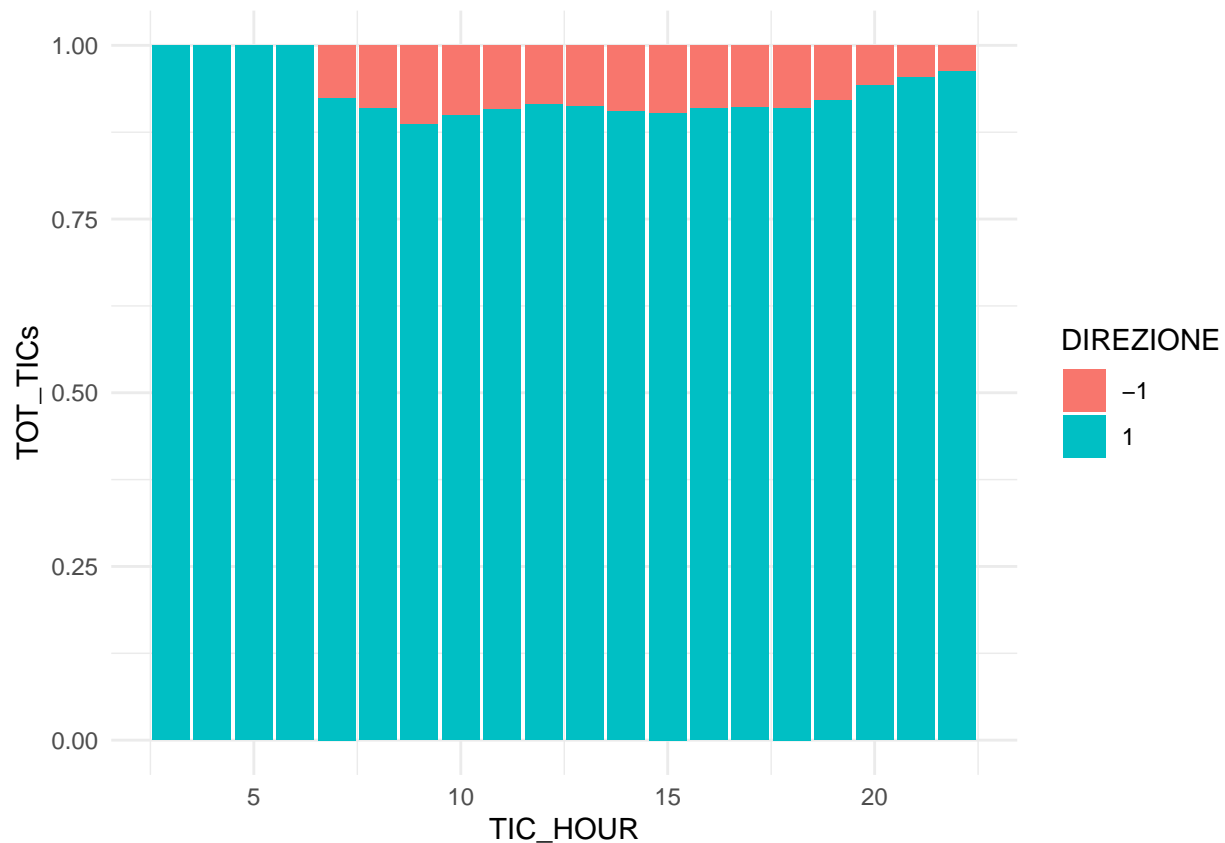
```
## plot aggregate
plot_df7_dist_hour <- (
  ggplot(data=df7_dist_hour
        , aes(fill=DIREZIONE, x=TIC_HOUR, y=TOT_TICs)) +
  geom_bar(stat="identity") +
  theme_minimal()
)

plot_df7_dist_hour
```



```
## plot aggregate percent
plot_df7_dist_hour_percent <- (
  ggplot(data=df7_dist_hour
    , aes(fill=DIREZIONE, x=TIC_HOUR, y=TOT_TICs)) +
    geom_bar(stat="identity", position="fill" ) +
    theme_minimal()
)

plot_df7_dist_hour_percent
```

```
### Variable COD_REPARTO ###
```

```
## compute aggregate
```

```
df7_dist_dep <- tickets_clean %>%
  group_by(COD_REPARTO, DIREZIONE) %>%
  summarise(TOT_TICs = n_distinct(ID_SCONTRINO)
            , TOT_CLIs = n_distinct(ID_CLI)) %>%
  left_join(df7_dist_direction %>%
            select(DIREZIONE
                  , ALL_TOT_TICs = TOT_TICs
                  , ALL_TOT_CLIs = TOT_CLIs)
            , by = 'DIREZIONE'
  ) %>%
  mutate(PERCENT_TICs = TOT_TICs/ALL_TOT_TICs
        , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%
  select(-ALL_TOT_TICs, -ALL_TOT_CLIs)
```

```
df7_dist_dep
```

```
## # A tibble: 28 x 6
```

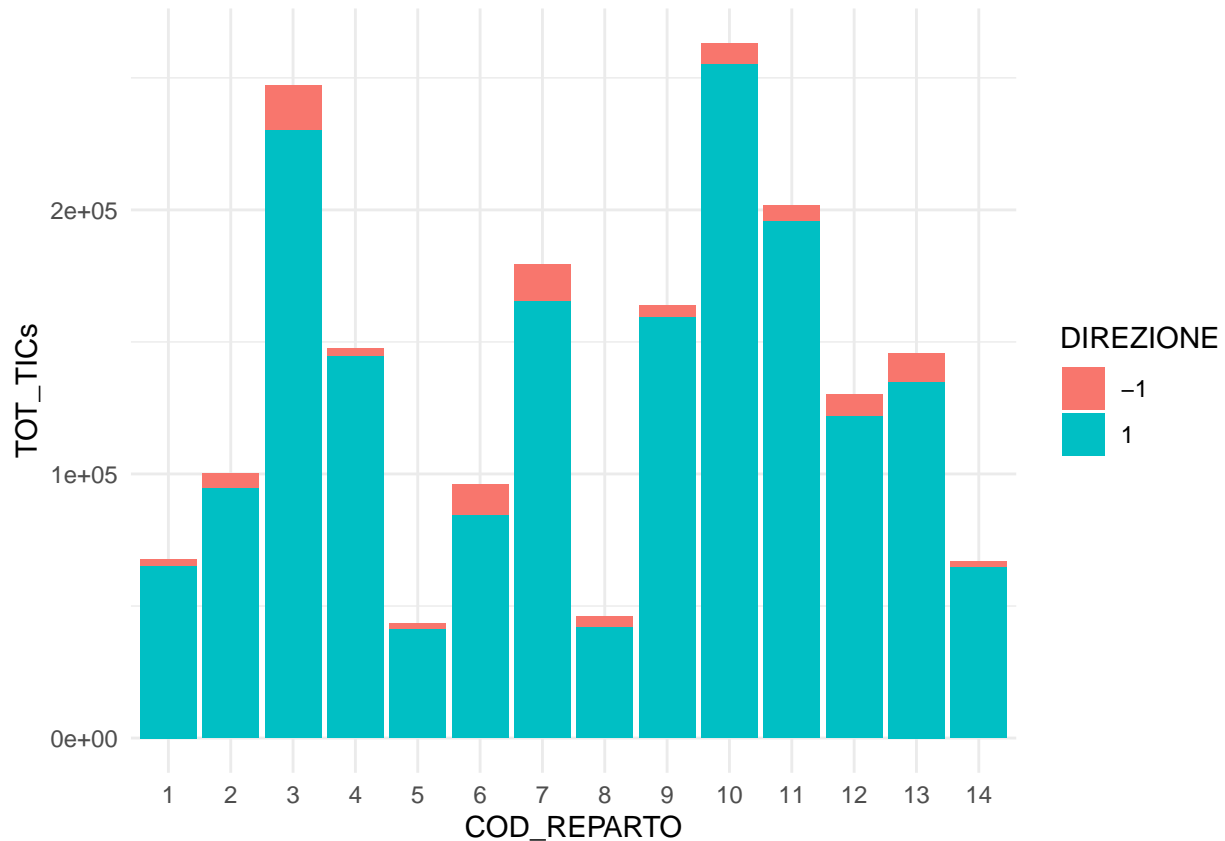
```
## # Groups:   COD_REPARTO [14]
```

```
##   COD_REPARTO DIREZIONE TOT_TICs TOT_CLIs PERCENT_TICs PERCENT_CLIs
##   <fct>       <fct>      <int>  <int>    <dbl>      <dbl>
## 1 1          -1         2512   1928    0.0279    0.0414
## 2 1           1        65151  30531   0.0718    0.144
## 3 2          -1         5604   4598    0.0621    0.0986
```

```
## 4 2      1      94618  54055      0.104      0.255
## 5 3     -1     17083  10835      0.189      0.232
## 6 3      1    229972  93224      0.253      0.439
## 7 4     -1      3139   2761      0.0348     0.0592
## 8 4      1   144544  73069      0.159      0.344
## 9 5     -1      2374   2035      0.0263     0.0436
## 10 5     1     41220  29916      0.0454     0.141
## # ... with 18 more rows
```

```
## plot aggregate
plot_df7_dist_dep <- (
  ggplot(data=df7_dist_dep
    , aes(fill=DIREZIONE, x=COD_REPARTO, y=TOT_TICs)) +
    geom_bar(stat="identity") +
    theme_minimal()
)

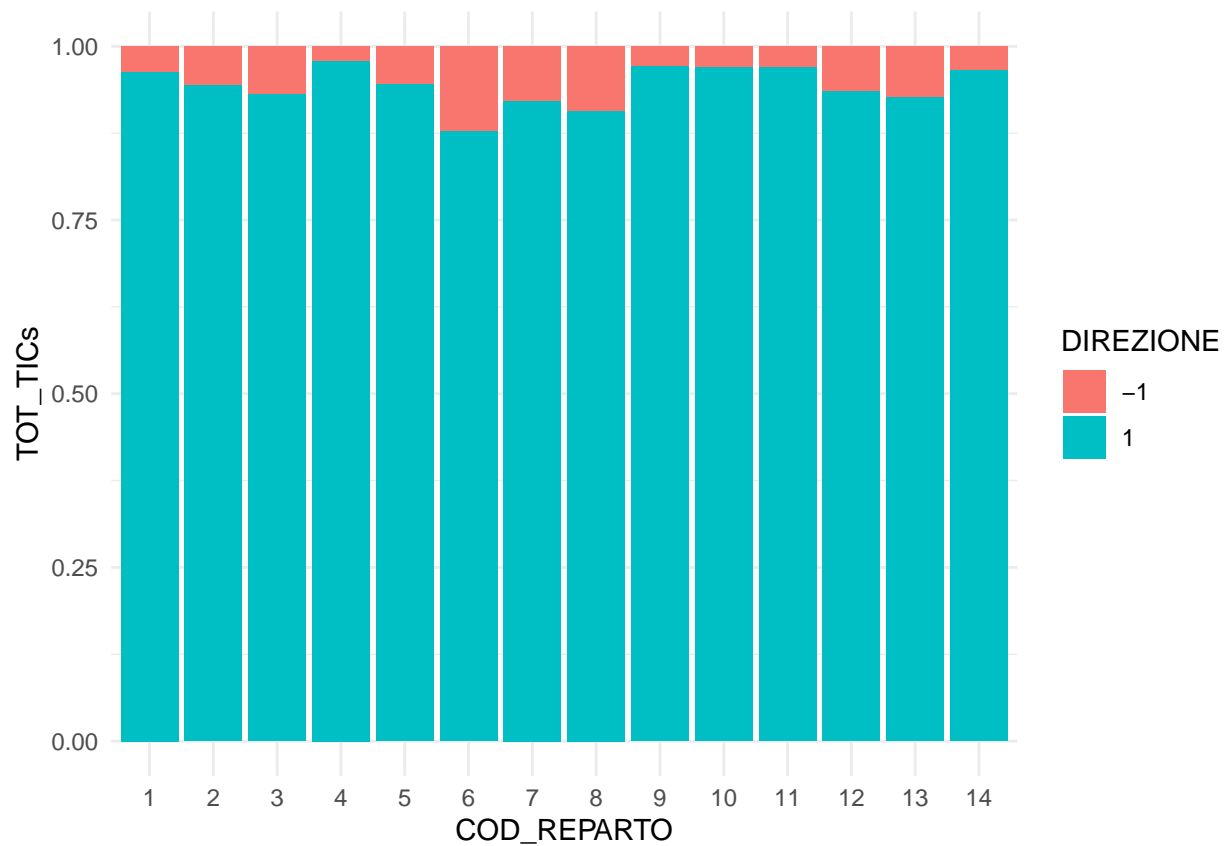
plot_df7_dist_dep
```



```
## plot aggregate percent
plot_df7_dist_dep_percent <- (
  ggplot(data=df7_dist_dep
    , aes(fill=DIREZIONE, x=COD_REPARTO, y=TOT_TICs)) +
    geom_bar(stat="identity", position="fill") +
    theme_minimal()
)
```

```
)
```

```
plot_df7_dist_dep_percent
```



```
### Variable TIC_DATE_TYP ###
```

```
## compute aggregate
```

```
df7_dist_datetyp <- tickets_clean %>%  
  group_by(TIC_DATE_TYP, DIREZIONE) %>%  
  summarise(TOT_TICs = n_distinct(ID_SCONTRINO)  
            , TOT_CLIs = n_distinct(ID_CLI)) %>%  
  left_join(df7_dist_direction %>%  
            select(DIREZIONE  
                  , ALL_TOT_TICs = TOT_TICs  
                  , ALL_TOT_CLIs = TOT_CLIs)  
            , by = 'DIREZIONE'  
  ) %>%  
  mutate(PERCENT_TICs = TOT_TICs/ALL_TOT_TICs  
        , PERCENT_CLIs = TOT_CLIs/ALL_TOT_CLIs) %>%  
  select(-ALL_TOT_TICs, -ALL_TOT_CLIs)
```

```
df7_dist_datetyp
```

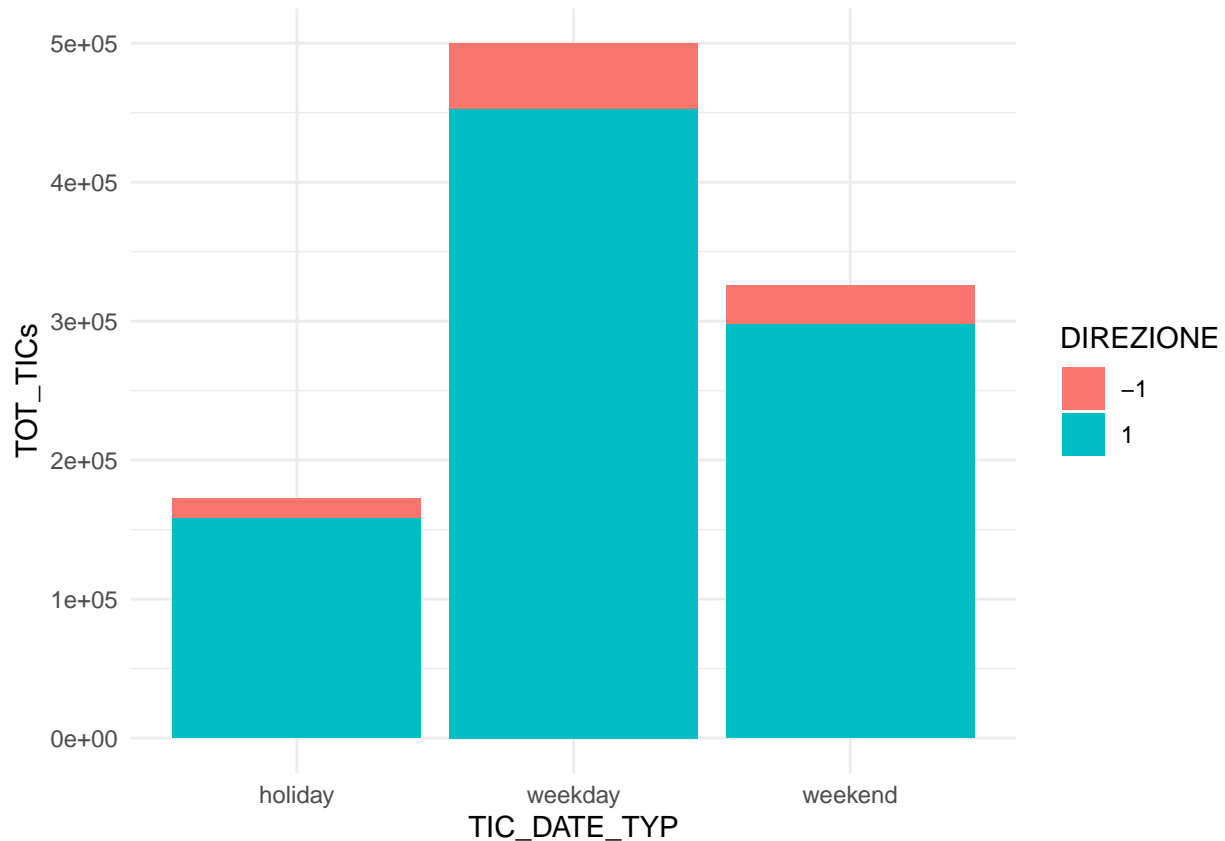
```
## # A tibble: 6 x 6
```

```
## # Groups:   TIC_DATE_TYP [3]
```

