First delivery - ADEI

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Contents

1 Presentation

We are going to work with dataset bank-additional-full.csv with all examples (41188) and 20 inputs, ordered by date (from May 2008 to November 2010), very close to the data analyzed in [Moro et al., 2014].

Deliverables are concerned with Multivariant Data Analysis and model building for response variables: Y-Duration of the call and binary factor Y (Binary Target) if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

2 Bank client data

2.1 Description

Input variables:

1. age (numeric)
2. job : type of job (categorical: 'admin.','blue-collar','entrepreneur','housemaid','management','retired','self-employed','services','student','technician','unemployed','unknown')
3. marital : marital status (categorical: 'divorced','married','single','unknown'; note: 'divorced' means divorced or widowed)
4. education (categorical:'basic.4y','basic.6y','basic.9y','high.school','illiterate','professional.course','university.degree','unkno
5. default: has credit in default? (categorical: 'no','yes','unknown')
6. housing: has housing loan? (categorical: 'no','yes','unknown')
7. loan: has personal loan? (categorical: 'no','yes','unknown')# related with the last contact of the current campaign:
8. contact: contact communication type (categorical:'cellular','telephone')
9. month: last contact month of year (categorical: 'jan', 'feb', 'mar',..., 'nov', 'dec')
10. day_of_week: last contact day of the week (categorical:'mon','tue','wed','thu','fri')

11. duration: last contact duration, in seconds (numeric). Important note: this attribute highly affects the output target (e.g., if duration=0 then y='no'). Yet, the duration is not known before a call is performed. Also, after the end of the call y is obviously known. Thus, this input should only be included for benchmark purposes and should be discarded if the intention is to have a realistic predictive model.
12. campaign: number of contacts performed during this campaign and for this client (numeric, includes last contact)
13. pdays: number of days that passed by after the client was last contacted from a previous campaign (numeric; 999 means client was not previously contacted)
14. previous: number of contacts performed before this campaign and for this client (numeric)
15. poutcome: outcome of the previous marketing campaign (categorical: 'failure','nonexistent','success')# social and economic context attributes
16. emp.var.rate: employment variation rate - quarterly indicator (numeric)
17. cons.price.idx: consumer price index - monthly indicator (numeric)
18. cons.conf.idx: consumer confidence index - monthly indicator (numeric)
19. euribor3m: euribor 3 month rate - daily indicator (numeric)
20. nr.employed: number of employees - quarterly indicator (numeric)
21. y - has the client subscribed a term deposit? (binary: 'yes','no')

3 Loading packages

4 Loading data

```
#rm(list=ls())
# Load Required Packages: to be increased over the course

#setwd("C:/Users/lmontero/Dropbox/DOCENCIA/FIB-ADEI/PRACTICA/BankMarketing")
#setwd("D:/DOCENCIA/FIB-ADEI/PRACTICA/BankMarketing")

# Josep
#setwd("~/Developer/r-studio/laboratory-adei/data-directory")
#load("~/Developer/r-studio/laboratory-adei/data-directory/5000_samples.RData")

# Alex
setwd("D:/Google Drive/Uni/ADEI/data-directory")
load(path.expand("D:/Google Drive/Uni/ADEI/data-directory/5000_samples.RData"))

summary(df)
```

```
##       age                 job           marital
##  Min.   :17.00   admin.     :1288   divorced: 546
##  1st Qu.:32.00   blue-collar:1156   married :3029
##  Median :38.00   technician : 831   single  :1416
##  Mean   :39.97   services   : 471   unknown :   9
##  3rd Qu.:47.00   management : 345
##  Max.   :92.00   retired    : 187
##                  (Other)    : 722
##                education       default        housing          loan
##  university.degree  :1431   no     :3939   no     :2226   no     :4138
##  high.school        :1169   unknown:1061   unknown: 112   unknown: 112
##  basic.9y           : 758   yes    :   0   yes    :2662   yes    : 750
##  professional.course: 668
##  basic.4y           : 493
##  basic.6y           : 272
```

```
##  (Other)            : 209
##       contact          month      day_of_week    duration
##  cellular :3182   may    :1679   fri: 948    Min.   :   4.0
##  telephone:1818   jul    : 907   mon:1017    1st Qu.: 104.0
##                   aug    : 699   thu:1031    Median : 181.0
##                   jun    : 660   tue:1005    Mean   : 263.7
##                   nov    : 502   wed: 999    3rd Qu.: 328.0
##                   apr    : 323               Max.   :3078.0
##                   (Other): 230
##     campaign          pdays          previous             poutcome
##  Min.   : 1.000   Min.   :  0.0   Min.   :0.0000   failure    : 493
##  1st Qu.: 1.000   1st Qu.:999.0   1st Qu.:0.0000   nonexistent:4315
##  Median : 2.000   Median :999.0   Median :0.0000   success    : 192
##  Mean   : 2.647   Mean   :957.9   Mean   :0.1772
##  3rd Qu.: 3.000   3rd Qu.:999.0   3rd Qu.:0.0000
##  Max.   :42.000   Max.   :999.0   Max.   :5.0000
##
##   emp.var.rate     cons.price.idx  cons.conf.idx      euribor3m
##  Min.   :-3.4000   Min.   :92.20   Min.   :-50.80   Min.   :0.634
##  1st Qu.:-1.8000   1st Qu.:93.08   1st Qu.:-42.70   1st Qu.:1.344
##  Median : 1.1000   Median :93.88   Median :-41.80   Median :4.857
##  Mean   : 0.1029   Mean   :93.58   Mean   :-40.59   Mean   :3.641
##  3rd Qu.: 1.4000   3rd Qu.:93.99   3rd Qu.:-36.40   3rd Qu.:4.961
##  Max.   : 1.4000   Max.   :94.77   Max.   :-26.90   Max.   :5.045
##
##   nr.employed     y
##  Min.   :4964   no :4416
##  1st Qu.:5099   yes: 584
##  Median :5191
##  Mean   :5168
##  3rd Qu.:5228
##  Max.   :5228
##
```

5 Univariate Descriptive Analysis

Creem factors per cada variable posant abans NA a aquells valos erronis o faltants.

5.1 Transform missing and wrong data to NAs

```
#Default
sel<-which(df$default=="unknown");length(sel)
```

```
## [1] 1061
```

```
df$default[sel] <- NA
df$default <- factor(df$default)
summary(df$default)
```

```
##   no NA's
## 3939 1061
```

```
#marital
sel<-which(df$marital=="unknown");length(sel)
```

```
## [1] 9
```

```
df$marital[sel] <- NA
df$marital <- factor(df$marital)
summary(df$marital)
```

```
## divorced  married   single     NA's
##      546     3029     1416        9
```

```
#Housing
sel<-which(df$housing=="unknown");length(sel)
```

```
## [1] 112
```

```
df$housing[sel] <- NA
df$housing <- factor(df$housing)
summary(df$housing)
```

```
##   no  yes NA's
## 2226 2662  112
```

```
#Loan
sel<-which(df$loan=="unknown");length(sel)
```

```
## [1] 112
```

```
df$loan[sel] <- NA
df$loan <- factor(df$loan)
summary(df$loan)
```

```
##   no  yes NA's
## 4138  750  112
```

```
#Job
sel<-which(df$job=="unknown");length(sel)
```

```
## [1] 43
```

```
df$job[sel] <- NA
df$job <- factor(df$job)
summary(df$job)
```

```
##        admin.   blue-collar  entrepreneur     housemaid    management
##          1288          1156           181           132           345
##       retired self-employed      services       student    technician
##           187           152           471           100           831
##    unemployed          NA's
##           114            43
```

```
S
```

```
## function (object, brief, ...)
## {
##     UseMethod("S")
## }
## <bytecode: 0x00000000196240e0>
## <environment: namespace:car>
```

```
#Education
sel<-which(df$education=="unknown");length(sel)
```

```
## [1] 207
```

```
df$education[sel] <- NA
df$education <- factor(df$education)
summary(df$education)
```

```
##            basic.4y            basic.6y            basic.9y
##                 493                 272                 758
##         high.school          illiterate professional.course
##                1169                   2                 668
##   university.degree                NA's
##                1431                 207
```

```
#Pdays
sel<-which(df$pdays==999);length(sel)
```

```
## [1] 4793
```

```
df$pdays[sel] <- NA
summary(df$pdays)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.000   3.000   6.000   5.792   7.000  18.000    4793
```

```
#Poutcome
sel<-which(df$poutcome=="nonexistent");length(sel)
```

```
## [1] 4315
```

```
df$poutcome[sel] <- NA
df$poutcome <- factor(df$poutcome)
summary(df$poutcome)
```

```
## failure success    NA's
##     493     192    4315
```

5.2 Create new factors corresponding to qualitative concepts.

5.2.1 Month

```
#Modify factor levels label
df$f.month <- factor(df$month, labels=paste("Month", sep="-", levels(df$month)))
table(df$f.month)
```

```
##
## Month-apr Month-aug Month-dec Month-jul Month-jun Month-mar Month-may
##       323       699        19       907       660        66      1679
## Month-nov Month-oct Month-sep
##       502        79        66
```

```
# Define new factor categories: 1-Spring | 2-Summer | 3-Resta
df$f.season <- 3

# 1 level - spring
sel<-which(df$f.month %in% c("Month-mar","Month-apr","Month-may"))
df$f.season[sel] <-1

# 2 level - Summer
sel<-which(df$f.month %in% c("Month-jun","Month-jul","Month-aug"))
```

```
df$f.season[sel] <-2

table(df$f.season);summary(df$f.season)
```

```
##
##    1    2    3
## 2068 2266  666
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00    1.00    2.00    1.72    2.00    3.00
```

```
df$f.season<-factor(df$f.season,levels=1:3,labels=c("Spring","Summer","Aut-Win"))
summary(df$f.season)
```

```
##  Spring  Summer Aut-Win
##    2068    2266     666
```

5.2.2 Job

```
#Modify factor levels label
df$f.job <- factor(df$job, labels=paste("Job", sep="-", levels(df$job)))

table(df$f.job)
```

```
##
##        Job-admin.   Job-blue-collar  Job-entrepreneur     Job-housemaid
##              1288              1156               181               132
##    Job-management       Job-retired Job-self-employed      Job-services
##               345               187               152               471
##       Job-student    Job-technician    Job-unemployed
##               100               831               114
```

```
# Define new factor categories: 1-selfemployed | 2-worker | 3-other
df$f.jobsituation<-3

# 1 level - self-employed
sel<-which(df$f.job %in% c("Job-entrepreneur","Job-housemaid","Job-self-employed"))
df$f.jobsituation[sel] <- 1

# 2 level - worker
sel<-which(df$f.job %in% c("Job-admin","Job-blue-collar","Job-management","Job-services","Job-technician
df$f.jobsituation[sel] <- 2

table(df$f.jobsituation);summary(df$f.jobsituation)
```

```
##
##    1    2    3
##  465 2803 1732
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   2.000   2.000   2.253   3.000   3.000
```

```
df$f.jobsituation<-factor(df$f.jobsituation,levels=1:3,labels=c("Self-employed","Worker","Other"))
summary(df$f.jobsituation)
```

```
## Self-employed        Worker         Other
##           465          2803          1732
```

5.2.3 Pdays

```
table(df$pdays)
```

```
##
##  0  1  2  3  4  5  6  7  8  9 10 11 12 13 15 16 17 18
##  1  5 12 62 17  5 48 13  5  9  7  2  4  8  3  1  4  1
```

```
# Define new factor categories: 1-contacted | 2-not contacted
df$f.prev_contacted<-2

# 1 level - contacted
sel<-which(df$pdays %in% c(1:20))
df$f.prev_contacted[sel] <- 1

# 2 level - not contacted
sel<-which(df$pdays %in% c(21:1000))
df$f.prev_contacted[sel] <- 2

table(df$f.prev_contacted);summary(df$f.prev_contacted)
```

```
##
##    1    2
##  206 4794
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   2.000   2.000   1.959   2.000   2.000
```

```
df$f.prev_contacted<-factor(df$f.prev_contacted,levels=1:2,labels=c("Contacted","No-contacted"))
summary(df$pdays)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.000   3.000   6.000   5.792   7.000  18.000    4793
```

5.2.4 Education

```
#Modify factor levels label
df$education <- factor(df$education, labels=paste("Edu", sep="-", levels(df$education)))

table(df$education)
```

```
##
##            Edu-basic.4y            Edu-basic.6y            Edu-basic.9y
##                     493                     272                     758
##         Edu-high.school         Edu-illiterate Edu-professional.course
##                    1169                       2                     668
##   Edu-university.degree
##                    1431
```

```
# Define new factor categories: 1-mandatory | 2-nonmandatory | 3-other
df$f.education<-3

# 1 level - mandatory
sel<-which(df$education %in% c("Edu-basic.4y","Edu-basic.6y", "Edu-basic.9y", "Edu-high.school"))
df$f.education[sel] <- 1

# 2 level - nonmandatory
```

```r
sel<-which(df$education %in% c("Edu-professional.course","Edu-university.degree"))
df$f.education[sel] <- 2

table(df$f.education);summary(df$f.education)
```

```
##
##    1    2    3
## 2692 2099  209
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   1.000   1.000   1.503   2.000   3.000
```

```r
df$f.education<-factor(df$f.education,levels=1:3,labels=c("Mandatory","Non-Mandatory","Other"))
summary(df$f.education)
```

```
##     Mandatory Non-Mandatory         Other
##          2692          2099           209
```

5.2.5 Extra Factorization

```r
#Housing

df$f.housing<-factor(df$housing,labels=paste("f",sep=".",levels(df$housing)))
table(df$f.housing);summary(df$f.housing);
```

```
##
##  f.no f.yes
##  2226  2662
```

```
##  f.no f.yes  NA's
##  2226  2662   112
```

```r
#Marital

df$f.marital<-factor(df$marital,labels=paste("f",sep=".",levels(df$marital)))
table(df$f.marital);summary(df$f.marital);
```

```
##
## f.divorced  f.married   f.single
##        546       3029       1416
```

```
## f.divorced  f.married   f.single       NA's
##        546       3029       1416          9
```

```r
#Default
df$f.default<-factor(df$default, labels=paste("f",sep=".",levels(df$default)))
df$f.default <- factor(df$f.default , levels = c(levels(df$f.default), "f.si"))
table(df$f.default);
```

```
##
## f.no f.si
## 3939    0
```

```r
#Loan
df$f.loan<-factor(df$loan,labels=paste("f",sep=".",levels(df$loan)))
table(df$f.loan);summary(df$f.loan)
```

```
##
##  f.no f.yes
```

```
##  4138   750
```

```
##  f.no f.yes  NA's
##  4138   750   112
```

```
#Contact
df$f.contact<-factor(df$contact,labels=paste("f",sep=".",levels(df$contact)))
table(df$f.contact);summary(df$f.contact)
```

```
##
##  f.cellular f.telephone
##        3182        1818
```

```
##  f.cellular f.telephone
##        3182        1818
```

```
#Day of Week
df$f.day<-factor(df$day_of_week,labels=paste("f.day",sep=".",levels(df$day)))
table(df$f.day);summary(df$f.day)
```

```
##
## f.day.fri f.day.mon f.day.thu f.day.tue f.day.wed
##       948      1017      1031      1005       999
```

```
## f.day.fri f.day.mon f.day.thu f.day.tue f.day.wed
##       948      1017      1031      1005       999
```

5.3 Create new factors corresponding to quantitative concepts.

5.3.1 Age discreatization

```
summary(df$age)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   17.00   32.00   38.00   39.97   47.00   92.00
```

```
qulist<-quantile(df$age,seq(0,1,0.25),na.rm=TRUE)

varaux<-factor(cut(df$age,breaks=qulist,include.lowest=T))
table(varaux)
```

```
## varaux
## [17,32] (32,38] (38,47] (47,92]
##    1353    1248    1202    1197
```

```
tapply(df$age,varaux,median)
```

```
## [17,32] (32,38] (38,47] (47,92]
##      29      35      43      53
```

```
varaux<-factor(cut(df$age,breaks=c(17,30,40,50,95),include.lowest=T))
table(varaux)
```

```
## varaux
## [17,30] (30,40] (40,50] (50,95]
##     887    2003    1252     858
```

```
tapply(df$age,varaux,median)
```

```
## [17,30] (30,40] (40,50] (50,95]
##      28      35      45      55
```

```r
df$f.age<-factor(cut(df$age,breaks=c(17,30,40,50,95),include.lowest=T))

summary(df$f.age)
```

```
## [17,30] (30,40] (40,50] (50,95]
##     887    2003    1252     858
```

```r
levels(df$f.age)<-paste0("f.age-",levels(df$f.age))
```

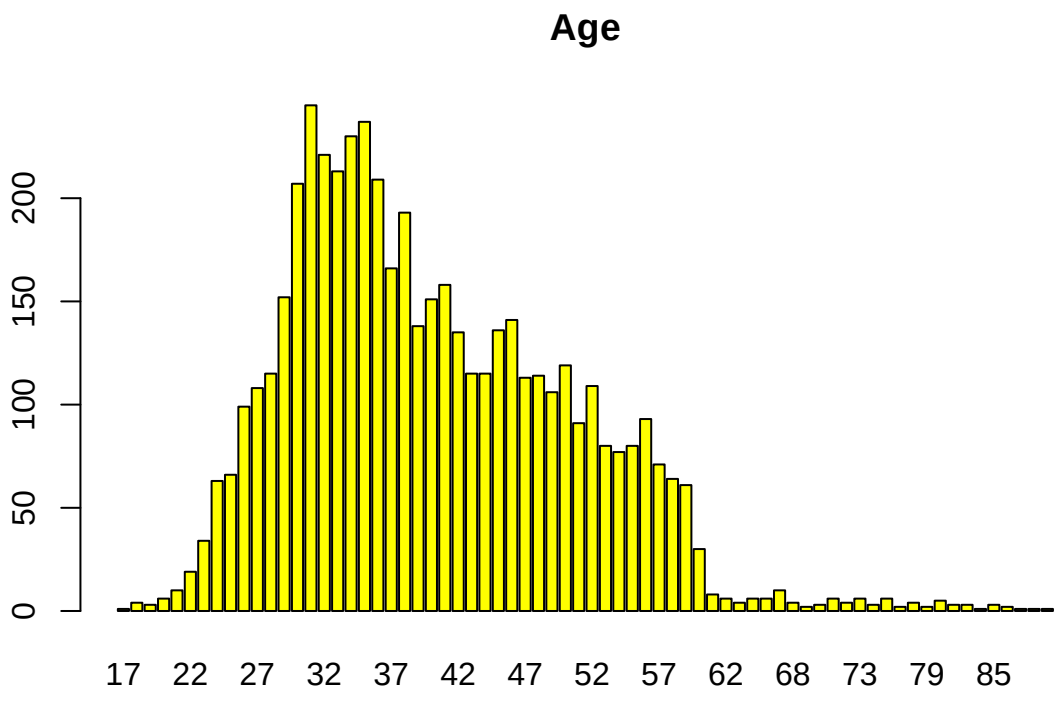
6 Exploratory Data Analysis

6.1 Age

```r
summary(df$age)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   17.00   32.00   38.00   39.97   47.00   92.00
```

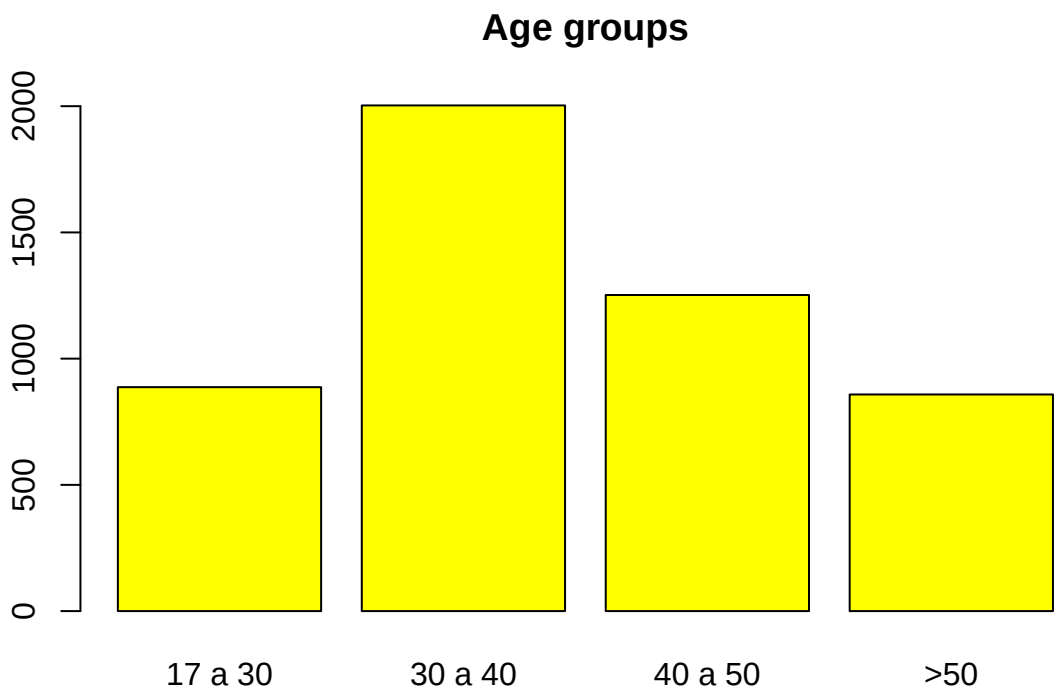
```r
barplot(table(df$age), main= "Age",col="yellow")
```




```r
summary(df$f.age)
```

```
## f.age-[17,30] f.age-(30,40] f.age-(40,50] f.age-(50,95]
##           887          2003          1252           858
```

```r
barplot(table(df$f.age), main="Age groups",names.arg=c("17 a 30","30 a 40","40 a 50",">50"),col="yellow
```

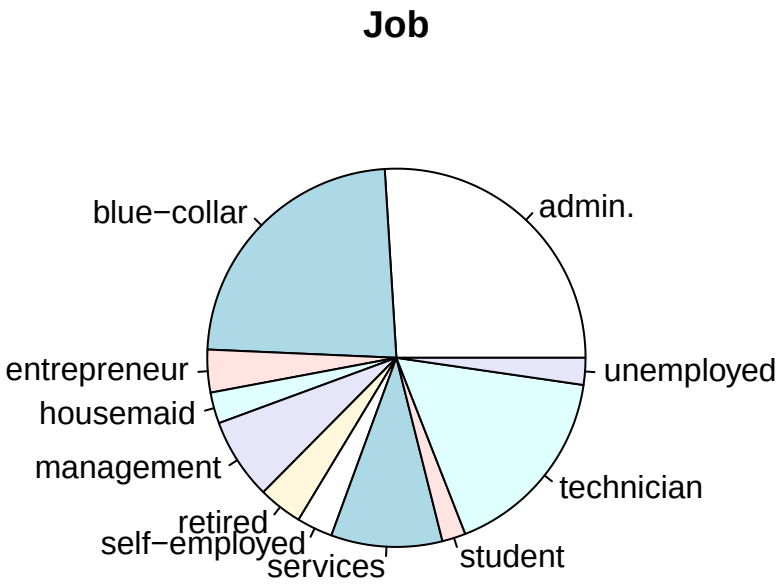


6.2 Job

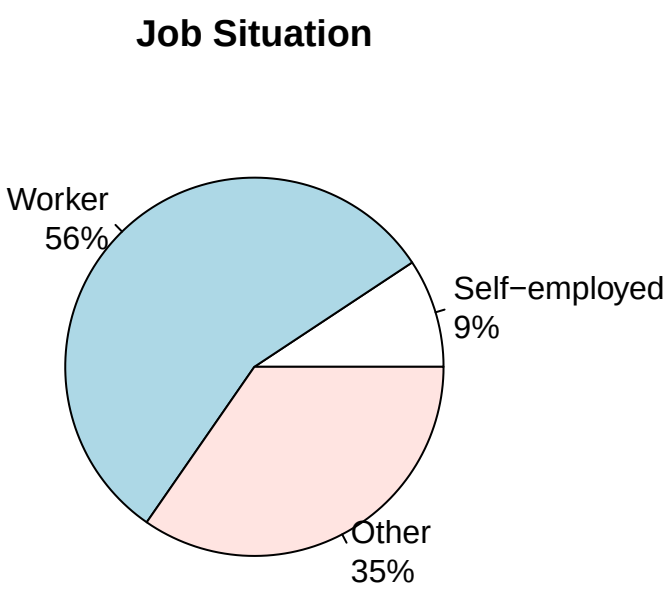
```
table(df$job)
```

```
##
##        admin.   blue-collar  entrepreneur     housemaid    management
##          1288          1156           181           132           345
##       retired self-employed      services       student    technician
##           187           152           471           100           831
##    unemployed
##           114
```

```
pie(table(df$job), main= "Job")
```




```
aux <- table(df$f.jobsituation)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # add % to labels
pie(aux,labels = lbls, main="Job Situation")
```