	TIC_DATE_TYP	DIREZIONE	TOT_TICs	TOT_CLIs	PERCENT_TICs	PERCENT_CLIs
	<chr>	<fct>	<int>	<int>	<dbl>	<dbl>
## 1	holiday	-1	14522	10759	0.161	0.231
## 2	holiday	1	157868	81742	0.174	0.385
## 3	weekday	-1	47294	28981	0.524	0.622
## 4	weekday	1	452679	153338	0.499	0.723
## 5	weekend	-1	28373	19565	0.315	0.420
## 6	weekend	1	297299	125137	0.327	0.590

```
## plot aggregate
plot_df7_dist_datetyp <- (
  ggplot(data=df7_dist_datetyp
    , aes(fill=DIREZIONE, x=TIC_DATE_TYP, y=TOT_TICs)) +
  geom_bar(stat="identity") +
  theme_minimal()
)

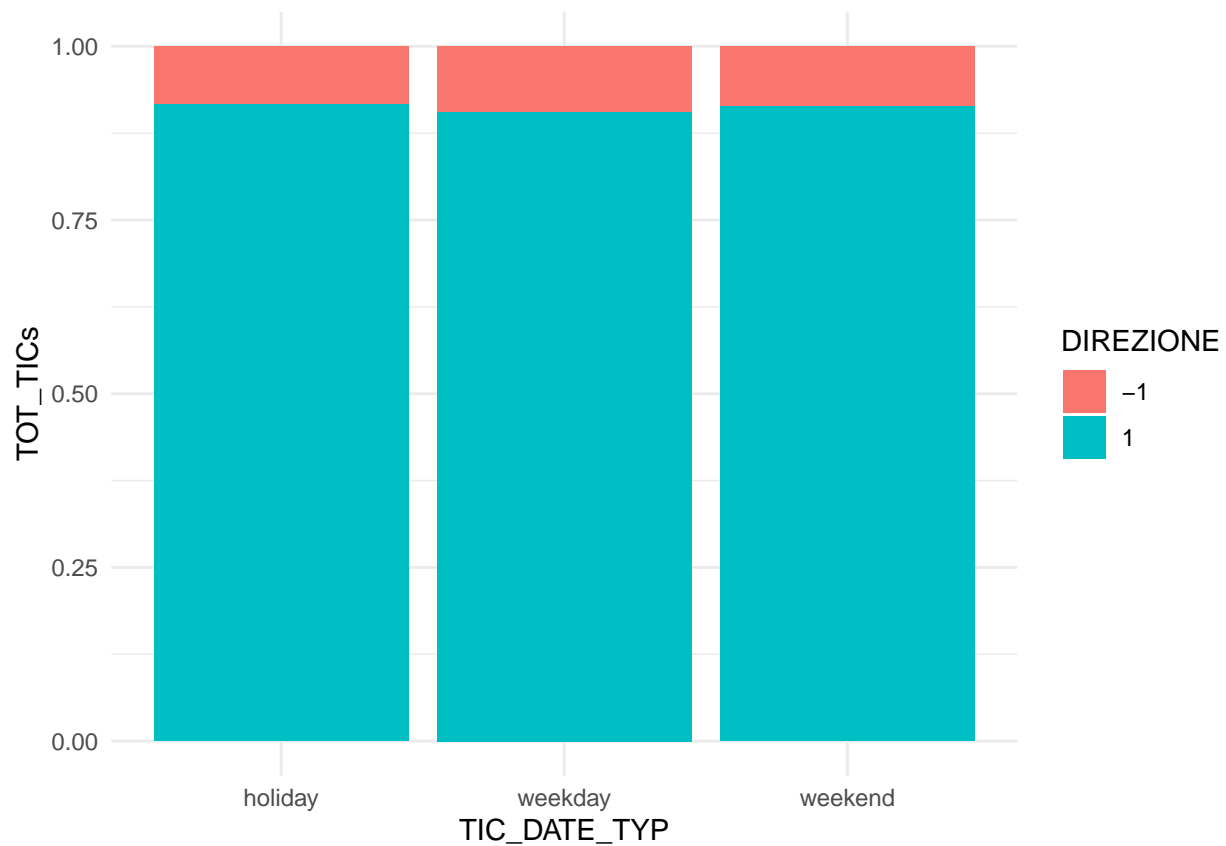
plot_df7_dist_datetyp
```



```
## plot aggregate percent
plot_df7_dist_datetyp_percent <- (
  ggplot(data=df7_dist_datetyp
    , aes(fill=DIREZIONE, x=TIC_DATE_TYP, y=TOT_TICs)) +
  geom_bar(stat="identity", position="fill" ) +
  theme_minimal()
)
```

)

plot_df7_dist_datetyp_percent



Variable average IMPORTO_LORDO and average SCONTO per TICKET

compute aggregate

```
df7_dist_importosconto <- tickets_clean %>%  
  group_by(ID_SCONTRINO, DIREZIONE) %>%  
  summarise(IMPORTO_LORDO = sum(IMPORTO_LORDO)  
            , SCONTO = sum(SCONTO)) %>%  
  ungroup() %>%  
  as.data.frame()
```

```
df7_dist_avgimportosconto <- df7_dist_importosconto %>%  
  group_by(DIREZIONE) %>%  
  summarise(AVG_IMPORTO_LORDO = mean(IMPORTO_LORDO)  
            , AVG_SCONTO = mean(SCONTO))
```

df7_dist_avgimportosconto

A tibble: 2 x 3

```
##   DIREZIONE AVG_IMPORTO_LORDO AVG_SCONTO  
##   <fct>      <dbl>      <dbl>  
## 1 -1        -110.      -8.29
```

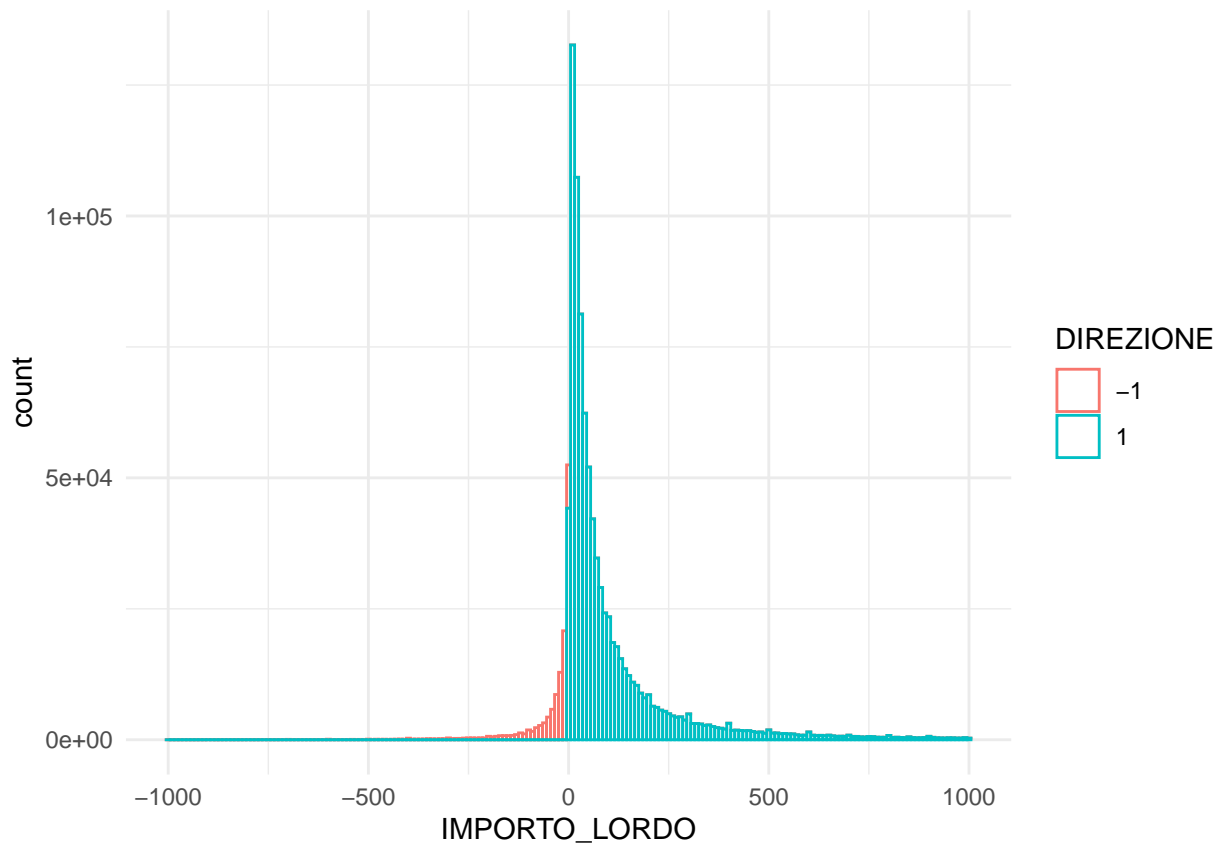
```
## 2 1
```

```
164.
```

```
11.8
```

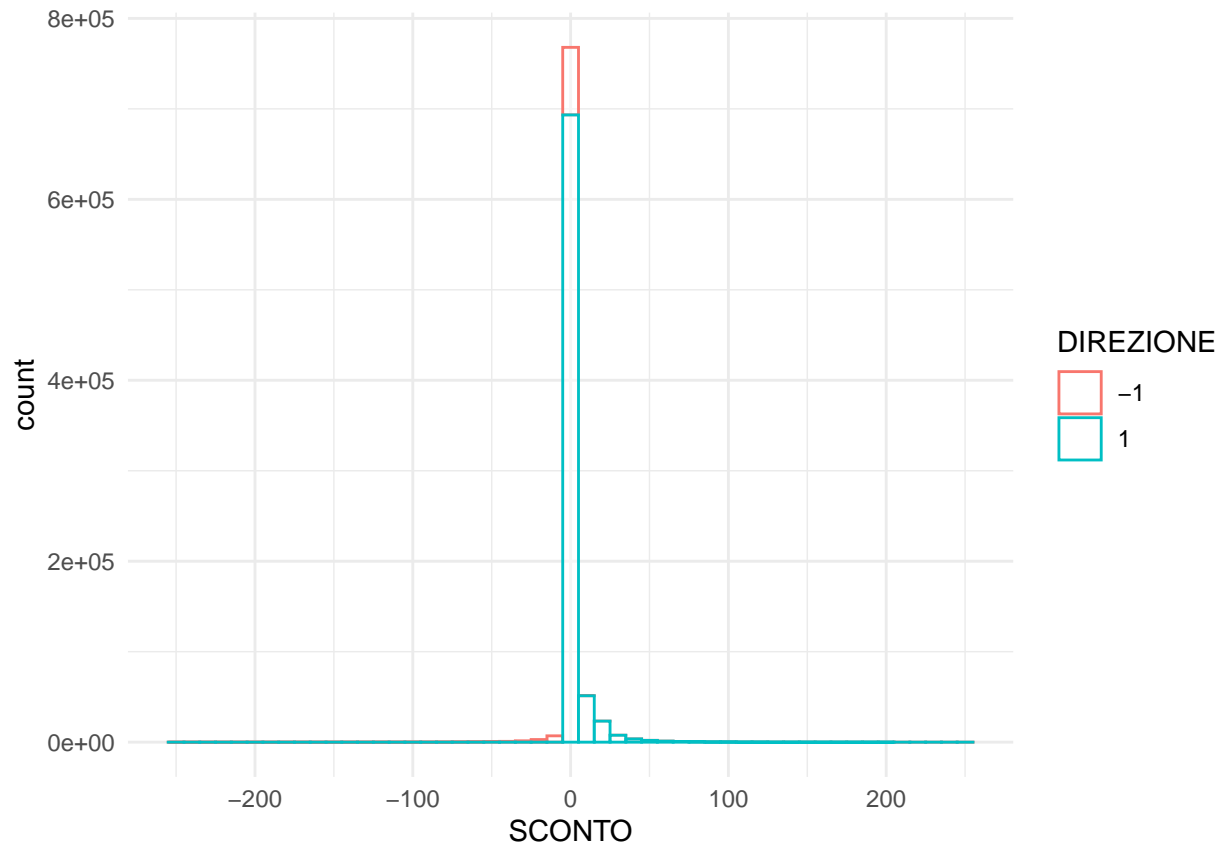
```
## plot aggregate
plot_df7_dist_importo <- (
  ggplot(data=df7_dist_importosconto %>%
    filter((IMPORTO_LORDO > -1000) & (IMPORTO_LORDO < 1000))
    , aes(color=DIREZIONE, x=IMPORTO_LORDO)) +
  geom_histogram(binwidth=10, fill="white", alpha=0.5) +
  theme_minimal()
)

plot_df7_dist_importo
```



```
## plot aggregate
plot_df7_dist_sconto <- (
  ggplot(data=df7_dist_importosconto %>%
    filter((SCONTO > -250) & (IMPORTO_LORDO < 250))
    , aes(color=DIREZIONE, x=SCONTO)) +
  geom_histogram(binwidth=10, fill="white", alpha=0.5) +
  theme_minimal()
)

plot_df7_dist_sconto
```



```
#### TO DO df_7 ####
# EXPLORE average IMPORTO_LORDO and average SCONTO by COD_REPARTO

## compute aggregate
df7_dist_importosconto_reparto <- tickets_clean %>%
  group_by(COD_REPARTO, DIREZIONE) %>%
  summarise(IMPORTO_LORDO = sum(IMPORTO_LORDO)
            , SCONTO = sum(SCONTO)) %>%
  ungroup() %>%
  as.data.frame()

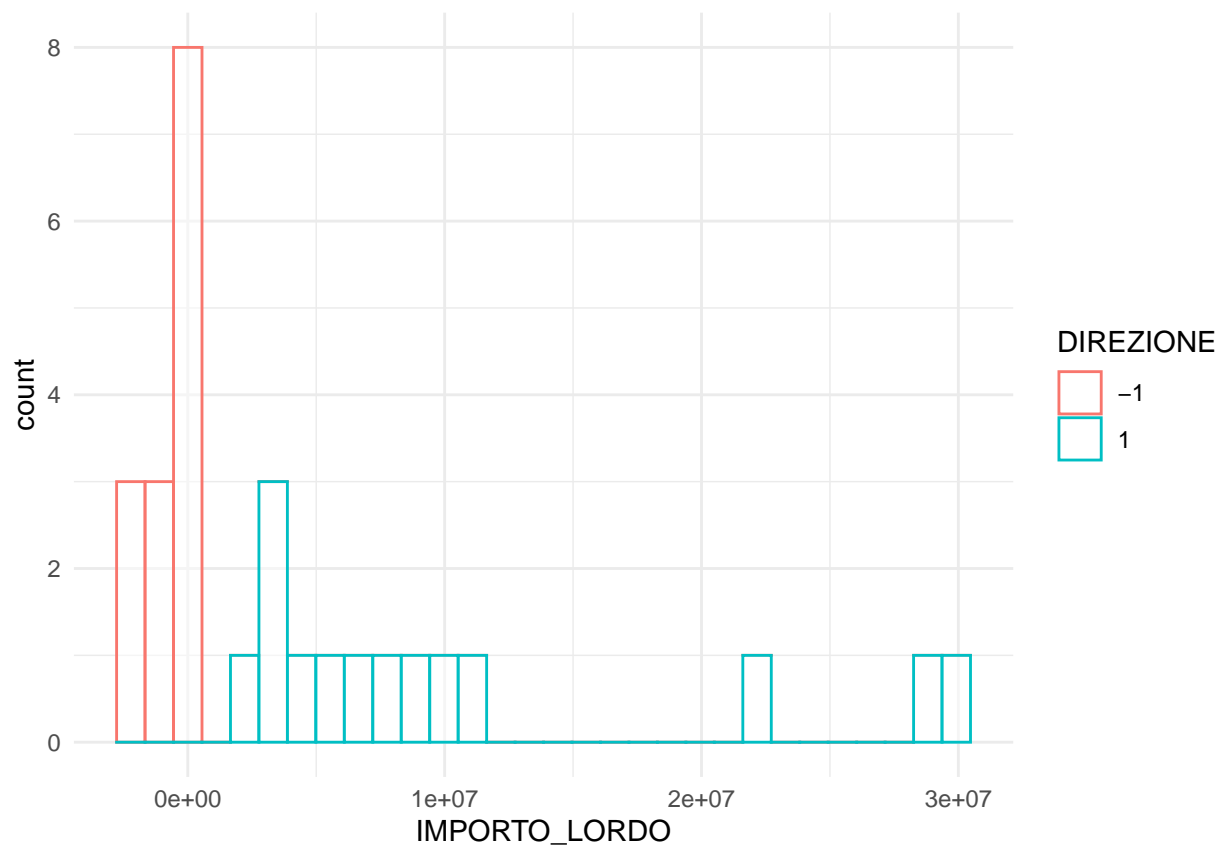
df7_dist_avgimportosconto_reparto <- df7_dist_importosconto_reparto %>%
  group_by(DIREZIONE) %>%
  summarise(AVG_IMPORTO_LORDO = mean(IMPORTO_LORDO)
            , AVG_SCONTO = mean(SCONTO))

df7_dist_avgimportosconto_reparto
```

```
## # A tibble: 2 x 3
##   DIREZIONE AVG_IMPORTO_LORDO AVG_SCONTO
##   <fct>         <dbl>         <dbl>
## 1 -1           -706252.      -53409.
## 2 1           10649178.     762487.
```

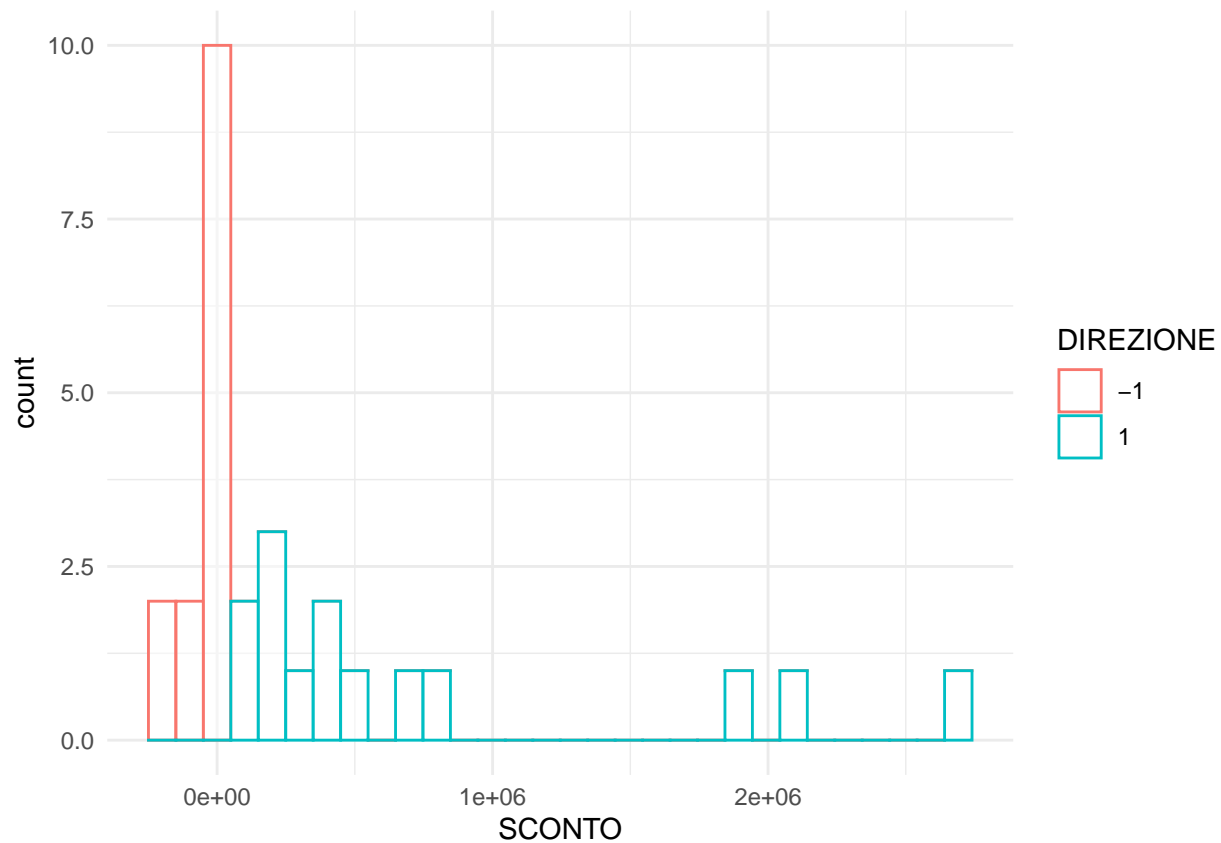
```
#-----
## plot aggregate
plot_df7_dist_importo_reparto <- (
  ggplot(data=df7_dist_importosconto_reparto %>%
    filter()
    , aes(color=DIREZIONE, x=IMPORTO_LORDO)) +
  geom_histogram(fill="white", alpha=0.5) +
  theme_minimal()
)

plot_df7_dist_importo_reparto
```



```
## plot aggregate
plot_df7_dist_sconto_reparto <- (
  ggplot(data=df7_dist_importosconto_reparto %>%
    filter()
    , aes(color=DIREZIONE, x=SCONTO)) +
  geom_histogram(fill="white", alpha=0.5) +
  theme_minimal()
)

plot_df7_dist_sconto_reparto
```

```
# -----
# EXPLORE ID_ARTICOLO DISTRIBUTIONS (i.e. num TICs by ID_ARTICOLO)

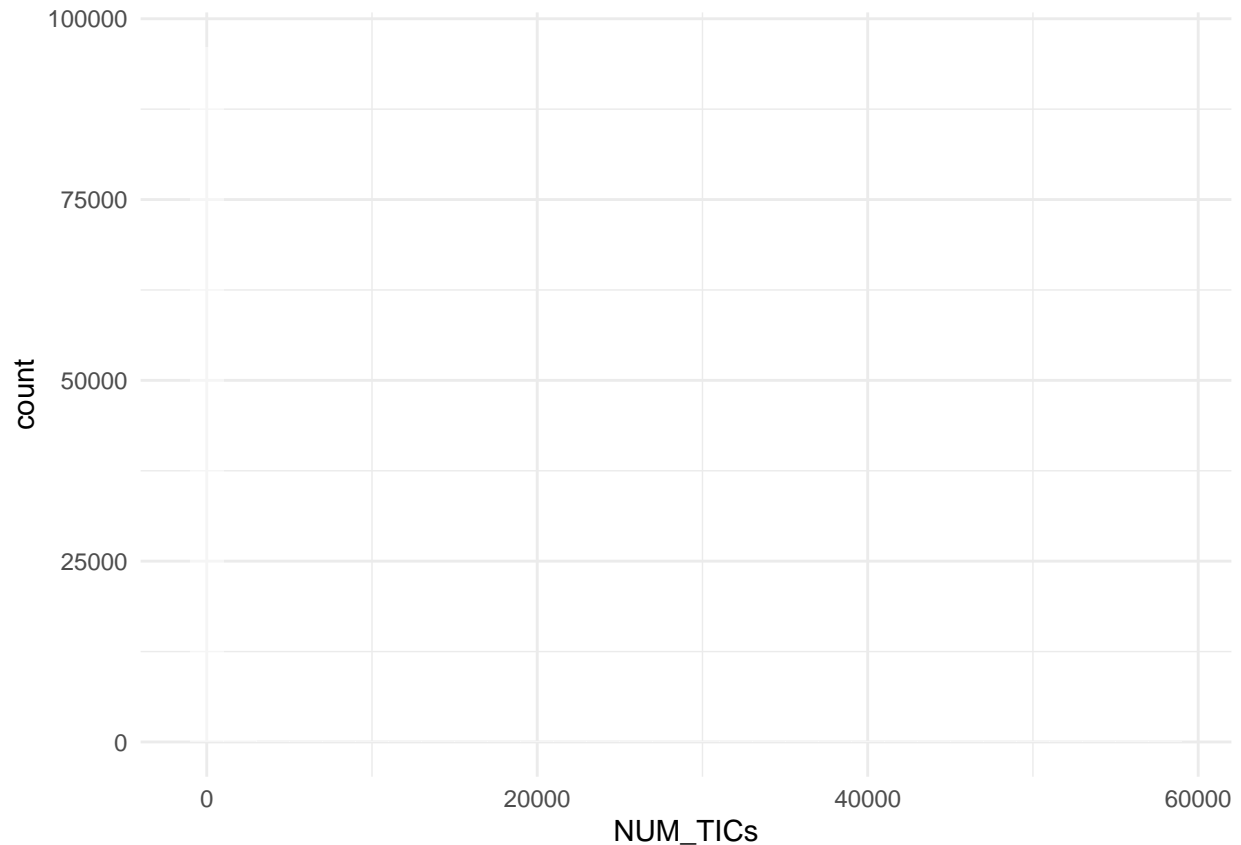
# number of tics per articolo
df7_dist_tics_articolo <-tickets_clean %>%
  group_by(ID_ARTICOLO) %>%
  summarise(NUM_TICs = sum(n_distinct(ID_SCONTRINO))) %>%
  ungroup()

df7_dist_tics_articolo
```

```
## # A tibble: 96,347 x 2
##   ID_ARTICOLO NUM_TICs
##   <int>      <int>
## 1     16921         5
## 2     16923        10
## 3     18278        30
## 4     18280        12
## 5     18296         8
## 6     44821         1
## 7     67396        66
## 8     92260        14
## 9    297003        28
## 10    297262        18
## # ... with 96,337 more rows
```

```
plot_df7_dist_tics_articolo <- (
  ggplot(data=df7_dist_tics_articolo %>%
    filter()
    , aes(color=ID_ARTICOLO, x=NUM_TICS)) +
  geom_histogram(fill="white", alpha=0.5) +
  theme_minimal()
)

plot_df7_dist_tics_articolo
```



```
# EXPLORE average IMPORTO_LORDO and average SCONTO per ID_CLI

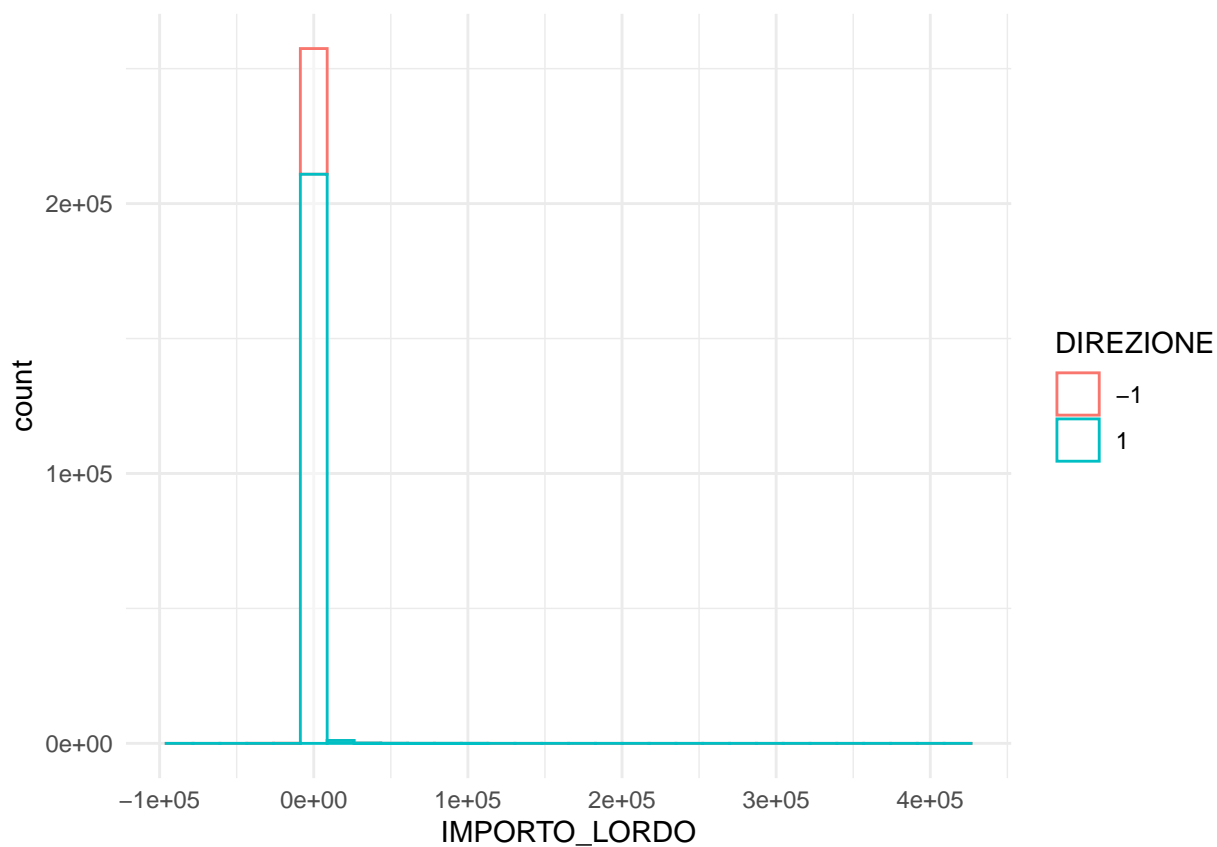
## compute aggregate
df7_dist_importosconto_cli <- tickets_clean %>%
  group_by(ID_CLI, DIREZIONE) %>%
  summarise(IMPORTO_LORDO = sum(IMPORTO_LORDO)
    , SCONTO = sum(SCONTO)) %>%
  ungroup() %>%
  as.data.frame()

df7_dist_avgimportosconto_cli <- df7_dist_importosconto_cli %>%
  group_by(DIREZIONE) %>%
  summarise(AVG_IMPORTO_LORDO = mean(IMPORTO_LORDO)
    , AVG_SCONTO = mean(SCONTO))
```

```
df7_dist_avgimportosconto_cli
```

```
## # A tibble: 2 x 3
##   DIREZIONE AVG_IMPORTO_LORDO AVG_SCONTO
##   <fct>      <dbl>      <dbl>
## 1 -1        -212.      -16.0
## 2 1         703.       50.3
```

```
#-----
## plot aggregate
plot_df7_dist_importo_cli <- (
  ggplot(data=df7_dist_importosconto_cli %>%
    filter()
    , aes(color=DIREZIONE, x=IMPORTO_LORDO)) +
  geom_histogram(fill="white", alpha=0.5) +
  theme_minimal()
)
plot_df7_dist_importo_cli
```