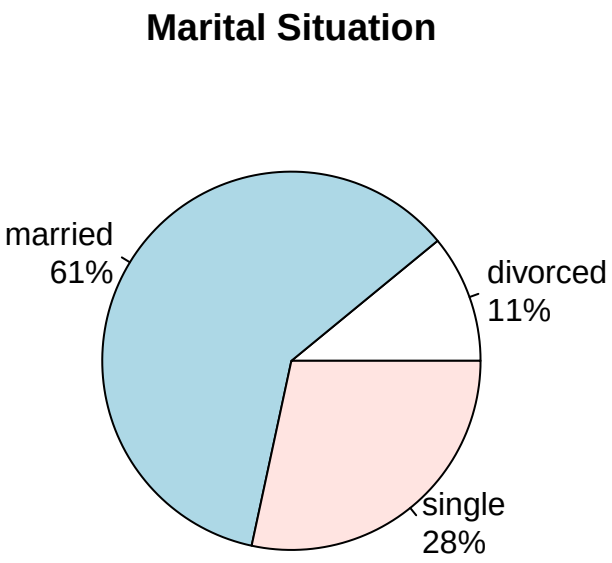


6.3 Marital

```
table(df$marital)
```

```
##
## divorced  married   single
##      546     3029     1416
```

```
aux <- table(df$marital)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # add % to labels
pie(aux,labels = lbls, main="Marital Situation")
```

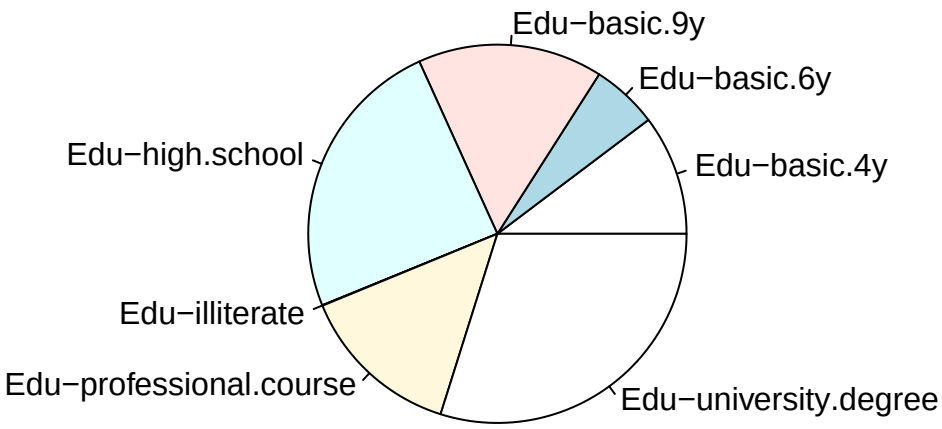


##Education

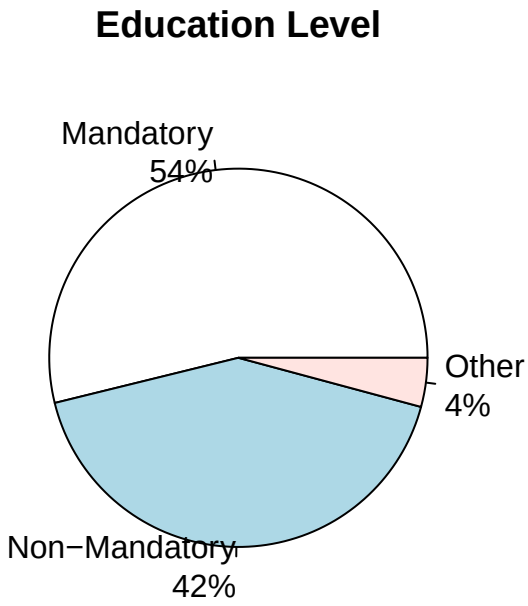
```
table(df$education)
```

```
##
##            Edu-basic.4y            Edu-basic.6y            Edu-basic.9y
##                     493                     272                     758
##         Edu-high.school         Edu-illiterate Edu-professional.course
##                    1169                       2                     668
##   Edu-university.degree
##                    1431
```

```
pie(table(df$education), main= "Education")
```




```
aux <- table(df$f.education)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls, main="Education Level")
```



6.4 Default-Housing-Loan

```
table(df$default)
```

```
##
##   no
## 3939
```

```
table(df$housing)
```

```
##
##   no  yes
## 2226 2662
```

```
table(df$loan)
```

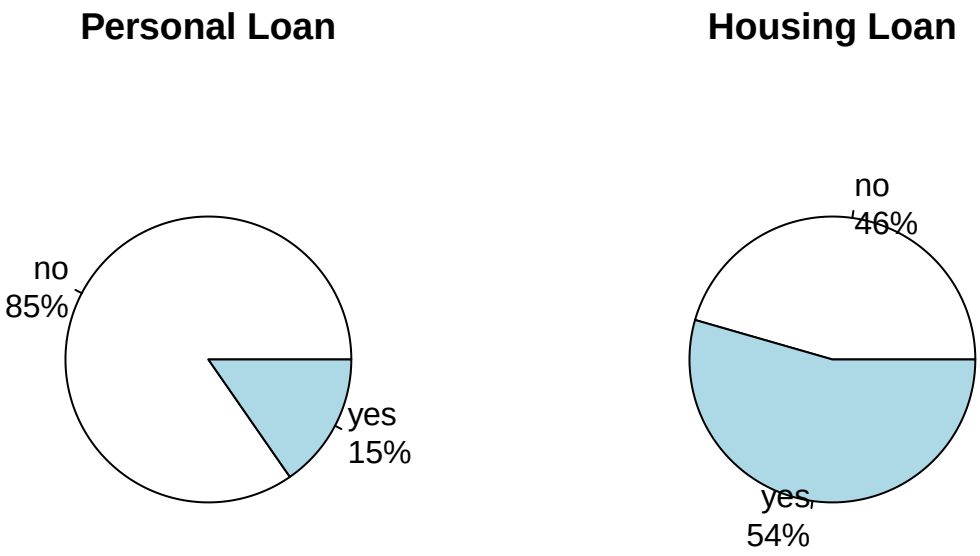
```
##
##   no  yes
## 4138  750
```

```
attach(mtcars)
```

```
## The following object is masked from package:ggplot2:
##
##     mpg
```

```
par(mfrow=c(1,2))
aux <- table(df$loan)
pct <- round(aux/sum(aux)*100)
```

```r
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls, main="Personal Loan")
aux <- table(df$housing)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls, main="Housing Loan")
```




```r
# Retornar l'attach a l'estat predeterminat
attach(mtcars)
```

```
## The following objects are masked from mtcars (pos = 3):
##
##     am, carb, cyl, disp, drat, gear, hp, mpg, qsec, vs, wt
##
## The following object is masked from package:ggplot2:
##
##     mpg
```

```r
par(mfrow=c(1,1))
```

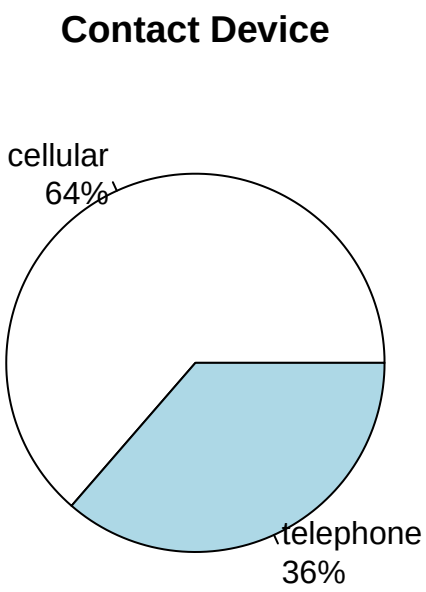
Com es pot veure no hem el gràfic de deutes, ja que el 100% d'individus que han contestat a l'enquesta no en tenien.

6.5 Contact Device

```
table(df$contact)
```

```
##
##  cellular telephone
##      3182      1818
```

```
aux <- table(df$contact)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls, main="Contact Device")
```



6.6 Date - Month and season

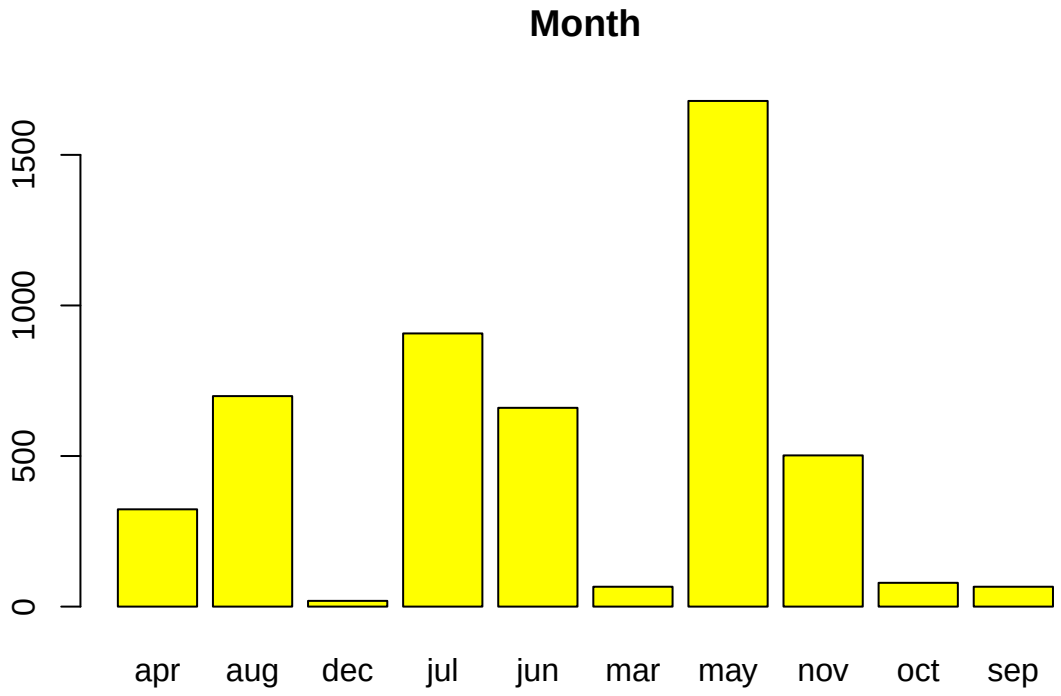
```
table(df$month)
```

```
##
##  apr  aug  dec  jul  jun  mar  may  nov  oct  sep
##  323  699   19  907  660   66 1679  502   79   66
```

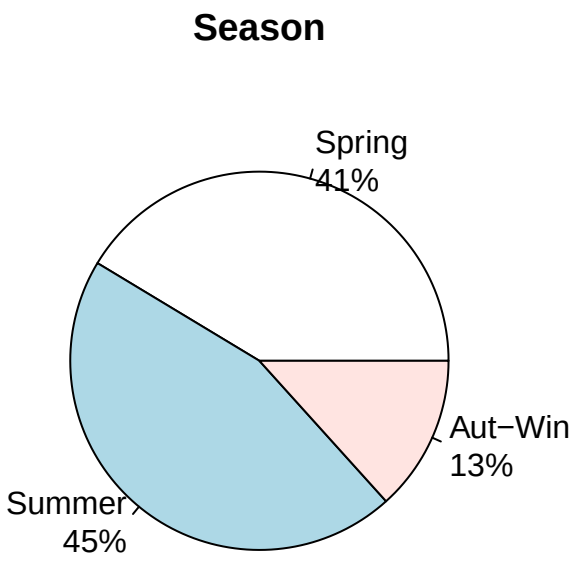
```
table(df$f.season)
```

```
##
##  Spring  Summer Aut-Win
##    2068    2266     666
```

```r
barplot(table(df$month), main= "Month", col="yellow")
```




```r
aux <- table(df$f.season)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls,
   main="Season")
```