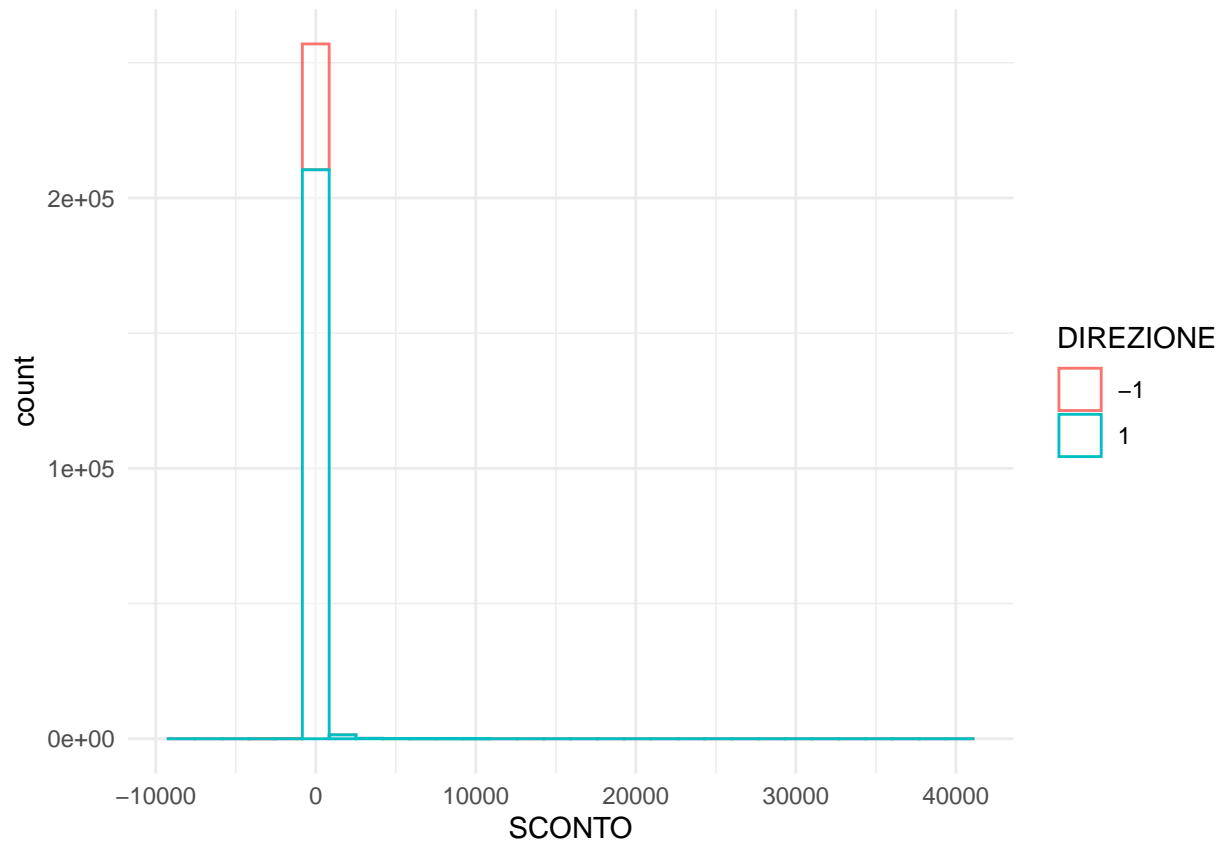


```
## plot aggregate
plot_df7_dist_sconto_cli <- (
  ggplot(data=df7_dist_importosconto_cli %>%
    filter()
```

```

    , aes(color=DIREZIONE, x=SCONTO)) +
    geom_histogram(fill="white", alpha=0.5) +
    theme_minimal()
)
plot_df7_dist_sconto_cli

```



```

# -----

# compute the distribution of customers by number of purchases (as described in the slides)

df7_dist_total_purch <- tickets_clean %>%
  filter(DIREZIONE == 1) %>%
  group_by(ID_CLI) %>%
  summarise(TOT_PURCHASE = n_distinct(ID_SCONTRINO)) %>%
  arrange(desc(TOT_PURCHASE))

df7_dist_total_purch

## # A tibble: 212,124 x 2
##   ID_CLI TOT_PURCHASE
##   <int>     <int>
## 1 376925         177
## 2 117212         155

```

```
## 3 248975      154
## 4 341579      149
## 5  99384      147
## 6 362177      146
## 7 150014      136
## 8 162298      133
## 9 187412      132
## 10 140765     131
## # ... with 212,114 more rows
```

```
# compute the days for next purchase curve (as described in the slides)
#TROPPO TEMPO A RUNNARE
```

```
#data_for_next_purchase <- tickets_clean %>%
# filter(DIREZIONE == 1) %>% #-- Only Purchases
#select(ID_CLI,
#       ID_ARTICOLO,
#       TIC_DATE,
#       DIREZIONE) %>% #-- Variable Selection
#arrange(ID_CLI)
#data_for_next_purchase
```

```
#df_np <- data_for_next_purchase %>%
# group_by(ID_CLI) %>%
#mutate(Diff = TIC_DATE - lag(TIC_DATE))
```

```
#data_for_next_purchase
```

```
#df_days_curve <- as.data.frame(table(df_date_diff$Days_difference))
#colnames(df_days_curve) <- c("Days_diff", "Freq")
#df_days_curve <- df_days_curve[-1, ]
#df_days_curve$Perc <- df_days_curve$Freq/sum(df_days_curve$Freq)
```

```
#df_days_curve
```

```
#### FINAL REVIEW df_7_clean ####
```

```
str(tickets_clean)
```

```
## 'data.frame': 4263220 obs. of 14 variables:
## $ ID_SCONTRINO : chr "51299709701/05/18718488513770" "51299709701/05/18718488513770" "513994069
## $ ID_CLI : int 318714 318714 324419 332611 325589 325589 56975 323722 323722 320632 ...
## $ ID_NEG : int 48 48 47 36 35 35 20 27 27 48 ...
## $ ID_ARTICOLO : int 34216854 34216854 36167733 32404540 35811412 35811741 36167733 34326222 34
## $ COD_REPARTO : Factor w/ 14 levels "1","2","3","4",...: 2 2 9 13 9 9 9 12 12 9 ...
## $ DIREZIONE : Factor w/ 2 levels "-1","1": 2 2 2 2 2 2 2 2 2 ...
## $ IMPORTO_LORDO : num 22.8 22.8 1290 134 399 ...
## $ SCONTO : num 0.05 0 491 34.1 0 0 491 0 0 10.9 ...
## $ TIC_DATETIME : POSIXct, format: "2018-05-01 07:18:48" "2018-05-01 07:18:48" ...
## $ TIC_HOUR : int 7 7 7 7 7 7 7 7 7 ...
## $ TIC_DATE : Date, format: "2018-05-01" "2018-05-01" ...
## $ TIC_DATE_WEEKDAY: num 3 3 3 3 3 3 3 3 3 ...
```

```
## $ TIC_DATE_HOLIDAY: logi TRUE TRUE TRUE TRUE TRUE TRUE ...
## $ TIC_DATE_TYP      : chr "holiday" "holiday" "holiday" "holiday" ...
```

```
summary(tickets_clean)
```

```
## ID_SCONTRINO      ID_CLI      ID_NEG      ID_ARTICOLO
## Length:4263220    Min.      : 5    Min.      : 2.00    Min.      : 16921
## Class :character   1st Qu.:211201  1st Qu.:14.00    1st Qu.:34141800
## Mode  :character   Median :411821  Median :27.00    Median :35558446
##                      Mean  :411433  Mean  :25.93    Mean  :38022591
##                      3rd Qu.:601672  3rd Qu.:38.00    3rd Qu.:36144465
##                      Max.   :934729  Max.   :49.00    Max.   :82231481
##
## COD_REPARTO      DIREZIONE    IMPORTO_LORDO      SCONTO
## 3      : 870478    -1: 241788    Min.      :-17465.00    Min.      :-2472.000
## 10     : 497667    1 :4021432    1st Qu.: 2.67    1st Qu.: 0.000
## 11     : 440747          Median : 7.50    Median : 0.000
## 7      : 427446          Mean  : 32.65    Mean  : 2.329
## 9      : 357451          3rd Qu.: 22.00    3rd Qu.: 0.000
## 13     : 295028          Max.   : 17465.00    Max.   : 4853.590
## (Other):1374403
## TIC_DATETIME      TIC_HOUR      TIC_DATE
## Min.      :2018-05-01 07:18:48    Min.      : 3.00    Min.      :2018-05-01
## 1st Qu.:2018-08-12 14:05:04    1st Qu.:11.00    1st Qu.:2018-08-12
## Median :2018-11-09 16:37:45    Median :15.00    Median :2018-11-09
## Mean  :2018-11-06 03:19:32    Mean  :14.42    Mean  :2018-11-05
## 3rd Qu.:2019-02-02 12:49:36    3rd Qu.:17.00    3rd Qu.:2019-02-02
## Max.   :2019-04-30 21:57:25    Max.   :22.00    Max.   :2019-04-30
##
## TIC_DATE_WEEKDAY TIC_DATE_HOLIDAY TIC_DATE_TYP
## Min.      :1.000    Mode :logical    Length:4263220
## 1st Qu.:2.000    FALSE:2656938    Class :character
## Median :4.000    TRUE :1606282    Mode  :character
## Mean  :4.096
## 3rd Qu.:6.000
## Max.   :7.000
##
```

```
tickets_clean1 <- tickets_clean
```

```
#modello RFM
```

```
rfm_study_period <- tickets_clean %>%
  filter(TIC_DATE > as.Date("01/01/2018",
                             format = "%d/%m/%Y")) #-- Active Clients
```

```
#RECENCY
```

```
rfm_recency <- rfm_study_period %>%
  group_by(ID_CLI) %>% #-- Grouped By Clients
  summarise(LAST_PURCHASE_DATE = max(TIC_DATE))
```

```

rfm_recency$RECENCY <- difftime(as.Date("30/04/2019",
                                     format = "%d/%m/%Y"),      #-- Recency
                                rfm_recency$LAST_PURCHASE_DATE,
                                units = "days")

#MONETARY

rfm_monetary <- rfm_study_period %>%
  filter(DIREZIONE == 1) %>% #-- Only Purchases
  group_by(ID_CLI) %>% #-- Grouped By Clients
  summarise(IMPORTO_LORDO = sum(IMPORTO_LORDO),
            SCONTO = sum(SCONTO),
            SPESA = IMPORTO_LORDO - SCONTO) %>%
  ungroup() %>%
  as.data.frame() %>%
  arrange(desc(IMPORTO_LORDO))

#FREQUENCY

rfm_frequency <- rfm_study_period %>%
  filter(DIREZIONE == 1) %>% #-- Only Purchases
  group_by(ID_CLI) %>% #-- Grouped By Clients
  summarise(TOT_PURCHASE = n_distinct(ID_SCONTRINO)) %>%
  arrange(desc(TOT_PURCHASE))

#MERGE

rfm <- merge(rfm_frequency, #-- Frequency
             rfm_monetary, #-- Monetary
             by = "ID_CLI") #-- Key for Merge
rfm <- merge(rfm, #-- Frequency + Monetary
             rfm_recency, #-- Recency
             by = "ID_CLI") #-- Key for Merge

tickets_clean<- rfm

df<-tickets_clean[, c("ID_CLI", "LAST_PURCHASE_DATE", "TOT_PURCHASE", "IMPORTO_LORDO")]
colnames(df)[c(1,2,4)]<-c("tIDColName", "tDateColName", "tAmountColName")

getDataFrame <- function(df, startDate, endDate, tIDColName="tIDColName", tDateColName="tDateColName", tAmountColName="tAmountColName")

#order the dataframe by date descendingly
df <- df[order(df[,tDateColName],decreasing = TRUE),]

#remove the record before the start data and after the end Date

```

```

df <- df[df[,tDateColName]>= startDate,]
df <- df[df[,tDateColName]<= endDate,]

#remove the rows with the duplicated IDs, and assign the df to a new df.
newdf <- df[!duplicated(df[,tIDColName]),]

# caculate the Recency(days) to the endDate, the smaller days value means more recent
Recency<-as.numeric(difftime(endDate,newdf[,tDateColName],units="days"))

# add the Days column to the newdf data frame
newdf <-cbind(newdf,Recency)

#order the dataframe by ID to fit the return order of table() and tapply()
newdf <- newdf[order(newdf[,tIDColName]),]

# caculate the frequency
fre <- as.data.frame(table(df[,tIDColName]))
Frequency <- fre[,2]
newdf <- cbind(newdf,Frequency)

#caculate the Money per deal
m <- as.data.frame(tapply(df[,tAmountColName],df[,tIDColName],sum))
Monetary <- m[,1]/Frequency
newdf <- cbind(newdf,Monetary)

return(newdf)

} # end of function getDataFrame

#function getIndependentScore

getIndependentScore <- function(df,r=5,f=5,m=5) {

  if (r<=0 || f<=0 || m<=0) return

  #order and the score
  df <- df[order(df$Recency,-df$Frequency,-df$Monetary),]
  R_Score <- scoring(df,"Recency",r)
  df <- cbind(df, R_Score)

  df <- df[order(-df$Frequency,df$Recency,-df$Monetary),]
  F_Score <- scoring(df,"Frequency",f)
  df <- cbind(df, F_Score)

  df <- df[order(-df$Monetary,df$Recency,-df$Frequency),]
  M_Score <- scoring(df,"Monetary",m)
  df <- cbind(df, M_Score)

  #order the dataframe by R_Score, F_Score, and M_Score desc
  df <- df[order(-df$R_Score,-df$F_Score,-df$M_Score),]

```



```

# caculate the total score
Total_Score <- c(100*df$R_Score + 10*df$F_Score+df$M_Score)

df <- cbind(df,Total_Score)

return (df)

} # end of function getIndependentScore

#Score function

scoring <- function (df,column,r=5){

  #get the length of rows of df
  len <- dim(df)[1]

  score <- rep(0,times=len)

  # get the quantity of rows per 1/r e.g. 1/5
  nr <- round(len / r)
  if (nr > 0){

    # seperate the rows by r aliquots
    rStart <-0
    rEnd <- 0
    for (i in 1:r){

      #set the start row number and end row number
      rStart = rEnd+1

      #skip one "i" if the rStart is already in the i+1 or i+2 or ...scope.
      if (rStart> i*nr) next

      if (i == r){
        if(rStart<=len ) rEnd <- len else next
      }else{
        rEnd <- i*nr
      }

      # set the Recency score
      score[rStart:rEnd]<- r-i+1

      # make sure the customer who have the same recency have the same score
      s <- rEnd+1
      if(i<r & s <= len){
        for(u in s: len){
          if(df[rEnd,column]==df[u,column]){
            score[u]<- r-i+1
            rEnd <- u
          }else{

```

```

        break;
      }
    }

  }

}

}

return(score)
} #end of function Scoring

# set the start and the end date of the analysis
startDate<-as.Date('2018-01-09')
endDate<-as.Date('2019-04-30')
df <- getDataFrame(df,startDate,endDate)

df1 <-getIndependentScore(df)

df1 <- df1[,-4]

##Draw the histograms in the R, F, and M dimensions so that we can see the distribution of customers in

drawHistograms <- function(df,r=5,f=5,m=5){

  #set the layout plot window
  par(mfrow = c(f,r))

  names <-rep("",times=m)
  for(i in 1:m) names[i]<-paste("M",i)

  for (i in 1:f){
    for (j in 1:r){
      c <- rep(0,times=m)
      for(k in 1:m){
        tmpdf <-df[df$R_Score==j & df$F_Score==i & df$M_Score==k,]
        c[k]<- dim(tmpdf)[1]

      }
      if (i==1 & j==1)
        barplot(c,col="lightblue",names.arg=names)
      else
        barplot(c,col="lightblue")
      if (j==1) title(ylab=paste("F",i))
      if (i==1) title(main=paste("R",j))

    }
  }

  par(mfrow = c(1,1))

```

```

} # end of drawHistograms function

#drawHistograms(df1)  margini ampii

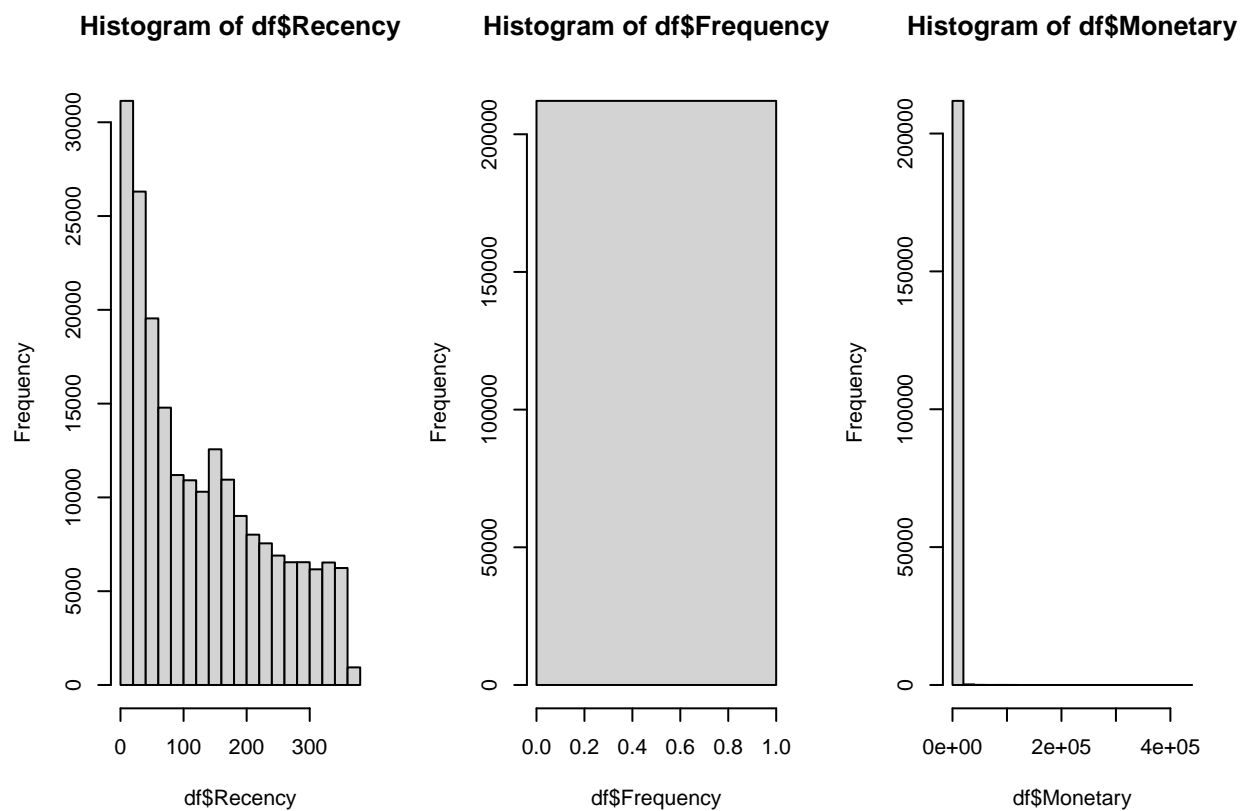
par(mfrow = c(1,3))

hist(df$Recency)

hist(df$Frequency)

hist(df$Monetary)

```



```

S500<-df1[df1$Total_Score>500,]

dim(S500)

```

```
## [1] 42533    10
```

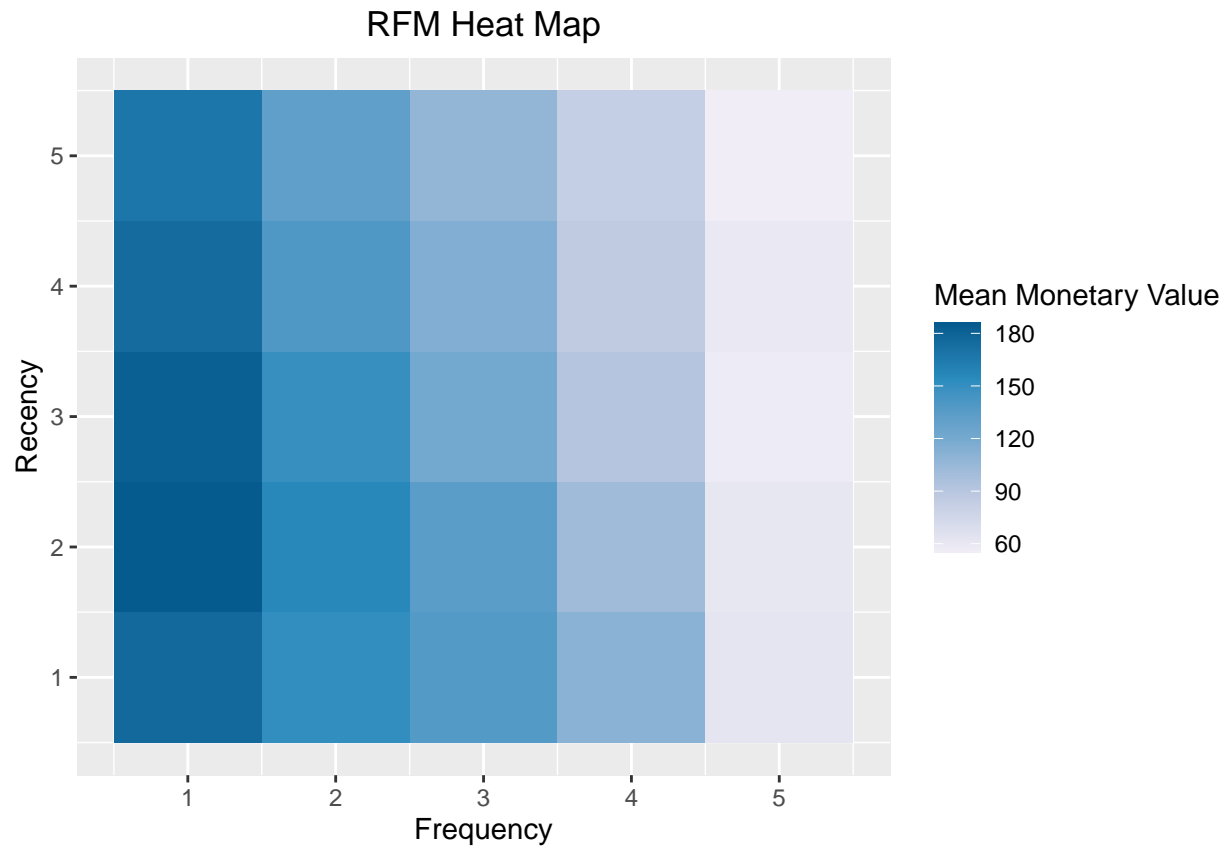
```

df_1<-df1[, c("tIDColName","TOT_PURCHASE","Monetary","Recency","tDateColName")]
colnames(df_1)[c(1,2,3,4,5)] <- c("customer_id","number_of_orders","revenue","recency_days","analysis_date")
rfm_data_customer<-df_1

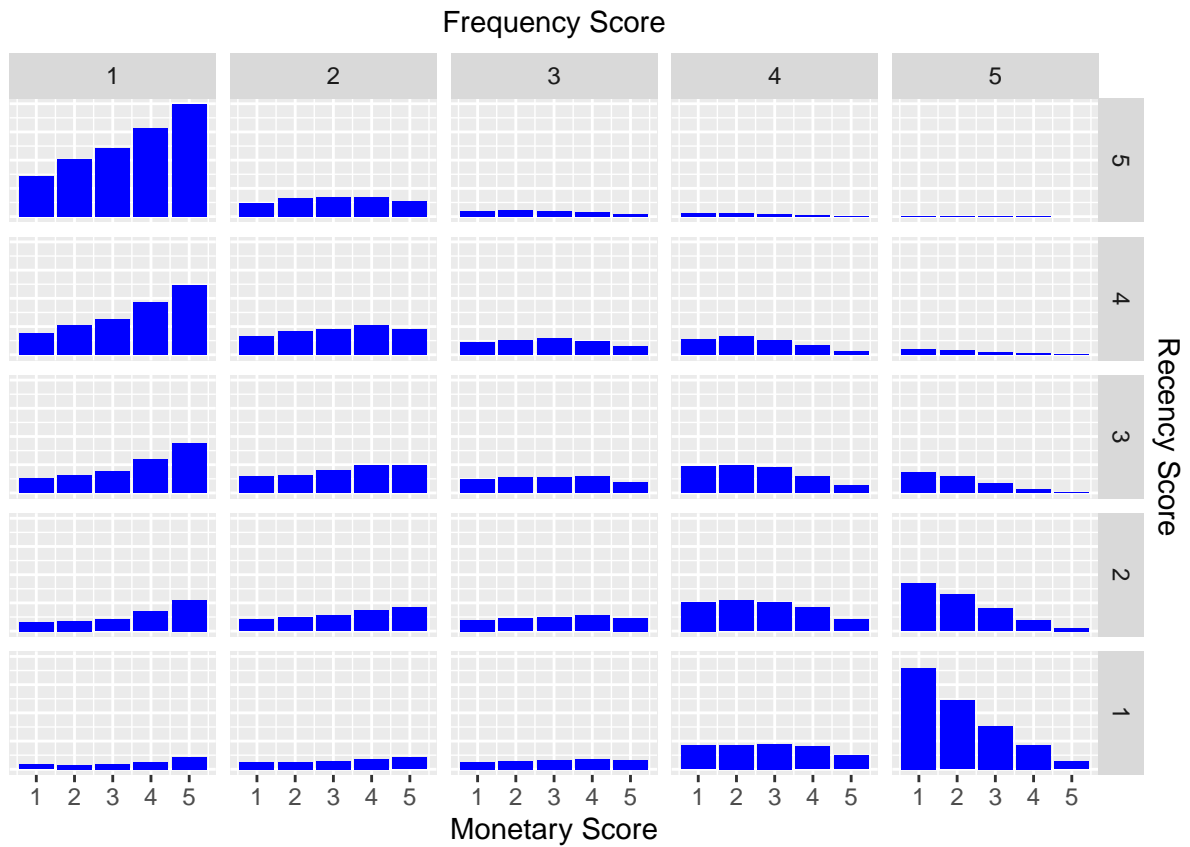
analysis_date <- lubridate::as_date('2018-04-30')

```

```
rfm_result<- rfm_table_customer(rfm_data_customer, customer_id, number_of_orders, revenue,recency_days,  
  
rfm_heatmap(rfm_result)
```

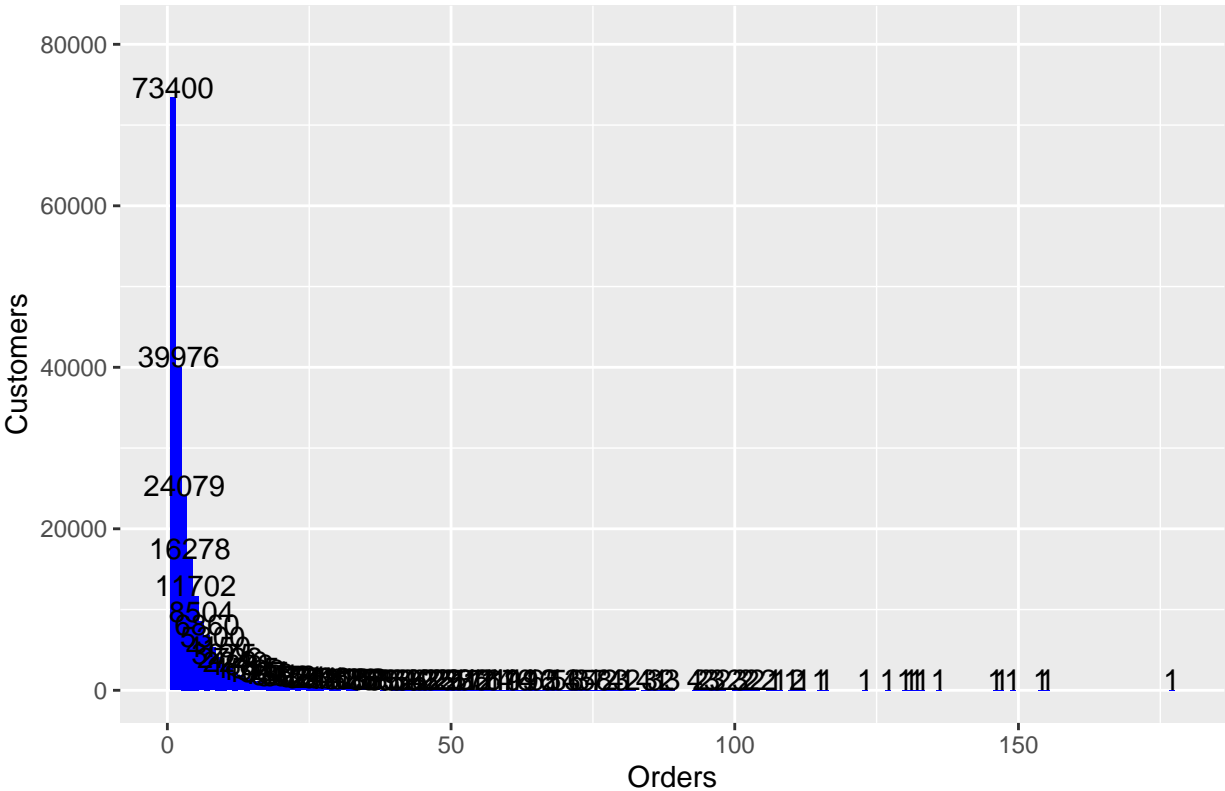


```
rfm_bar_chart(rfm_result)
```



```
rfm_order_dist(rfm_result)
```

Customers by Orders



#name of segments

```
segment <- c(
  "Champions", "Loyal Customers", "Potential Loyalist",
  "New Customers", "Promising", "Need Attention",
  "About To Sleep", "At Risk", "Can't Lose Them", "Hibernating",
  "Lost"
)
description <- c(
  "Bought recently, buy often and spend the most",
  "Spend good money. Responsive to promotions",
  "Recent customers, spent good amount, bought more than once",
  "Bought more recently, but not often",
  "Recent shoppers, but haven't spent much",
  "Above average recency, frequency & monetary values",
  "Below average recency, frequency & monetary values",
  "Spent big money, purchased often but long time ago",
  "Made big purchases and often, but long time ago",
  "Low spenders, low frequency, purchased long time ago",
  "Lowest recency, frequency & monetary scores"
)
recency <- c("4 - 5", "2 - 5", "3 - 5", "4 - 5", "3 - 4", "2 - 3", "2 - 3", "<= 2", "<= 1", "1 - 2", "<= 0")
frequency <- c("4 - 5", "3 - 5", "1 - 3", "<= 1", "<= 1", "2 - 3", "<= 2", "2 - 5", "4 - 5", "1 - 2", "<= 0")
monetary <- c("4 - 5", "3 - 5", "1 - 3", "<= 1", "<= 1", "2 - 3", "<= 2", "2 - 5", "4 - 5", "1 - 2", "<= 0")
segments <- tibble(
  Segment = segment, Description = description,
```

```
R = recency, `F` = frequency, M = monetary
)

segments %>%
  kable() %>%
  kable_styling(full_width = TRUE, font_size = 12)
```