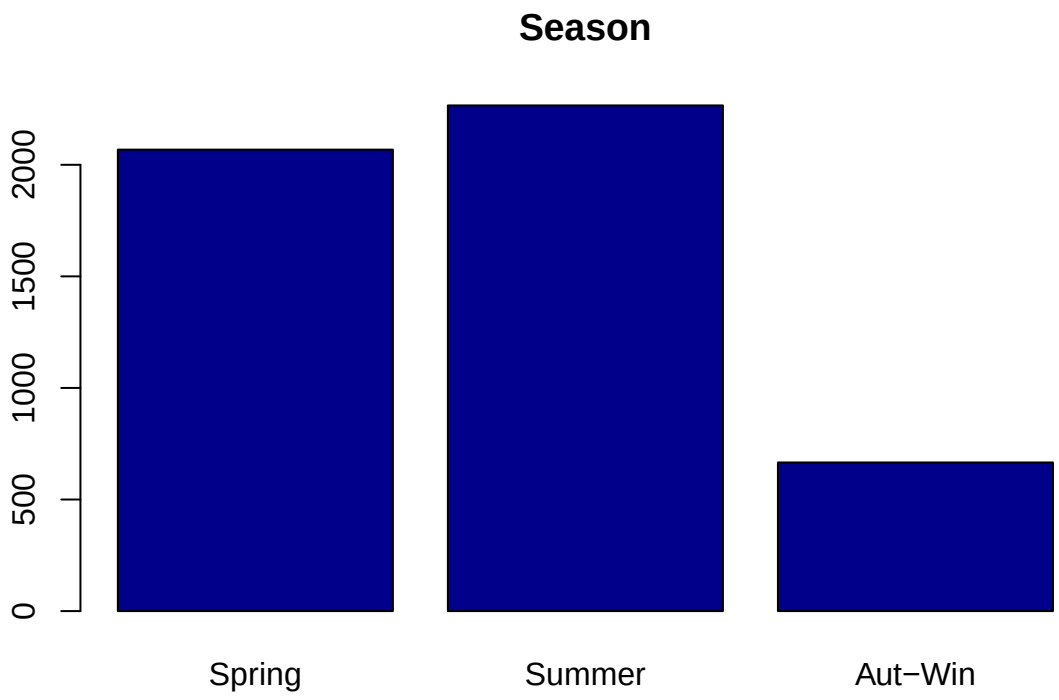


6.7 Date - Day of the week

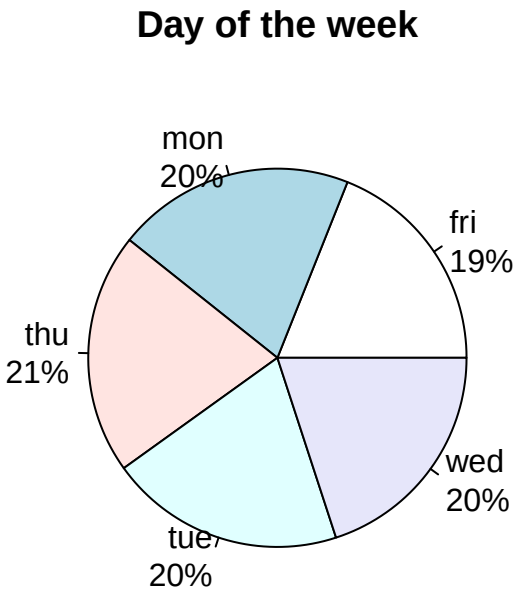
```
table(df$day_of_week)
```

```
##
##  fri  mon  thu  tue  wed
##  948 1017 1031 1005  999
```

```
barplot(table(df$f.season), main= "Season", col="darkblue")
```




```
aux <- table(df$day_of_week)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls,
   main="Day of the week")
```

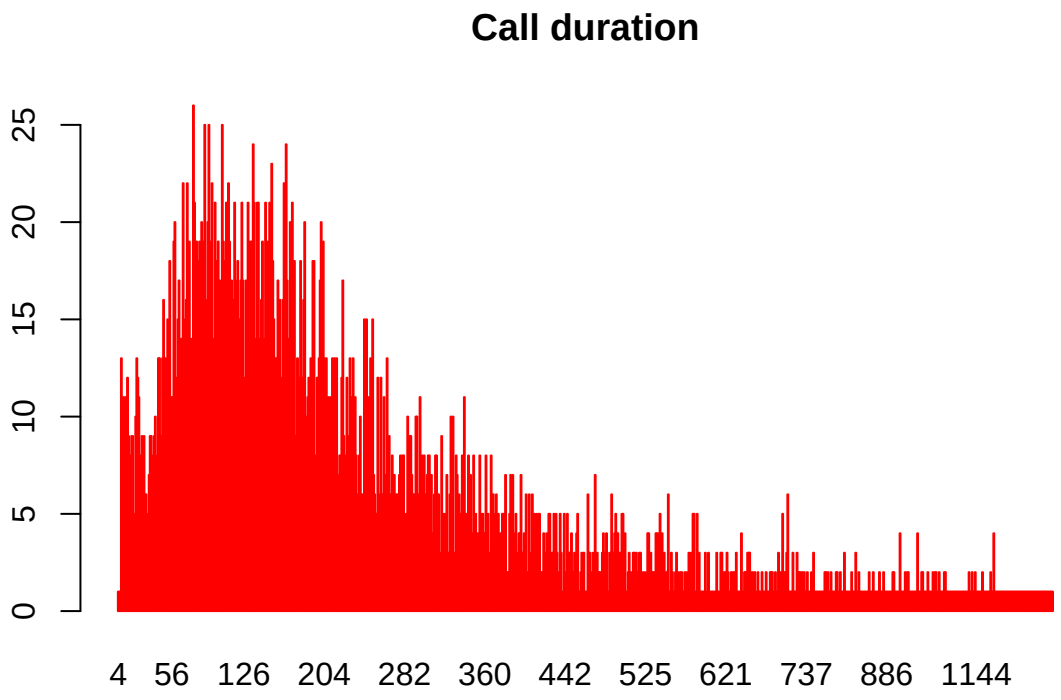


6.8 Duration

```
summary(df$duration)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     4.0   104.0   181.0   263.7   328.0  3078.0
```

```
barplot(table(df$duration),col="yellow",border="red", main="Call duration")
```

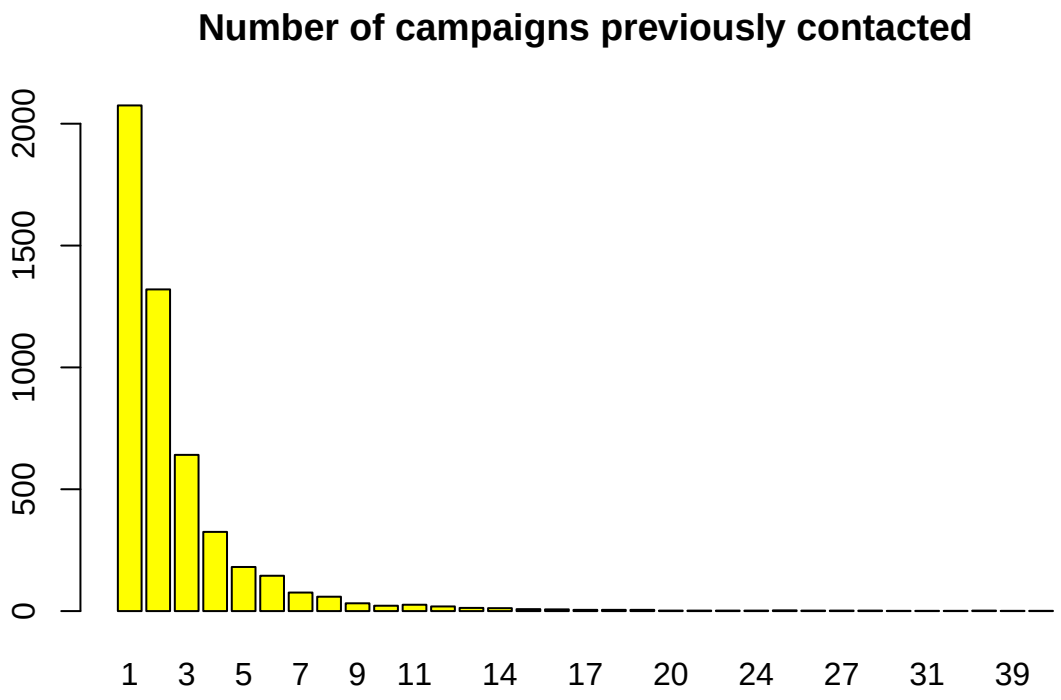


6.9 Campaign

```
summary(df$campaign)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   1.000   2.000   2.647   3.000  42.000
```

```
barplot(table(df$campaign),col="yellow", main="Number of campaigns previously contacted")
```

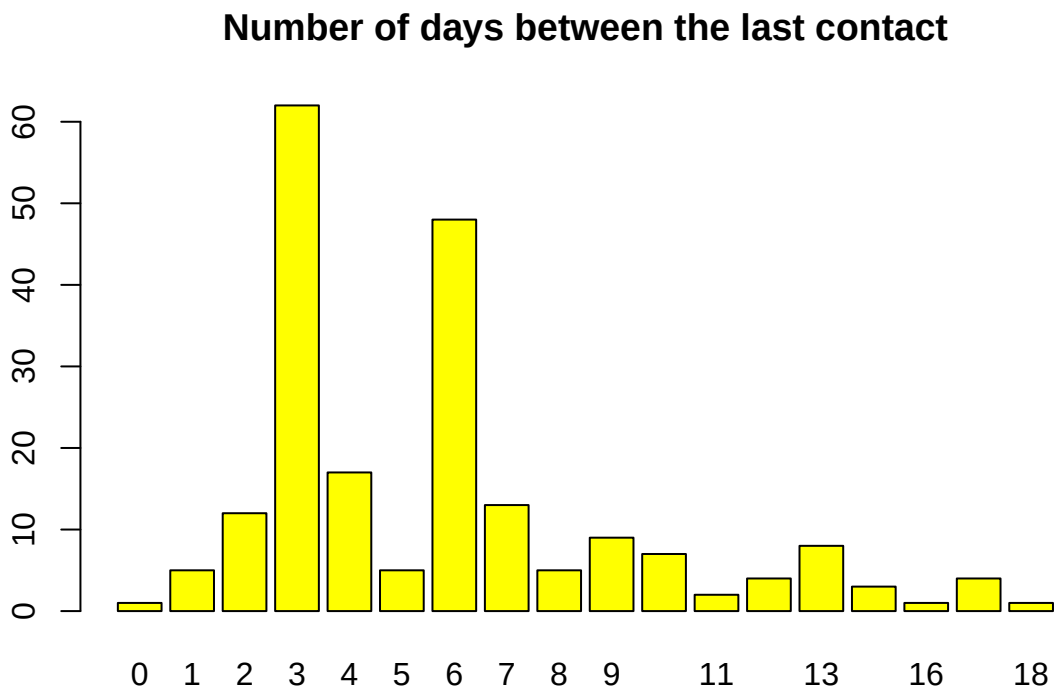


6.10 PDays

```
summary(df$pdays)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.000   3.000   6.000   5.792   7.000  18.000    4793
```

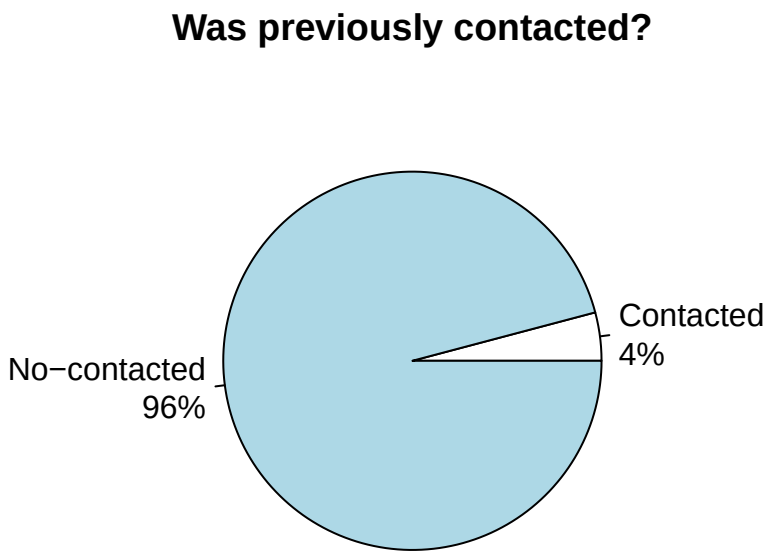
```
barplot(table(df$pdays),col="yellow", main="Number of days between the last contact")
```




```
table(df$f.prev_contacted)
```

```
##
##    Contacted No-contacted
##          206         4794
```

```
aux <- table(df$f.prev_contacted)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls,
   main="Was previously contacted?")
```



6.11 Prevously

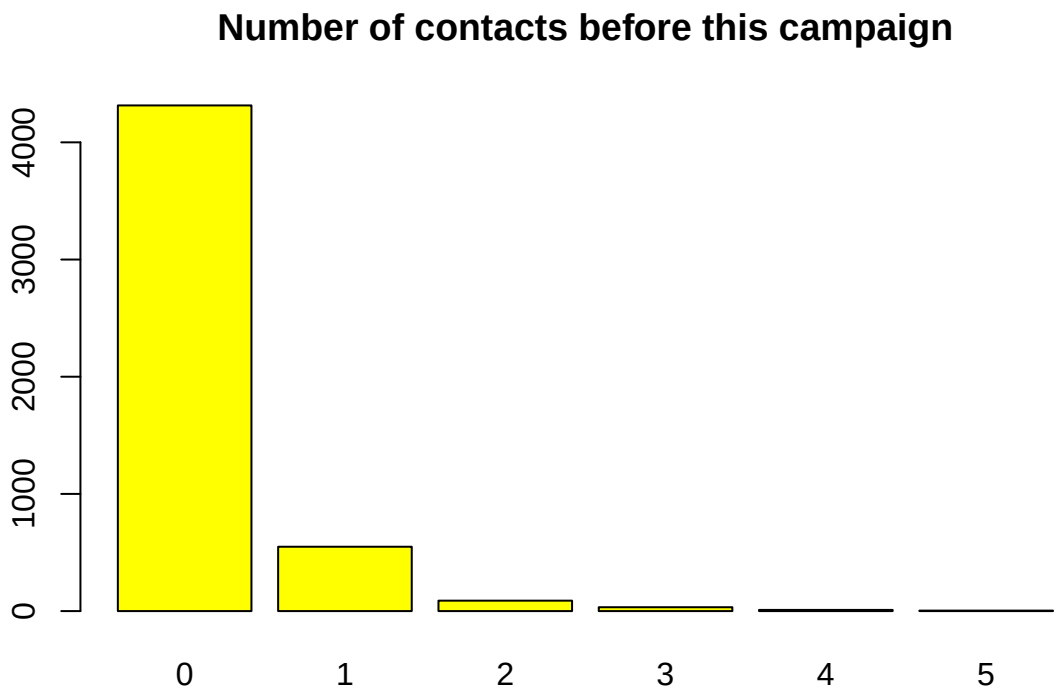
```
summary(df$previous)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.0000  0.0000  0.0000  0.1772  0.0000  5.0000
```

```
table(df$previous)
```

```
##
##    0    1    2    3    4    5
## 4315  549   89   33   10    4
```

```
barplot(table(df$previous),col="yellow", main="Number of contacts before this campaign")
```

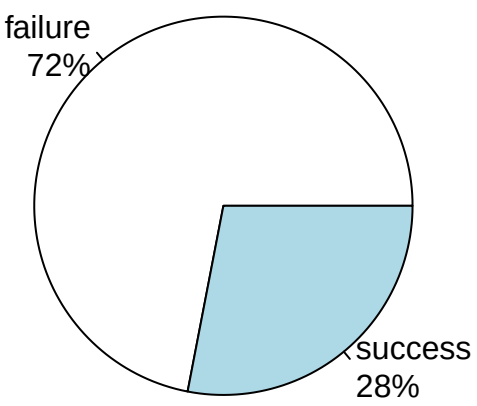


6.12 POutcome

```
table(df$poutcome)
```

```
##
## failure success
##     493     192
```

```
aux <- table(df$poutcome)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls,
   main="Outome of the previous marketing campaign")
```

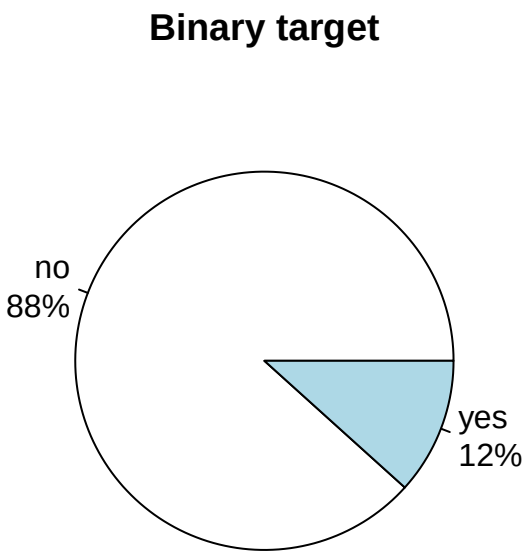


6.13 Y

```
table(df$y)
```

```
##
##   no  yes
## 4416  584
```

```
aux <- table(df$y)
pct <- round(aux/sum(aux)*100)
lbls <- paste(names(aux), "\n", pct, sep="")
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(aux,labels = lbls,
   main="Binary target")
```



7 Data Quality Report

7.1 Missing Values

```
vmiss<-rep(0,nrow(df))

nInitialVariables<- 21
nmiss<-rep(0,nInitialVariables)

initialVariables <- 0:21
names(nmiss) <- names(df[initialVariables])
names(df[initialVariables])
```

```
##  [1] "age"            "job"            "marital"        "education"
##  [5] "default"        "housing"        "loan"           "contact"
##  [9] "month"          "day_of_week"    "duration"       "campaign"
## [13] "pdays"          "previous"       "poutcome"       "emp.var.rate"
## [17] "cons.price.idx" "cons.conf.idx"  "euribor3m"      "nr.employed"
## [21] "y"
```

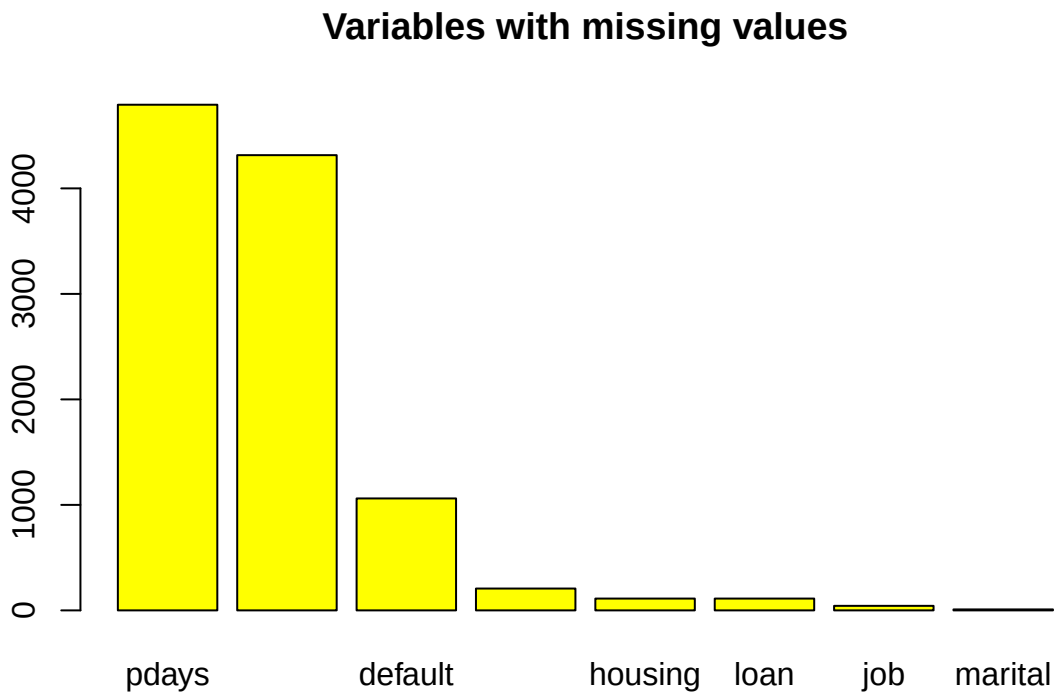
```
for(j in 1:21) {
  nmiss[j]<-nmiss[j]+sum(is.na(df[,j]))
}

nmiss_aux <- nmiss[ nmiss != 0 ]
nmiss_aux <- sort(nmiss_aux, decreasing = TRUE)
```

```r
table(nmiss_aux)
```

```
## nmiss_aux
##    9   43  112  207 1061 4315 4793
##    1    1    2    1    1    1    1
```

```r
barplot(nmiss_aux, col="yellow", main="Variables with missing values");
```



Al barplot sols apareixen les variables amb dades mancants.

7.2 Errors

```r
verrs<-rep(0, nrow(df))

nInitialVariables<- 21
nerrs<-rep(0, nInitialVariables)

initialVariables <- 0:21
names(nerrs) <- names(df[initialVariables])
names(df[initialVariables])
```

```
##  [1] "age"            "job"            "marital"        "education"
##  [5] "default"        "housing"        "loan"           "contact"
##  [9] "month"          "day_of_week"    "duration"       "campaign"
## [13] "pdays"          "previous"       "poutcome"       "emp.var.rate"
## [17] "cons.price.idx" "cons.conf.idx"  "euribor3m"      "nr.employed"
## [21] "y"
```

7.2.1 Job

```
v<-c("admin.", "blue-collar", "entrepreneur", "housemaid", "management", "retired", "self-employed","se
llista<-which(!is.element(df[2], v));
verrs[llista]<-verrs[llista]+1
nerrs[2]<-nerrs[2]+sum(!is.element(df[,2], v))
```

7.2.2 Marital

```
v<-c("divorced", "married", "single", NA)
llista<-which(!is.element(df[3], v));
verrs[llista]<-verrs[llista]+1
nerrs[3]<-nerrs[3]+sum(!is.element(df[,3], v))
```

7.2.3 Education

```
v<-c("Edu-basic.4y", "Edu-basic.6y", "Edu-basic.9y", "Edu-high.school", "Edu-illiterate", "Edu-professi
llista<-which(!is.element(df[4], v));
verrs[llista]<-verrs[llista]+1
nerrs[4]<-nerrs[4]+sum(!is.element(df[,4], v))
```

7.2.4 Default

```
v<-c("no", "yes", NA)
llista<-which(!is.element(df[5], v));
verrs[llista]<-verrs[llista]+1
nerrs[5]<-nerrs[5]+sum(!is.element(df[,5], v))
```

7.2.5 Housing

```
v<-c("no", "yes", NA)
llista<-which(!is.element(df[6], v));
verrs[llista]<-verrs[llista]+1
nerrs[6]<-nerrs[6]+sum(!is.element(df[,6], v))
```

7.2.6 Loan

```
v<-c("no", "yes", NA)
llista<-which(!is.element(df[7], v));
verrs[llista]<-verrs[llista]+1
nerrs[7]<-nerrs[7]+sum(!is.element(df[,7], v))
```

7.2.7 Contact

```
v<-c("cellular", "telephone", NA)
llista<-which(!is.element(df[8], v));
verrs[llista]<-verrs[llista]+1
nerrs[8]<-nerrs[8]+sum(!is.element(df[,8], v))
```

7.2.8 Month

```
v<-c("apr", "aug", "dec", "jul", "jun", "mar", "may", "nov", "oct", "sep", "jan", "feb", NA)
llista<-which(!is.element(df[9], v));
verrs[llista]<-verrs[llista]+1
nerrs[9]<-nerrs[9]+sum(!is.element(df[,9], v))
```

7.2.9 Day of week

```
v<-c("mon", "tue", "wed", "thu", "fri", NA)
llista<-which(!is.element(df[10], v));
verrs[llista]<-verrs[llista]+1
nerrs[10]<-nerrs[10]+sum(!is.element(df[,10], v))
```