Segment	Description	R	F	M
Champions	Bought recently, buy often and spend the most	4 - 5	4 - 5	4 - 5
Loyal Customers	Spend good money. Responsive to promotions	2 - 5	3 - 5	3 - 5
Potential Loyalist	Recent customers, spent good amount, bought more than once	3 - 5	1 - 3	1 - 3
New Customers	Bought more recently, but not often	4 - 5	<= 1	<= 1
Promising	Recent shoppers, but haven't spent much	3 - 4	<= 1	<= 1
Need Attention	Above average recency, frequency & monetary values	2 - 3	2 - 3	2 - 3
About To Sleep	Below average recency, frequency & monetary values	2 - 3	<= 2	<= 2
At Risk	Spent big money, purchased often but long time ago	<= 2	2 - 5	2 - 5
Can't Lose Them	Made big purchases and often, but long time ago	<= 1	4 - 5	4 - 5
Hibernating	Low spenders, low frequency, purchased long time ago	1 - 2	1 - 2	1 - 2
Lost	Lowest recency, frequency & monetary scores	<= 2	<= 2	<= 2


```

segment_names <- c("Champions", "Loyal Customers", "Potential Loyalist",
                  "New Customers", "Promising", "Need Attention", "About To Sleep",
                  "At Risk", "Can't Lose Them", "Lost")

recency_lower <- c(4, 2, 3, 4, 3, 2, 2, 1, 1, 1)
recency_upper <- c(5, 5, 5, 5, 4, 3, 3, 2, 1, 2)
frequency_lower <- c(4, 3, 1, 1, 1, 2, 1, 2, 4, 1)
frequency_upper <- c(5, 5, 3, 1, 1, 3, 2, 5, 5, 2)
monetary_lower <- c(4, 3, 1, 1, 1, 2, 1, 2, 4, 1)
monetary_upper <- c(5, 5, 3, 1, 1, 3, 2, 5, 5, 2)

segments <- rfm_segment(rfm_result, segment_names, recency_lower, recency_upper, frequency_lower, frequ

segments<- rfm_segment(rfm_result, segment_names, recency_lower, recency_upper,
                      frequency_lower, frequency_upper, monetary_lower, monetary_upper)

#use datatable
#segments %>%
#  datatable(
#    filter = "top",
#    options = list(pageLength = 9, autoWidth = TRUE),
#    colnames = c(
#      "Index", "Customer", "Segment", "RFM",
#      "Orders", "Total Spend", "R", "F", "M", "amount"
#    )
#  )
# )
# collegamento html, link nelle slide

#verifica

segments %>%
  count(segment) %>%
  arrange(desc(n)) %>%
  rename(Segment = segment, Count = n)

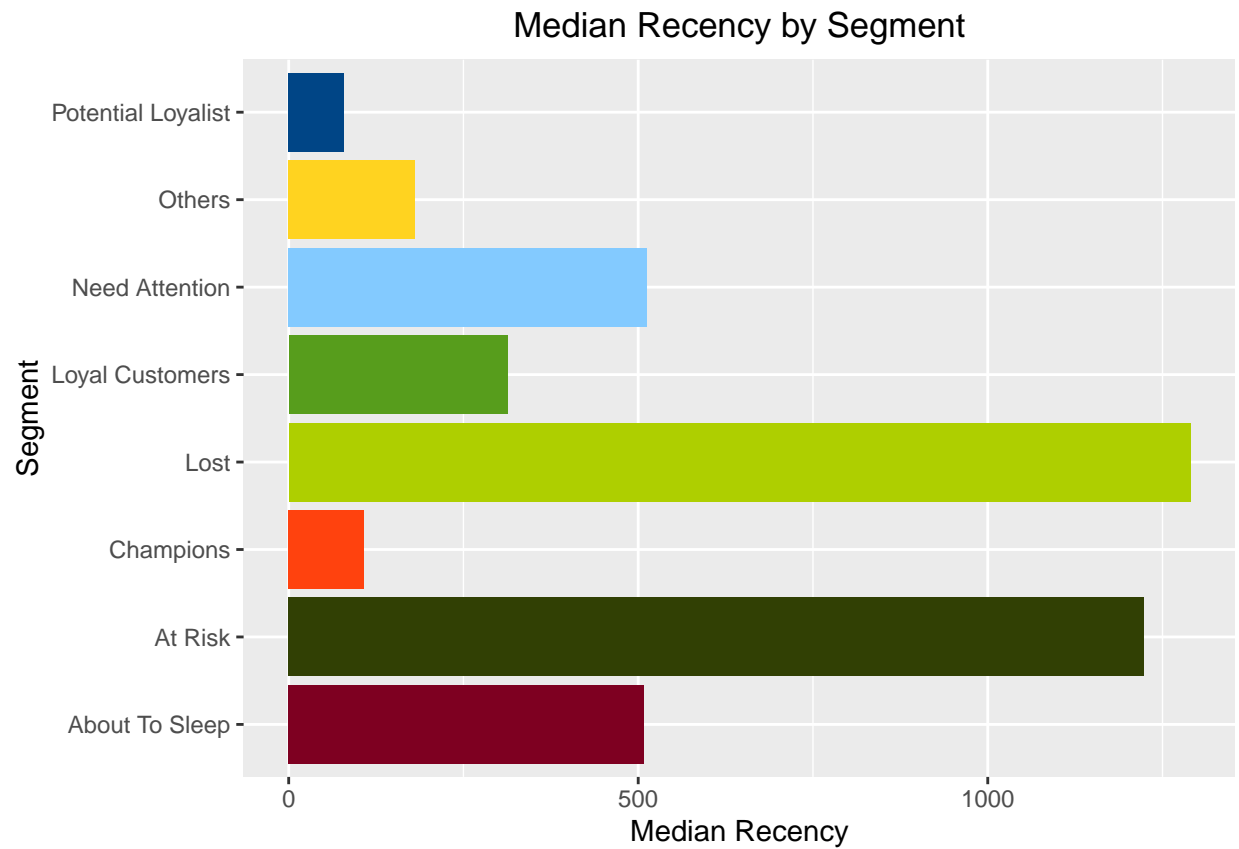
```

```

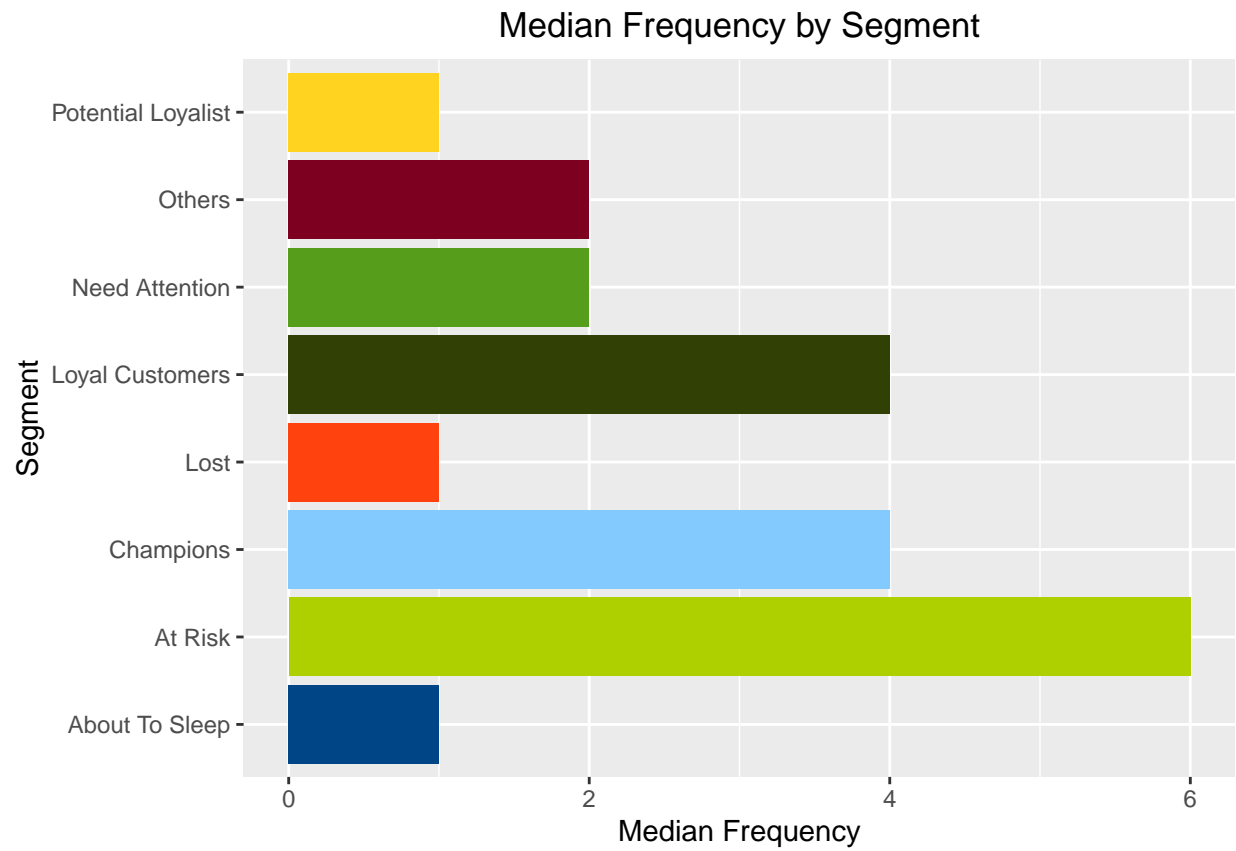
##           Segment Count
## 1           Others 88627
## 2 Potential Loyalist 48746
## 3           At Risk 36892
## 4   Loyal Customers 28507
## 5     Need Attention  3702
## 6   About To Sleep  2747
## 7         Champions  1464
## 8             Lost   1439

```

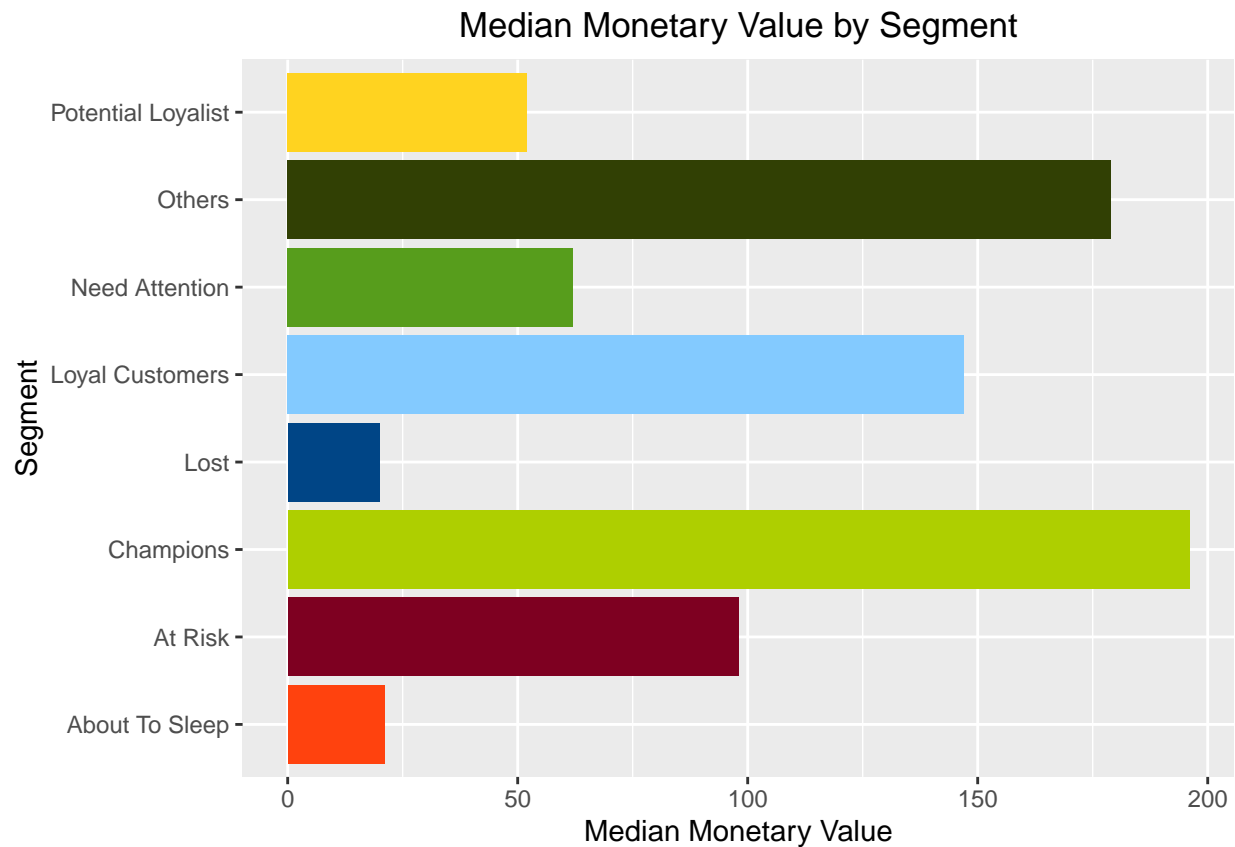
```
rfm_plot_median_recency(segments)
```



```
rfm_plot_median_frequency(segments)
```



```
rfm_plot_median_monetary(segments)
```



#MODELLO CHURN###

```
tickets_clean <- tickets_clean1
```

```
churn_study_period <- tickets_clean %>%
  filter(TIC_DATE < as.Date("01/01/2019",
                             format = "%d/%m/%Y"),
         TIC_DATE > as.Date("01/10/2018",
                             format = "%d/%m/%Y"))
```

```
churn_recency <- churn_study_period %>%
  filter(DIREZIONE == 1) %>%
  group_by(ID_CLI) %>%
  summarise(LAST_PURCHASE_DATE = max(TIC_DATE))
churn_recency$RECECY <- difftime(as.Date("01/01/2019",
                                         format = "%d/%m/%Y"),
                                churn_recency$LAST_PURCHASE_DATE,
                                units = "days")
```

#-- Recency

#HOLDOUT

```
churn_holdout <- tickets_clean %>%
  filter(DIREZIONE == 1,
```

```

    TIC_DATE <- as.Date("28/02/2019",
                        format = "%d/%m/%Y"),
    TIC_DATE > as.Date("01/01/2019",
                        format = "%d/%m/%Y"))
no_churner <- unique(churn_holdout$ID_CLI)

#-- Frequency to Merge
churn_frequency <- churn_study_period %>%
  filter(DIREZIONE == 1) %>%
  group_by(ID_CLI) %>%
  summarise(TOT_PURCHASE = n_distinct(ID_SCONTRINO)) %>%
  arrange(desc(TOT_PURCHASE))

#-- Monetary to Merge
churn_monetary <- churn_study_period %>%
  filter(DIREZIONE == 1) %>%
  group_by(ID_CLI) %>%
  summarise(IMPORTO_LORDO = sum(IMPORTO_LORDO),
            SCONTO = sum(SCONTO),
            SPESA = (IMPORTO_LORDO - SCONTO)) %>%
  ungroup() %>%
  as.data.frame() %>%
  arrange(desc(IMPORTO_LORDO))
churn <- merge(churn_recency, churn_frequency, by = "ID_CLI")
churn <- merge(churn, churn_monetary, by = "ID_CLI") %>%
  select(ID_CLI,
         REGENCY,
         SPESA,
         TOT_PURCHASE)

#Assign each customer a target variable 0/1 so that 1 is assigned to customers who have shaken in the h

churn$CHURN <- 1
for (i in c(1:nrow(churn))){
  if (churn$ID_CLI[i] %in% no_churner) churn$CHURN[i] <- 0
}
churn$CHURN <- as.factor(churn$CHURN)
table(churn$CHURN)

##
##      0      1
## 35373 59752

#Defining a set of potentially relevant variables to be computed within the lookback period:

churn <- left_join(churn, df_2_cli_account_clean[, c("ID_CLI", "TYP_JOB")], by = "ID_CLI") #-- Add Typ
churn <- left_join(churn, df_1_cli_fid_clean[, c("ID_CLI", "LAST_COD_FID")], by = "ID_CLI") #-- Add Typ
region <- left_join(df_2_cli_account_clean[, c("ID_CLI", "ID_ADDRESS")],
                   df_3_cli_address_clean[, c("ID_ADDRESS", "REGION")], by = "ID_ADDRESS") #-- Add Reg