7.2.10 Poutcome

```
v<-c("failure", "success", NA)
llista<-which(!is.element(df[,15], v));
verrs[llista]<-verrs[llista]+1
nerrs[15]<-nerrs[15]+sum(!is.element(df[,15], v))
```

7.2.11 Y

```
v<-c("yes", "no", NA)
llista<-which(!is.element(df[21], v));
verrs[llista]<-verrs[llista]+1
nerrs[21]<-nerrs[21]+sum(!is.element(df[,21], v))
```

Així els errors queden:

```
nerrs
```

```
##            age            job        marital      education        default
##              0              0              0              0              0
##        housing           loan        contact          month    day_of_week
##              0              0              0              0              0
##       duration       campaign          pdays       previous       poutcome
##              0              0              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

7.3 Outliers

```
vout<-rep(0,nrow(df))

nInitialVariables<- 21
nout<-rep(0,nInitialVariables)

initialVariables <- 0:21
names(nout) <- names(df[initialVariables])
names(df[initialVariables])
```

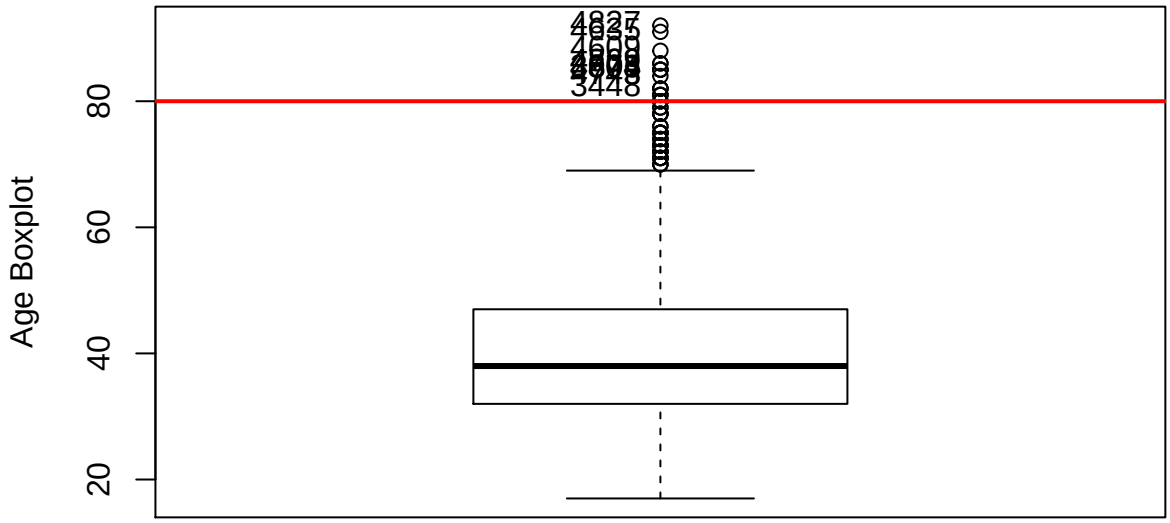
```
##  [1] "age"            "job"            "marital"        "education"
##  [5] "default"        "housing"        "loan"           "contact"
##  [9] "month"          "day_of_week"    "duration"       "campaign"
## [13] "pdays"          "previous"       "poutcome"       "emp.var.rate"
## [17] "cons.price.idx" "cons.conf.idx"  "euribor3m"      "nr.employed"
## [21] "y"
```

7.3.1 Age

```
Boxplot(df$age, ylab = "Age Boxplot")
```

```
##  [1] 4827 4635 4609 4732 4869 3675 4803 4804 4743 3448
```

```
sout <- 80
abline(h=sout,col="red",lwd=2)
```




```
outliers<-which(df$age>sout);length(outliers);
```

```
## [1] 15
```

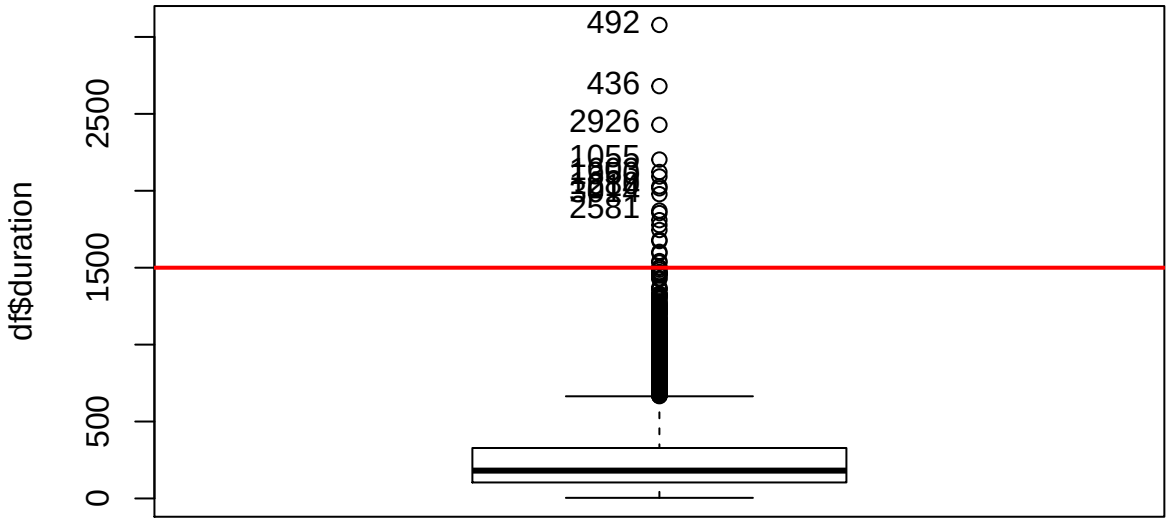
```
df$age[outliers] <- NA;
if(length(outliers)>0){
vout[outliers]<-vout[outliers]+1
nout["age"]<-length(outliers)}
```

7.3.2 duration

```
Boxplot(df$duration)
```

```
##  [1]  492  436 2926 1055 1603 1350 1680  214 3014 2581
```

```
sout <- 1500
abline(h=sout,col="red",lwd=2)
```




```
outliers<-which(df$duration>sout);length(outliers);
```

```
## [1] 21
```

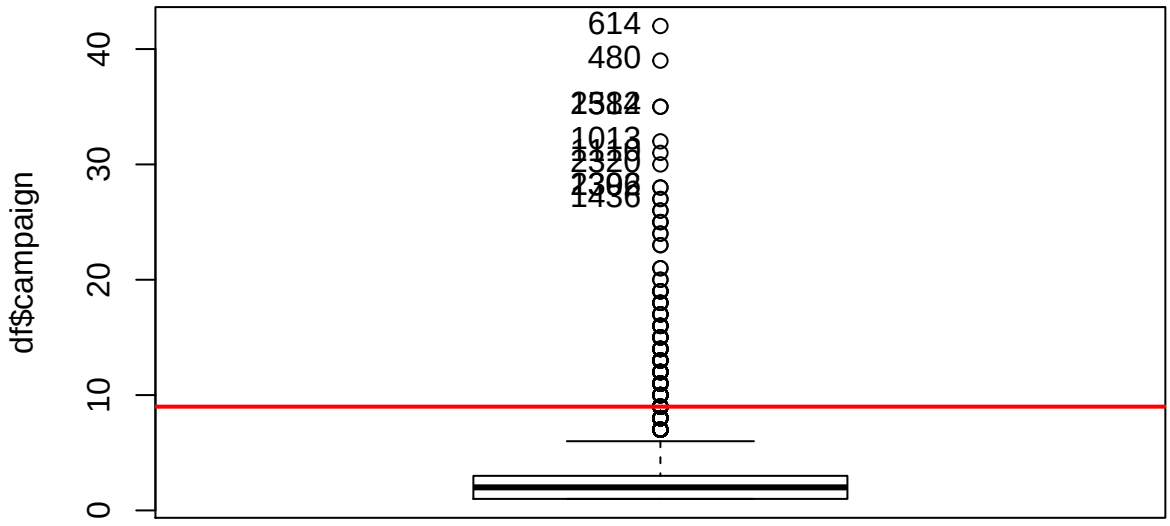
```
if(length(outliers)>0){
vout[outliers]<-vout[outliers]+1
nout["duration"]<-length(outliers)}
```

7.3.3 campaign

```
Boxplot(df$campaign)
```

```
##  [1]  614  480 1584 2312 1013 1110 2320 1392 2306 1436
```

```
sout <- 9
abline(h=sout,col="red",lwd=2)
```



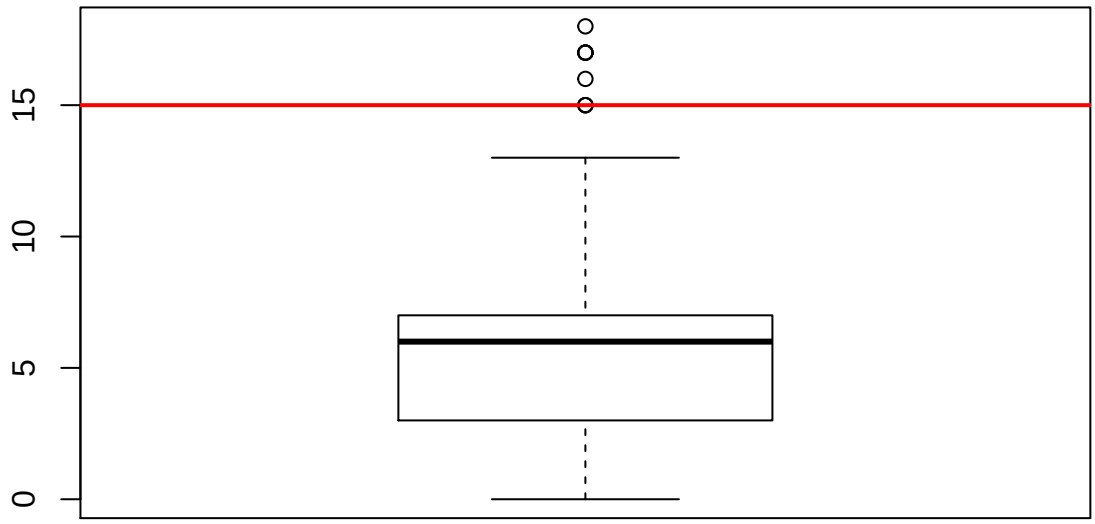

```
outliers<-which(df$campaign>sout);length(outliers);
```

```
## [1] 146
```

```
df$campaign[outliers] <- NA;
if(length(outliers)>0){
vout[outliers]<-vout[outliers]+1
nout["campaign"]<-length(outliers)}
```

7.3.4 pdays

```
boxplot(df$pdays);
sout <- 15;
abline(h=sout,col="red",lwd=2);
```




```
outliers<-which(df$pdays> sout); length(outliers);
```

```
## [1] 6
```

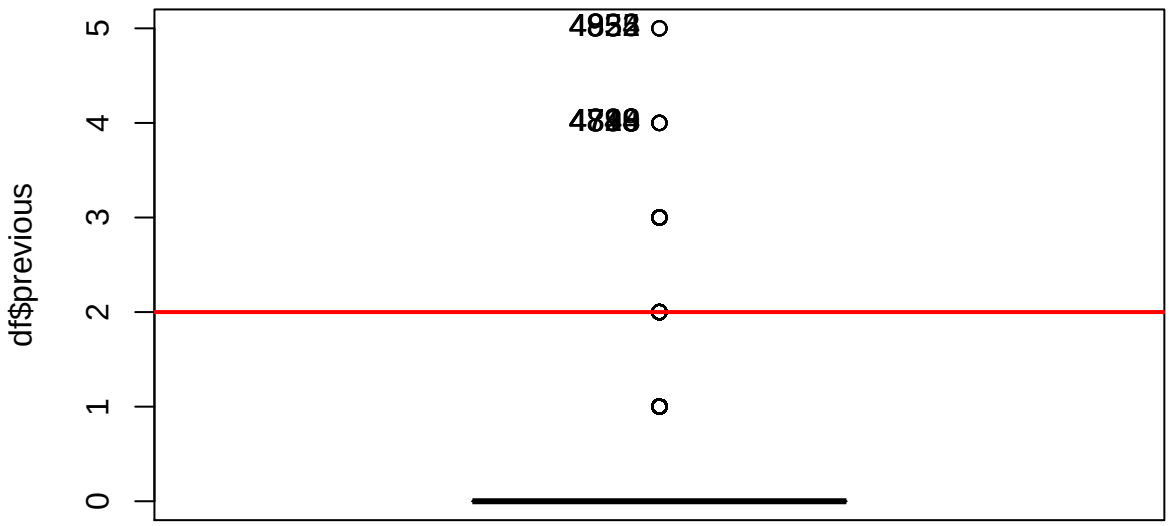
```
df$pdays[outliers] <- NA;
if(length(outliers)>0){
vout[outliers]<-vout[outliers]+1
nout["pdays"]<-length(outliers)}
```

7.3.5 previous

```
Boxplot(df$previous)
```

```
##  [1] 4822 4835 4952 4954 4719 4783 4790 4828 4844 4848
```

```
sout <- 2
abline(h=sout,col="red",lwd=2)
```




```
outliers<-which(df$previous> sout);
df$previous[outliers] <- NA;
length(outliers);
```

```
## [1] 47
```

```
if(length(outliers)>0){
vout[outliers]<-vout[outliers]+1
nout["previous"]<-length(outliers)}
```

Així els outliers queden:

```
nout
```

```
##            age            job        marital      education        default
##             15              0              0              0              0
##        housing           loan        contact          month    day_of_week
##              0              0              0              0              0
##       duration       campaign          pdays       previous       poutcome
##             21            146              6             47              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

8 Rank Variables

```
miss <- sort(nmiss, decreasing =  TRUE)
miss
```

```
##          pdays       poutcome        default      education        housing
##           4793           4315           1061            207            112
##           loan            job        marital            age        contact
##            112             43              9              0              0
##          month    day_of_week       duration       campaign       previous
##              0              0              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

```
err <- sort(nerrs, decreasing =  TRUE)
err
```

```
##            age            job        marital      education        default
##              0              0              0              0              0
##        housing           loan        contact          month    day_of_week
##              0              0              0              0              0
##       duration       campaign          pdays       previous       poutcome
##              0              0              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

```
miss <- sort(nmiss, decreasing =  TRUE)
miss
```

```
##          pdays       poutcome        default      education        housing
##           4793           4315           1061            207            112
##           loan            job        marital            age        contact
##            112             43              9              0              0
##          month    day_of_week       duration       campaign       previous
##              0              0              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

```
out <- sort(nout, decreasing =  TRUE)
out
```

```
##       campaign       previous       duration            age          pdays
##            146             47             21             15              6
##            job        marital      education        default        housing
##              0              0              0              0              0
##           loan        contact          month    day_of_week       poutcome
##              0              0              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

```
ranking <- nmiss + nerrs + nout;
ranking <- sort(ranking, decreasing = TRUE);
ranking
```

```
##          pdays       poutcome        default      education       campaign
##           4799           4315           1061            207            146
##        housing           loan       previous            job       duration
##            112            112             47             43             21
##            age        marital        contact          month    day_of_week
##             15              9              0              0              0
##   emp.var.rate cons.price.idx  cons.conf.idx      euribor3m    nr.employed
##              0              0              0              0              0
##              y
##              0
```

8.1 Individual

```
vmis<-rep(0, nrow(df))
nmis<-rep(0, ncol(df))
for(i in 1:nrow(df)) {
vmis[i]<-vmis[i]+sum(is.na(df[i,]))
}
### Create variable adding the total number missing values, outliers and errors
df$outliers<-vout
df$errors<-verrs
df$missings<-vmis
```

9 Correlation

```
##Outliers
condes(df, num.var = 35)
```

```
## $quanti
##                 correlation      p.value
## cons.price.idx  0.09277707 4.935483e-11
## duration        0.09217400 6.578690e-11
## missings        0.08750383 5.725813e-10
## cons.conf.idx   0.04206987 2.926427e-03
## campaign       -0.03485868 1.515141e-02
## nr.employed    -0.06723109 1.953740e-06
##
## $quali
##                             R2      p.value
## f.prev_contacted 0.0227976441 6.937572e-27
## month            0.0177019926 2.370453e-15
## f.month          0.0177019926 2.370453e-15
## poutcome         0.0126995605 1.354103e-14
## y                0.0058927611 5.488243e-08
## job              0.0078449930 4.672357e-05
## f.job            0.0078449930 4.672357e-05
## f.jobsituation   0.0036459260 1.088007e-04
## f.season         0.0026809265 1.221971e-03
```

```
## education        0.0035745603 1.249920e-02
## contact          0.0007892906 4.698187e-02
## f.contact        0.0007892906 4.698187e-02
## loan             0.0012042854 4.925618e-02
## f.loan           0.0012042854 4.925618e-02
##
## $category
##                     Estimate      p.value
## Contacted        0.081812419 6.937572e-27
## success          0.072116782 5.134633e-14
## Month-sep        0.132112071 3.375808e-10
## sep              0.132112071 3.375808e-10
## yes              0.025739217 5.488243e-08
## Other            0.014226777 4.381288e-05
## Job-retired      0.049221530 1.038034e-04
## retired          0.049221530 1.038034e-04
## Month-oct        0.059231366 1.236697e-04
## oct              0.059231366 1.236697e-04
## Job-student      0.062269658 6.151821e-04
## student          0.062269658 6.151821e-04
## Summer           0.009445982 1.934820e-03
## Edu-basic.4y     0.027994349 1.707508e-02
## f.no             0.016447061 1.881531e-02
## no               0.016447061 1.881531e-02
## f.single         0.020057898 3.525089e-02
## single           0.020057898 3.525089e-02
## f.married        0.004782537 3.900623e-02
## married          0.004782537 3.900623e-02
## f.age-(50,95]    0.011668659 4.206059e-02
## f.telephone      0.006289677 4.698187e-02
## telephone        0.006289677 4.698187e-02
## f.cellular      -0.006289677 4.698187e-02
## cellular        -0.006289677 4.698187e-02
## failure         -0.022404431 3.040848e-02
## Edu-basic.6y    -0.022588815 2.423028e-02
## Job-services    -0.032252635 2.269021e-02
## services        -0.032252635 2.269021e-02
## Month-jul       -0.017164598 1.433353e-02
## jul             -0.017164598 1.433353e-02
## Month-jun       -0.013342474 1.180245e-02
## jun             -0.013342474 1.180245e-02
## Job-blue-collar -0.024858369 1.096798e-02
## blue-collar     -0.024858369 1.096798e-02
## Edu-basic.9y    -0.013266682 7.404904e-03
## Month-nov       -0.064072886 6.542548e-04
## nov             -0.064072886 6.542548e-04
## Month-may       -0.048442732 3.132088e-04
## may             -0.048442732 3.132088e-04
## Spring          -0.014074703 2.863111e-04
## Worker          -0.013828160 4.717187e-05
## no              -0.025739217 5.488243e-08
## NA              -0.049712351 1.179041e-09
## No-contacted    -0.081812419 6.937572e-27
```

```r
##Errors
#condes(df, num.var = 36) ##NO FUNCIONA, NO HI HA ERRORS
##Missings
condes(df, num.var = 37)
```

```
## $quanti
##                correlation       p.value
## emp.var.rate    0.32059379 6.915468e-120
## euribor3m       0.31925495 7.539951e-119
## nr.employed     0.31676931 6.159986e-117
## cons.price.idx  0.25210903  2.394819e-73
## age             0.13225565  6.805599e-21
## outliers        0.08750383  5.725813e-10
## cons.conf.idx   0.04099752  3.738104e-03
## campaign        0.03483158  1.523054e-02
## previous       -0.42315303 2.030358e-214
##
## $quali
##                           R2       p.value
## default          0.535780204  0.000000e+00
## f.default        0.535780204  0.000000e+00
## loan             0.241643238 7.313059e-301
## f.loan           0.241643238 7.313059e-301
## housing          0.241517653 1.106051e-300
## f.housing        0.241517653 1.106051e-300
## poutcome         0.204236107 1.286462e-248
## f.prev_contacted 0.113007932 2.380717e-132
## education        0.080884953  6.578439e-87
## job              0.072449068  9.771474e-74
## f.job            0.072449068  9.771474e-74
## f.education      0.061370385  1.891864e-69
## contact          0.046652810  7.324880e-54
## f.contact        0.046652810  7.324880e-54
## month            0.049126070  4.716899e-49
## f.month          0.049126070  4.716899e-49
## y                0.029025116  7.096717e-34
## f.season         0.028568002  3.547259e-32
## f.age            0.022838134  7.424390e-25
## marital          0.022022645  5.860022e-24
## f.marital        0.022022645  5.860022e-24
## f.jobsituation   0.007767691  3.455343e-09
##
## $category
##                            Estimate       p.value
## NA                     1.087223059  0.000000e+00
## NA                     1.087223059  0.000000e+00
## NA                     2.698104360 2.243802e-302
## NA                     2.688966220 2.243802e-302
## NA                     2.698104360 2.243802e-302
## NA                     2.688966220 2.243802e-302
## NA                     1.158397313 1.944798e-227
## No-contacted           1.027183048 2.380717e-132
## NA                     1.151292413  5.804433e-57
## Other                  0.903536808  4.449317e-56
```

```
## f.telephone            0.272689164  7.324880e-54
## telephone              0.272689164  7.324880e-54
## NA                     2.521893692  1.678143e-49
## NA                     2.521893692  1.678143e-49
## no                     0.322138053  7.096717e-34
## Job-blue-collar        0.098621784  1.020782e-18
## blue-collar            0.098621784  1.020782e-18
## Summer                 0.274890250  5.082947e-18
## Edu-basic.4y           0.249890173  1.760364e-14
## NA                     2.130389105  5.531075e-12
## NA                     2.130389105  5.531075e-12
## f.age-(40,50]          0.184697514  9.683462e-11
## Month-jun              0.626592566  1.109488e-10
## jun                    0.626592566  1.109488e-10
## f.age-(50,95]          0.197797300  5.304722e-08
## Worker                 0.084409151  8.550677e-08
## Edu-basic.6y           0.209956096  5.955419e-07
## Month-jul              0.515360065  2.256065e-06
## jul                    0.515360065  2.256065e-06
## Job-housemaid          0.177813354  6.666548e-04
## housemaid              0.177813354  6.666548e-04
## Month-may              0.413964198  3.280969e-03
## may                    0.413964198  3.280969e-03
## Job-management        -0.307496264  3.868777e-02
## management            -0.307496264  3.868777e-02
## Job-technician        -0.266257317  2.039955e-02
## technician            -0.266257317  2.039955e-02
## Month-dec             -0.308176174  1.922055e-02
## dec                   -0.308176174  1.922055e-02
## f.yes                 -1.368490878  2.567887e-03
## yes                   -1.368490878  2.567887e-03
## f.age-(30,40]         -0.087930286  1.231375e-04
## Edu-high.school       -0.270472752  7.333131e-05
## Mandatory             -0.310407397  1.913837e-05
## f.no                  -1.341862621  4.952234e-06
## no                    -1.341862621  4.952234e-06
## Job-student           -0.747641192  2.037418e-06
## student               -0.747641192  2.037418e-06
## Month-apr             -0.014058527  4.532814e-08
## apr                   -0.014058527  4.532814e-08
## f.yes                 -1.347103599  7.963467e-09
## yes                   -1.347103599  7.963467e-09
## Month-oct             -0.439422010  7.506767e-09
## oct                   -0.439422010  7.506767e-09
## Month-mar             -0.521892282  5.489624e-09
## mar                   -0.521892282  5.489624e-09
## Other                 -0.143651719  4.699821e-10
## Month-sep             -0.643104404  2.884680e-11
## sep                   -0.643104404  2.884680e-11
## Month-nov             -0.008008424  7.921110e-12
## nov                   -0.008008424  7.921110e-12
## f.married             -0.550730444  3.578250e-13
## married               -0.550730444  3.578250e-13
## f.single              -0.855957411  5.880094e-14
```

```
## single                -0.855957411  5.880094e-14
## f.age-[17,30]         -0.294564528  6.798179e-15
## Job-admin.            -0.404908272  4.641734e-15
## admin.                -0.404908272  4.641734e-15
## Edu-university.degree -0.426412445  4.461532e-25
## Non-Mandatory         -0.593129411  1.085083e-26
## f.no                  -1.329613482  2.633646e-27
## no                    -1.329613482  2.633646e-27
## Aut-Win               -0.361408450  1.598668e-27
## yes                   -0.322138053  7.096717e-34
## f.cellular            -0.272689164  7.324880e-54
## cellular              -0.272689164  7.324880e-54
## failure               -0.104236689  2.835968e-95
## success               -1.054160624 5.664133e-127
## Contacted             -1.027183048 2.380717e-132
## f.no                  -1.087223059  0.000000e+00
## no                    -1.087223059  0.000000e+00
```

```
aggregate(df$missings, by=list(df$f.age), FUN=mean)
```

```
##         Group.1        x
## 1 f.age-[17,30] 2.153326
## 2 f.age-(30,40] 2.359960
## 3 f.age-(40,50] 2.632588
## 4 f.age-(50,95] 2.645688
```

```
aggregate(df$outliers, by=list(df$f.age), FUN=mean)
```

```
##         Group.1          x
## 1 f.age-[17,30] 0.04847802
## 2 f.age-(30,40] 0.04193709
## 3 f.age-(40,50] 0.04472843
## 4 f.age-(50,95] 0.06060606
```

```
aggregate(df$missings, by=list(df$f.jobsituation), FUN=mean)
```

```
##         Group.1        x
## 1 Self-employed 2.496774
## 2        Worker 2.521941
## 3         Other 2.293880
```

```
aggregate(df$outliers, by=list(df$f.jobsituation), FUN=mean)
```

```
##         Group.1          x
## 1 Self-employed 0.04946237
## 2        Worker 0.03603282
## 3         Other 0.06408776
```

```
aggregate(df$missings, by=list(df$f.education), FUN=mean)
```

```
##         Group.1        x
## 1     Mandatory 2.508544
## 2 Non-Mandatory 2.225822
## 3         Other 3.722488
```

```
aggregate(df$outliers, by=list(df$f.education), FUN=mean)
```

```
##         Group.1          x
```

```
## 1     Mandatory 0.04309064
## 2 Non-Mandatory 0.05050024
## 3         Other 0.06220096
```

```
aggregate(df$missings, by=list(df$f.marital), FUN=mean)
```

```
##      Group.1        x
## 1 f.divorced 2.368132
## 2  f.married 2.541103
## 3   f.single 2.235876
```

```
aggregate(df$outliers, by=list(df$f.marital), FUN=mean)
```

```
##      Group.1          x
## 1 f.divorced 0.04945055
## 2  f.married 0.04192803
## 3   f.single 0.05720339
```