```

```

churn <- left_join(churn, region, by = "ID_CLI")

#train test split
colnames(churn) <- c("ID_CLI", "REGENCY", "SPESA", "TOT_PURCHASE", "CHURN", "TYP_JOB", "LAST_COD_FID", "RE")

churn <- na.omit(churn)
train_index <- createDataPartition(churn$CHURN,
                                   p = .70,
                                   list = FALSE,
                                   times = 1)

train <- churn[train_index,]
test <- churn[-train_index,]
table(train$CHURN)

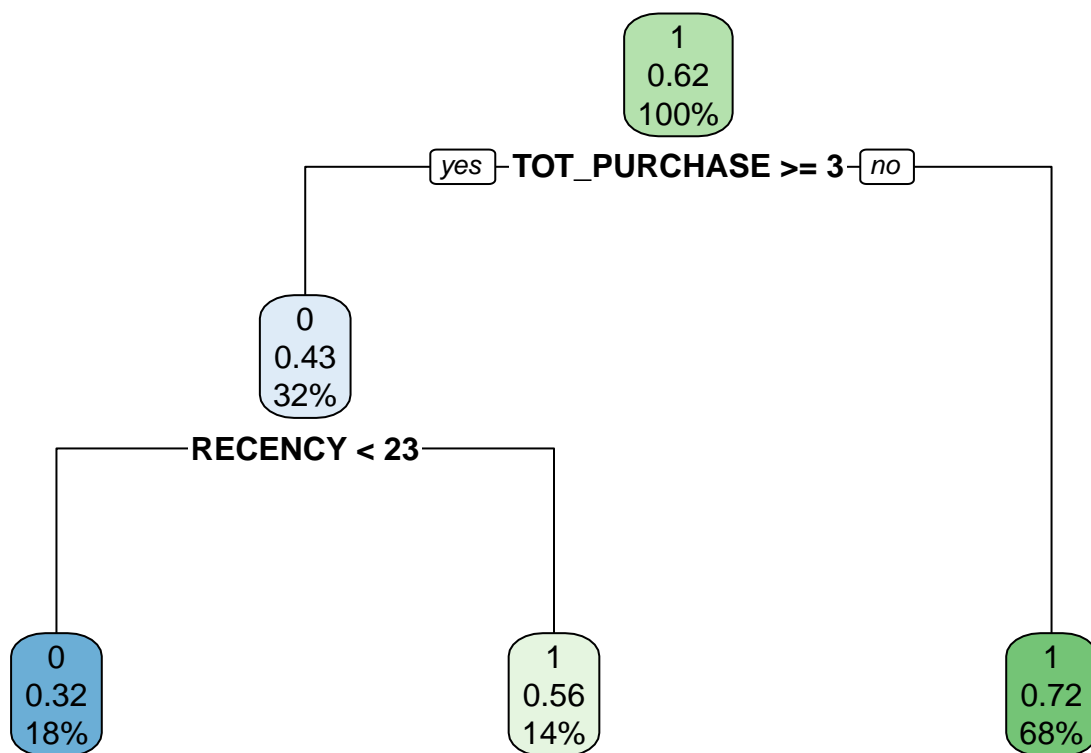
##
##      0      1
## 23972 39886

# Regression Trees (`tree`);
# Random Forest (`tree_rf`);
# Logistic Regression (`logistic`);

#REGRESSION TREE

tree <- rpart(CHURN ~ REGENCY + SPESA + TOT_PURCHASE + REGION + TYP_JOB,
              data = train)
rpart.plot(tree, extra = "auto")

```



```
summary(tree) ##-- num di acquisti è la variabile più importante
```

```
## Call:
## rpart(formula = CHURN ~ RECENCY + SPESA + TOT_PURCHASE + REGION +
##       TYP_JOB, data = train)
##   n= 63858
##
##           CP nsplit rel error   xerror   xstd
## 1 0.12431170      0 1.0000000 1.0000000 0.005104468
## 2 0.04601201      1 0.8756883 0.8734357 0.004948636
## 3 0.01000000      2 0.8296763 0.8325964 0.004886352
##
## Variable importance
## TOT_PURCHASE      RECENCY      SPESA
##           65           20           15
##
## Node number 1: 63858 observations,   complexity param=0.1243117
##   predicted class=1 expected loss=0.3753954 P(node) =1
##   class counts: 23972 39886
##   probabilities: 0.375 0.625
##   left son=2 (20676 obs) right son=3 (43182 obs)
##   Primary splits:
##     TOT_PURCHASE < 2.5      to the right, improve=2365.26700, (0 missing)
##     RECENCY          < 22.5  to the left,  improve=1820.92100, (0 missing)
##     SPESA            < 500.975 to the right, improve= 443.96030, (0 missing)
```

```

##      REGION      < 738243   to the right, improve= 92.87060, (0 missing)
##      TYP_JOB      splits as LLLLLLRLRLRLRLR, improve= 66.60719, (0 missing)
## Surrogate splits:
##      SPESA      < 300.955   to the right, agree=0.752, adj=0.233, (0 split)
##      RECENCY < 13.5        to the left,  agree=0.698, adj=0.067, (0 split)
##      REGION      < 744989   to the right, agree=0.677, adj=0.001, (0 split)
##      TYP_JOB splits as  RLRRRRRRRRRLRR, agree=0.676, adj=0.000, (0 split)
##
## Node number 2: 20676 observations,      complexity param=0.04601201
## predicted class=0 expected loss=0.4279358 P(node) =0.3237809
## class counts: 11828 8848
## probabilities: 0.572 0.428
## left son=4 (11493 obs) right son=5 (9183 obs)
## Primary splits:
##      RECENCY      < 22.5      to the left,  improve=576.75380, (0 missing)
##      TOT_PURCHASE < 5.5        to the right, improve=466.52420, (0 missing)
##      SPESA      < 1926.115 to the right, improve= 53.02154, (0 missing)
##      REGION      < 708682   to the right, improve= 35.93063, (0 missing)
##      TYP_JOB      splits as LLRLLLRLRLRLRLR, improve= 16.63414, (0 missing)
## Surrogate splits:
##      TOT_PURCHASE < 3.5        to the right, agree=0.610, adj=0.122, (0 split)
##      SPESA      < 60.435   to the right, agree=0.557, adj=0.002, (0 split)
##      REGION      < 825630.5 to the left,  agree=0.556, adj=0.001, (0 split)
##
## Node number 3: 43182 observations
## predicted class=1 expected loss=0.2812283 P(node) =0.6762191
## class counts: 12144 31038
## probabilities: 0.281 0.719
##
## Node number 4: 11493 observations
## predicted class=0 expected loss=0.3223701 P(node) =0.1799774
## class counts: 7788 3705
## probabilities: 0.678 0.322
##
## Node number 5: 9183 observations
## predicted class=1 expected loss=0.4399434 P(node) =0.1438034
## class counts: 4040 5143
## probabilities: 0.440 0.560

```

```

printcp(tree) #-- complexity parameter

```

```

##
## Classification tree:
## rpart(formula = CHURN ~ RECENCY + SPESA + TOT_PURCHASE + REGION +
##      TYP_JOB, data = train)
##
## Variables actually used in tree construction:
## [1] RECENCY      TOT_PURCHASE
##
## Root node error: 23972/63858 = 0.3754
##
## n= 63858
##
##      CP nsplit rel error  xerror      xstd

```



```
## 1 0.124312      0    1.00000 1.00000 0.0051045
## 2 0.046012      1    0.87569 0.87344 0.0049486
## 3 0.010000      2    0.82968 0.83260 0.0048864
```

#RANDOM FOREST

```
memory.limit(100000)
```

```
## [1] 1e+05
```

```
tree_rf <- randomForest(CHURN ~ RECENTY + SPESA + TOT_PURCHASE + REGION + TYP_JOB,
                        data = train, ntree = 100)
print(tree_rf)
```

```
##
```

```
## Call:
```

```
## randomForest(formula = CHURN ~ RECENTY + SPESA + TOT_PURCHASE + REGION + TYP_JOB, data = train
```

```
##           Type of random forest: classification
```

```
##           Number of trees: 100
```

```
## No. of variables tried at each split: 2
```

```
##
```

```
##           OOB estimate of  error rate: 31.47%
```

```
## Confusion matrix:
```

```
##           0      1 class.error
```

```
## 0 9659 14313  0.5970716
```

```
## 1 5783 34103  0.1449882
```

#LOGISTIC REGRESSION

```
logistic <- train(CHURN ~ RECENTY + SPESA + TOT_PURCHASE + REGION + TYP_JOB,
                  data = train,
                  method = "glm")
```

```
summary(logistic)
```

```
##
```

```
## Call:
```

```
## NULL
```

```
##
```

```
## Deviance Residuals:
```

```
##      Min       1Q   Median       3Q      Max
```

```
## -2.1594 -1.1616  0.6797  0.9107  4.7457
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error z value
```

## (Intercept)	1.899e-01	1.577e-01	1.204
## RECENTY	1.699e-02	3.896e-04	43.597
## SPESA	8.721e-06	6.598e-06	1.322
## TOT_PURCHASE	-2.138e-01	4.408e-03	-48.490
## REGION	5.272e-07	3.858e-08	13.666
## TYP_JOBArtigiano	-3.137e-01	3.971e-01	-0.790
## TYP_JOBCasalinga	-2.644e-01	3.951e-01	-0.669

```

## `TYP_JOBCommerciante/Esercente` -7.182e-01 4.897e-01 -1.467
## `TYP_JOBDirigente/Quadro/Funzionario` 9.216e-03 2.693e-01 0.034
## `TYP_JOBImpiegato/a` -4.313e-01 1.854e-01 -2.327
## TYP_JOBImprenditore 9.463e-02 4.378e-01 0.216
## `TYP_JOBIn cerca di occupazione` -3.738e-01 4.741e-01 -0.788
## `TYP_JOBLibero professionista` -1.949e-01 1.696e-01 -1.150
## `TYP_JOBNon Dichiara` 1.413e-01 3.360e-01 0.420
## `TYP_JOBOperaio/a` -5.756e-01 2.514e-01 -2.290
## `TYP_JOBPensionato/a` -2.481e-01 2.305e-01 -1.076
## `TYP_JOBRappresentante/Agente Commerciale` -1.047e+00 1.331e+00 -0.787
## TYP_JOBStudente -9.035e-01 6.779e-01 -1.333
## `TYP_JOB(missing)` 6.831e-02 1.558e-01 0.438
## Pr(>|z|)
## (Intercept) 0.228
## RECENCY <2e-16 ***
## SPESA 0.186
## TOT_PURCHASE <2e-16 ***
## REGION <2e-16 ***
## TYP_JOBArtigiano 0.430
## TYP_JOBCasalinga 0.503
## `TYP_JOBCommerciante/Esercente` 0.142
## `TYP_JOBDirigente/Quadro/Funzionario` 0.973
## `TYP_JOBImpiegato/a` 0.020 *
## TYP_JOBImprenditore 0.829
## `TYP_JOBIn cerca di occupazione` 0.430
## `TYP_JOBLibero professionista` 0.250
## `TYP_JOBNon Dichiara` 0.674
## `TYP_JOBOperaio/a` 0.022 *
## `TYP_JOBPensionato/a` 0.282
## `TYP_JOBRappresentante/Agente Commerciale` 0.431
## TYP_JOBStudente 0.183
## `TYP_JOB(missing)` 0.661
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 84518 on 63857 degrees of freedom
## Residual deviance: 76037 on 63839 degrees of freedom
## AIC: 76075
##
## Number of Fisher Scoring iterations: 4

```

#PREDICTION

```

# Prediction Treee
pred <- predict(tree, test[, -5], type = "class")
p1 <- unlist(pred)
confusionMatrix(p1, test$CHURN)

```

```

## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1

```

```
##          0  3322  1644
##          1  6951 15449
##
##          Accuracy : 0.6859
##          95% CI : (0.6804, 0.6914)
##    No Information Rate : 0.6246
##    P-Value [Acc > NIR] : < 2.2e-16
##
##          Kappa : 0.2533
##
## Mcnemar's Test P-Value : < 2.2e-16
##
##          Sensitivity : 0.3234
##          Specificity : 0.9038
##    Pos Pred Value : 0.6689
##    Neg Pred Value : 0.6897
##          Prevalence : 0.3754
##    Detection Rate : 0.1214
##    Detection Prevalence : 0.1815
##    Balanced Accuracy : 0.6136
##
##    'Positive' Class : 0
##
```

```
# Prediction RF
pred_rf <- predict(tree_rf, test[,-5], type = "class")
confusionMatrix(pred_rf, test$CHURN)
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction      0      1
##          0  4117  2495
##          1  6156 14598
##
##          Accuracy : 0.6839
##          95% CI : (0.6783, 0.6894)
##    No Information Rate : 0.6246
##    P-Value [Acc > NIR] : < 2.2e-16
##
##          Kappa : 0.2743
##
## Mcnemar's Test P-Value : < 2.2e-16
##
##          Sensitivity : 0.4008
##          Specificity : 0.8540
##    Pos Pred Value : 0.6227
##    Neg Pred Value : 0.7034
##          Prevalence : 0.3754
##    Detection Rate : 0.1504
##    Detection Prevalence : 0.2416
##    Balanced Accuracy : 0.6274
##
##    'Positive' Class : 0
```

```
##
```

```
#Prediction Logistic
```

```
pred_logistic <- predict(logistic, test[, -5], type = "raw")  
confusionMatrix(pred_logistic, test$CHURN)
```

```
## Confusion Matrix and Statistics
```

```
##
```

```
##           Reference
```

```
## Prediction      0      1
```

```
##           0  3632  1806
```

```
##           1  6641 15287
```

```
##
```

```
##           Accuracy : 0.6913
```

```
##           95% CI : (0.6858, 0.6968)
```

```
## No Information Rate : 0.6246
```

```
## P-Value [Acc > NIR] : < 2.2e-16
```

```
##
```

```
##           Kappa : 0.2736
```

```
##
```

```
## McNemar's Test P-Value : < 2.2e-16
```

```
##
```

```
##           Sensitivity : 0.3535
```

```
##           Specificity : 0.8943
```

```
## Pos Pred Value : 0.6679
```

```
## Neg Pred Value : 0.6971
```

```
## Prevalence : 0.3754
```

```
## Detection Rate : 0.1327
```

```
## Detection Prevalence : 0.1987
```

```
## Balanced Accuracy : 0.6239
```

```
##
```

```
## 'Positive' Class : 0
```

```
##
```

```
# Accuracy CHURN
```

```
accuracy <- as.data.frame(t(cbind(confusionMatrix(pred_logistic, test$CHURN)$overall[1],  
                                confusionMatrix(pred_rf, test$CHURN)$overall[1],  
                                confusionMatrix(pred, test$CHURN)$overall[1])))
```

```
accuracy <- as.data.frame(cbind(c( "Logistic", "Random Forest", "Tree"),  
                                accuracy))
```

```
colnames(accuracy) <- c("Models", "Accuracy")
```

```
ggplot(data = accuracy,
```

```
  aes(x = Models,
```

```
      y = Accuracy,
```

```
      fill = Models)) +
```

```
  geom_bar(stat = "identity") +
```

```
  coord_cartesian(ylim = c(0.681, 0.693)) +
```

```
  theme_minimal() +
```

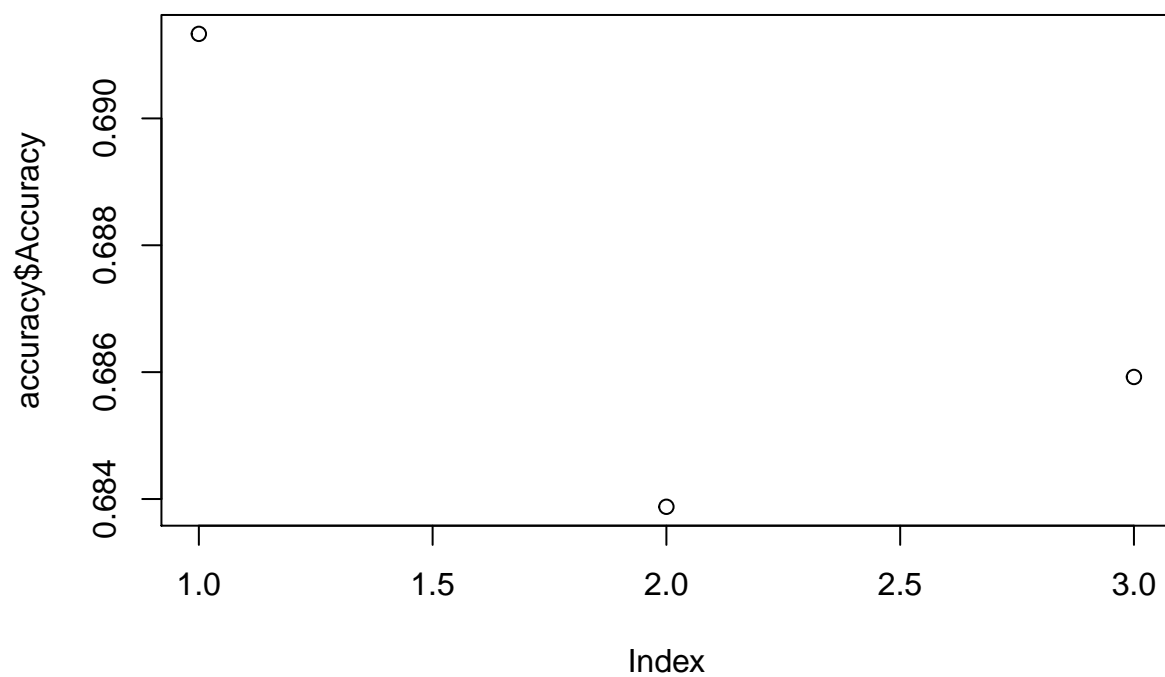
```
  guides(fill = FALSE) +
```

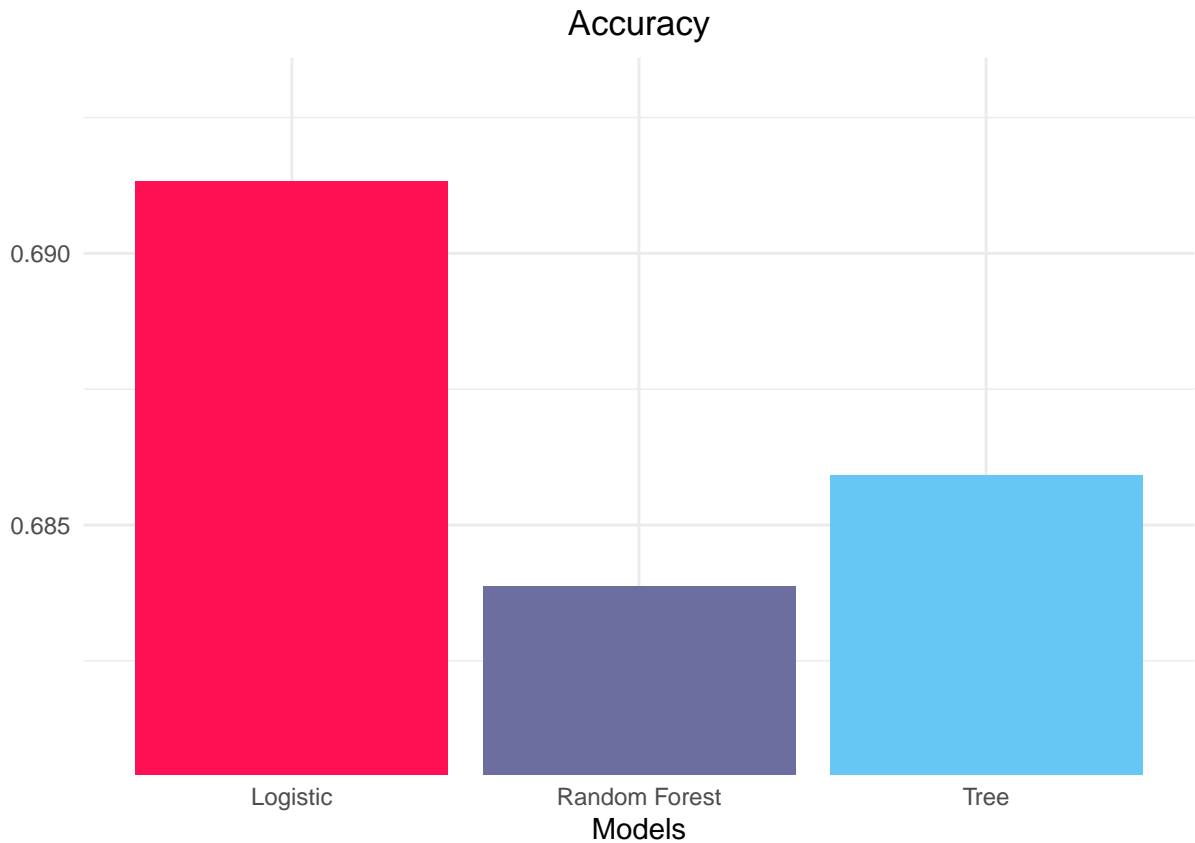
```
  labs(title = "Accuracy",
```

```
       x = "Models",
```

```
       y = " ") +
```

```
scale_fill_manual(values = c("#FF1053", "#6C6EA0", "#66C7F4", "#C1CAD6")) +  
theme(plot.title = element_text(hjust = 0.5)) + #-- Centering Title  
plot(accuracy$Accuracy)
```



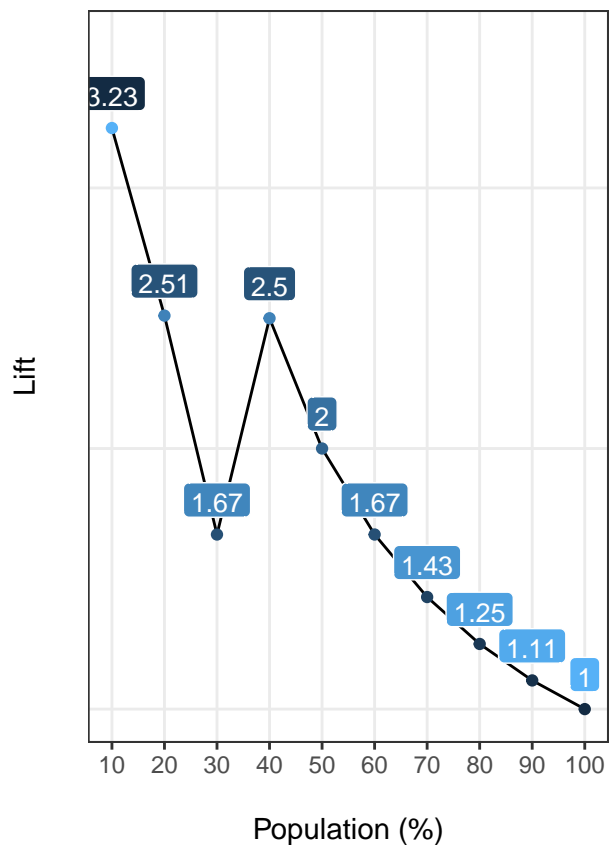
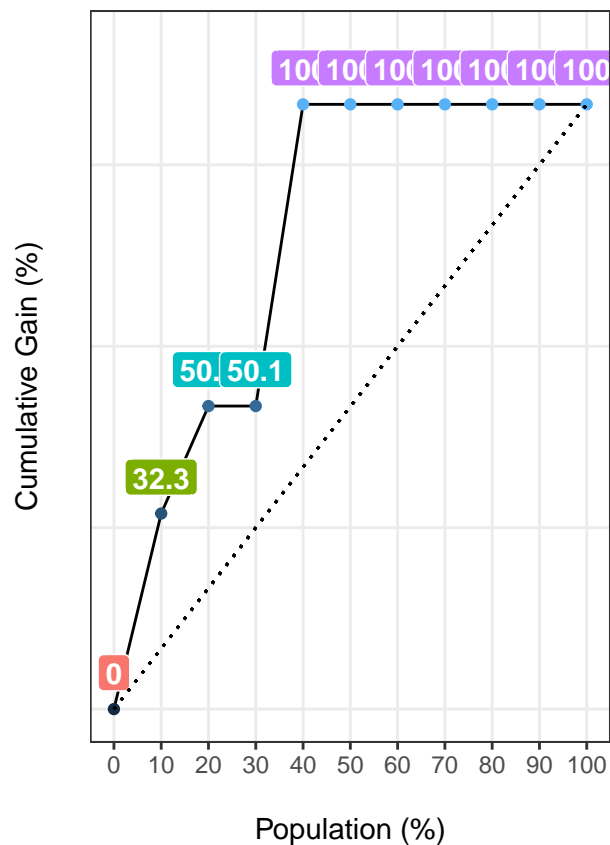


```
#Probability
p_tree = predict(tree, test[,-5], "prob")[,1]
p_rf = predict(tree_rf, test[,-5], "prob")[,1]
p_log = predict(logistic, test[,-5], "prob")[,1]

#Data
data_class = as.data.frame(cbind(p_tree, p_rf, p_log))
data_class = cbind(data_class, test$CHURN)
colnames(data_class) <- c("p_tree", "p_rf", "p_log", "churn")
head(data_class)
```

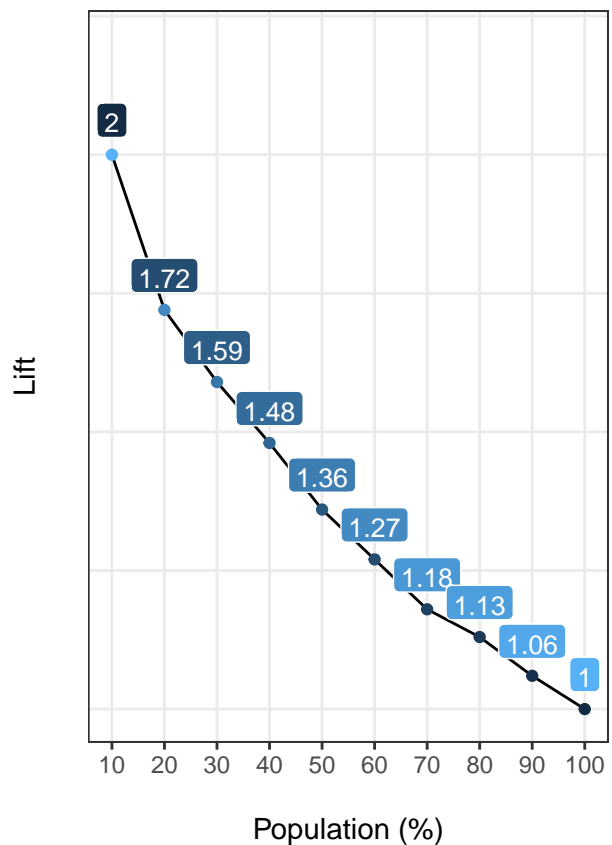
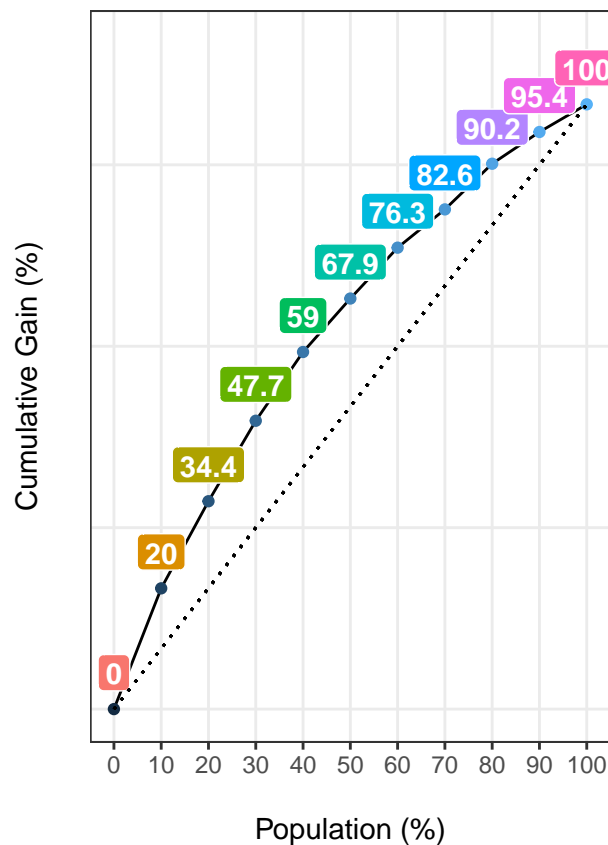
```
##      p_tree p_rf    p_log churn
## 5  0.6776299 0.51 0.9078449     0
## 19 0.4399434 0.59 0.4519669     0
## 23 0.2812283 0.13 0.3297312     0
## 26 0.2812283 0.22 0.3227350     1
## 30 0.2812283 0.12 0.2656898     1
## 31 0.4399434 0.44 0.4929244     1
```

```
#Lift
lift_tree = gain_lift(data = data_class, score = 'p_tree', target = 'churn')
```



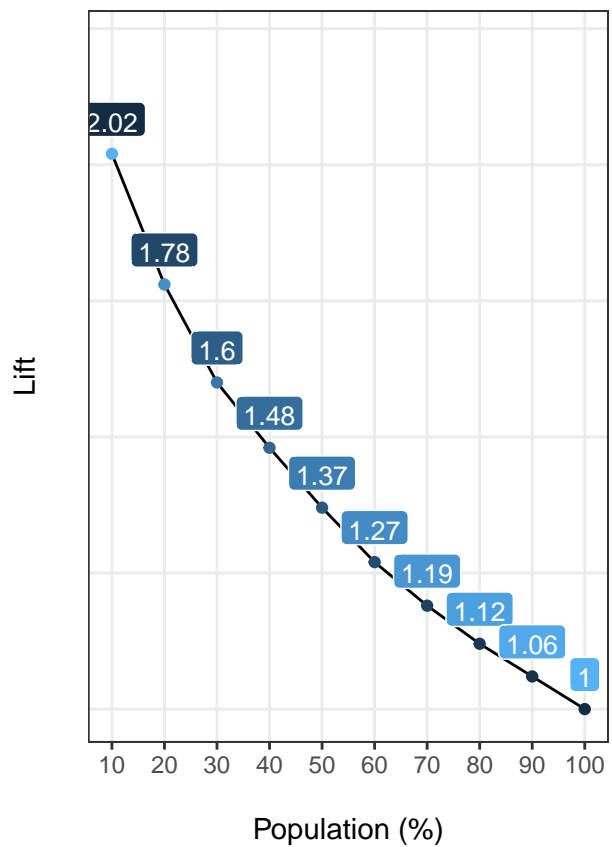
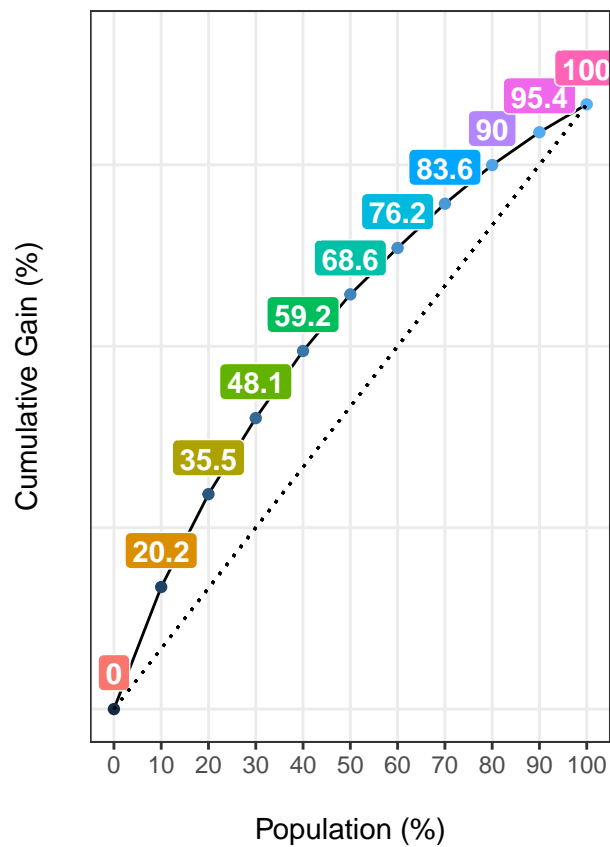
```
##      Population    Gain Lift Score.Point
## 1           10    32.34  3.23    0.6776299
## 2           20    50.11  2.51    0.4399434
## 3           30    50.11  1.67    0.4399434
## 4           40   100.00  2.50    0.2812283
## 5           50   100.00  2.00    0.2812283
## 6           60   100.00  1.67    0.2812283
## 7           70   100.00  1.43    0.2812283
## 8           80   100.00  1.25    0.2812283
## 9           90   100.00  1.11    0.2812283
## 10          100   100.00  1.00    0.2812283
```

```
lift_rf = gain_lift(data = data_class, score = 'p_rf', target = 'churn')
```



##	Population	Gain	Lift	Score.Point
## 1	10	19.97	2.00	0.71
## 2	20	34.37	1.72	0.56
## 3	30	47.68	1.59	0.43
## 4	40	59.05	1.48	0.33
## 5	50	67.89	1.36	0.26
## 6	60	76.30	1.27	0.20
## 7	70	82.63	1.18	0.16
## 8	80	90.18	1.13	0.11
## 9	90	95.43	1.06	0.07
## 10	100	100.00	1.00	0.00

```
lift_log = gain_lift(data = data_class, score = 'p_log', target = 'churn')
```

##	Population	Gain	Lift	Score.Point
## 1	10	20.19	2.02	0.6202572
## 2	20	35.54	1.78	0.4988127
## 3	30	48.12	1.60	0.4346111
## 4	40	59.22	1.48	0.3861201
## 5	50	68.58	1.37	0.3455547
## 6	60	76.25	1.27	0.3061185
## 7	70	83.57	1.19	0.2653652
## 8	80	89.96	1.12	0.2262721
## 9	90	95.39	1.06	0.1849110
## 10	100	100.00	1.00	0.1288746