10 Imputation

10.1 Numeric Variables

```
#Outliers -> missings

#Delete duration outliers
outliers<-which(df$duration>1500);length(outliers);
```

```
## [1] 21
```

```
df <- df[-outliers, ]

var_num <-names(df)[c(1, 12:14)] ## age,campaign,pdays,previous
length(var_num)
```

```
## [1] 4
```

```
summary(df[,var_num])
```

```
##       age           campaign         pdays           previous
##  Min.   :17.00   Min.   :1.000   Min.   : 0.000   Min.   :0.000
##  1st Qu.:32.00   1st Qu.:1.000   1st Qu.: 3.000   1st Qu.:0.000
##  Median :38.00   Median :2.000   Median : 5.000   Median :0.000
##  Mean   :39.83   Mean   :2.269   Mean   : 5.458   Mean   :0.147
##  3rd Qu.:47.00   3rd Qu.:3.000   3rd Qu.: 7.000   3rd Qu.:0.000
##  Max.   :80.00   Max.   :9.000   Max.   :15.000   Max.   :2.000
##  NA's   :15      NA's   :145     NA's   :4778     NA's   :47
```

```
res <- imputePCA(df[,var_num],ncp=2)
summary(res$completeObs)
```

```
##       age           campaign         pdays           previous
##  Min.   :17.00   Min.   :1.000   Min.   : 0.000   Min.   :-0.007828
##  1st Qu.:32.00   1st Qu.:1.000   1st Qu.: 5.338   1st Qu.: 0.000000
##  Median :38.00   Median :2.000   Median : 5.394   Median : 0.000000
##  Mean   :39.83   Mean   :2.271   Mean   : 5.389   Mean   : 0.146942
##  3rd Qu.:47.00   3rd Qu.:3.000   3rd Qu.: 5.433   3rd Qu.: 0.000000
##  Max.   :80.00   Max.   :9.000   Max.   :15.000   Max.   : 2.000000
```

```
#S'han imputat valors negatius a previous, els posem a 0

sel <- which(res$completeObs[,"previous"] < 0)
res$completeObs[sel,"previous"] <- 0

df$age <- res$completeObs[,"age"]
df$campaign <- res$completeObs[,"campaign"]
df$pdays <- res$completeObs[,"pdays"]
df$previous <- res$completeObs[,"previous"]
```

10.2 Factors

```
# TODO: ADD f.yes in f.loan with value 0
factors <-names(df)[c(24,28, 29 ,31)]; # f.job, f.housing, f.marital, f.loan
summary(df[,factors])
```

```
##              f.job      f.housing         f.marital      f.loan
##  Job-admin.     :1283   f.no :2220   f.divorced: 545   f.no :4120
##  Job-blue-collar:1154   f.yes:2647   f.married :3018   f.yes: 747
##  Job-technician : 829   NA's : 112   f.single  :1407   NA's : 112
##  Job-services   : 469                NA's      :   9
##  Job-management : 343
##  (Other)        : 860
##  NA's           :  41
```

```
resfact <- imputeMCA(df[,factors],ncp=3);
summary(resfact$completeObs)
```

```
##              f.job      f.housing         f.marital      f.loan
##  Job-admin.     :1303   f.no :2223   f.divorced: 545   f.no :4232
##  Job-blue-collar:1175   f.yes:2756   f.married :3027   f.yes: 747
##  Job-technician : 829                f.single  :1407
##  Job-services   : 469
##  Job-management : 343
##  Job-retired    : 186
##  (Other)        : 674
```

```
df$f.housing <- resfact$completeObs[,"f.housing"]
df$f.marital <- resfact$completeObs[,"f.marital"]
df$f.loan <- resfact$completeObs[,"f.loan"]
df$f.job <- resfact$completeObs[,"f.job"]
```

```
#Imputem manualment poutcome ja que pensem que els que no han respós a la pregunta molt probablement ta

sel <- which(is.na(df$poutcome))

df$poutcome <- factor(df$poutcome, labels=paste("Pout", sep="-", levels(df$poutcome)))

table(df$poutcome)
```

```
##
## Pout-failure Pout-success
##          491          192
```

```r
df$f.poutcome<-2

# 1 level - failure
sel<-which(df$poutcome %in% c("Pout-failure"))
df$f.poutcome[sel] <- 1
sel<- which(is.na(df$poutcome))
df$f.poutcome[sel] <- 1
table(df$f.poutcome)
```

```
##
##    1    2
## 4787  192
```

```r
# 2 level - success
sel<-which(df$poutcome %in% c("Pout-success"))
df$f.poutcome[sel] <- 2
summary(df$f.education)
```

```
##     Mandatory Non-Mandatory         Other
##          2685          2086           208
```

```r
df$f.poutcome<-factor(df$f.poutcome,levels=1:2,labels=c("f.Pout-failure","f.Pout-success"))
summary(df$f.poutcome)
```

```
## f.Pout-failure f.Pout-success
##           4787            192
```

```r
#Imputem manualment default ja que pensem que els que no han respós a la pregunta no poden ser imputats

sel <- which(is.na(df$default))
df$f.default[sel] <- "f.no"
table(df$f.default)
```

```
##
## f.no f.si
## 4979    0
```

11 Profiling

```r
condes(df[c(1:29, 31:34,38)],11)
```

```
## $quanti
##             correlation      p.value
## pdays        0.02993732 0.0346537787
## nr.employed -0.03189122 0.0244288564
## campaign    -0.04723473 0.0008560601
##
## $quali
##                            R2       p.value
## y                 0.160738690 1.169792e-191
## month             0.006371350  2.170869e-04
## f.month           0.006371350  2.170869e-04
## day_of_week       0.002933693  5.566255e-03
## f.day             0.002933693  5.566255e-03
## f.prev_contacted  0.001373939  8.903355e-03
```

```
## f.poutcome       0.001278653  1.162430e-02
## contact          0.001010183  2.491598e-02
## f.contact        0.001010183  2.491598e-02
## f.housing        0.001007355  2.511947e-02
## poutcome         0.001405185  3.024097e-02
##
## $category
##                       Estimate       p.value
## yes                 148.5619189 1.169792e-191
## f.day.wed            23.8425938  3.704865e-04
## wed                  23.8425938  3.704865e-04
## Contacted            21.9755934  8.903355e-03
## Month-dec           122.9070700  9.727753e-03
## dec                 122.9070700  9.727753e-03
## Job-self-employed    45.0705179  1.128480e-02
## self-employed        42.4765578  1.128480e-02
## f.Pout-success       21.9270496  1.162430e-02
## Pout-success         31.6018377  1.162430e-02
## Month-jul             0.4019466  1.503004e-02
## jul                   0.4019466  1.503004e-02
## no                   10.6116297  2.191781e-02
## f.cellular            7.8044172  2.491598e-02
## cellular              7.8044172  2.491598e-02
## f.no                  7.5382090  2.511947e-02
## Mandatory            11.4647925  2.667720e-02
## f.day.mon           -13.0962186  4.765549e-02
## mon                 -13.0962186  4.765549e-02
## yes                  -4.7751417  2.952173e-02
## Summer               -9.4533836  2.921958e-02
## f.yes                -7.5382090  2.511947e-02
## f.telephone          -7.8044172  2.491598e-02
## telephone            -7.8044172  2.491598e-02
## Job-housemaid       -48.9550116  2.360381e-02
## housemaid           -51.5489717  2.360381e-02
## f.Pout-failure      -21.9270496  1.162430e-02
## No-contacted        -21.9755934  8.903355e-03
## Month-aug           -40.1682151  4.976285e-03
## aug                 -40.1682151  4.976285e-03
## Month-jun           -43.5063607  1.930997e-03
## jun                 -43.5063607  1.930997e-03
## no                 -148.5619189 1.169792e-191
```

```
catdes(df, num.var = 21)
```

```
##
## Link between the cluster variable and the categorical variables (chi-square test)
## =================================================================================
##                         p.value df
## f.default         0.000000e+00  1
## f.prev_contacted 1.746438e-113  1
## poutcome         1.256455e-110  2
## f.poutcome       6.599570e-109  1
## month             2.092803e-78  9
## f.month           2.092803e-78  9
## f.job             2.831986e-27 10
```

```
## job               6.520196e-27 11
## contact           7.944988e-25  1
## f.contact         7.944988e-25  1
## default           1.313876e-11  1
## f.jobsituation    3.313476e-08  2
## f.age             4.789647e-08  3
## f.season          5.088671e-08  2
## f.marital         1.549949e-05  2
## marital           3.916274e-05  3
## education         8.492460e-05  7
## f.education       7.801545e-03  2
##
## Description of each cluster by the categories
## ============================================
## $no
##                                  Cla/Mod    Mod/Cla     Global
## f.prev_contacted=No-contacted   90.65577 98.1624319 95.8626230
## f.poutcome=f.Pout-failure       90.53687 98.3212341 96.1438040
## poutcome=NA                     91.13128 88.8157895 86.2823860
## f.contact=f.telephone           94.68733 38.8157895 36.2924282
## contact=telephone               94.68733 38.8157895 36.2924282
## f.month=Month-may               93.12612 35.3448276 33.6011247
## month=may                       93.12612 35.3448276 33.6011247
## default=NA                      94.41816 22.6406534 21.2291625
## job=blue-collar                 94.02080 24.6143376 23.1773448
## f.job=Job-blue-collar           93.95745 25.0453721 23.5991163
## f.jobsituation=Worker           90.30411 57.2595281 56.1357702
## f.marital=f.married             89.85795 61.7059891 60.7953404
## marital=married                 89.82770 61.5018149 60.6145812
## f.age=f.age-(30,40]             90.27569 40.8575318 40.0682868
## education=Edu-basic.9y          91.80978 15.7667877 15.2038562
## f.age=f.age-(40,50]             90.93098 25.7032668 25.0251054
## f.education=Mandatory           89.68343 54.6279492 53.9264913
## f.month=Month-nov               91.58317 10.3675136 10.0220928
## month=nov                       91.58317 10.3675136 10.0220928
## f.season=Summer                 89.63226 45.8938294 45.3303876
## f.month=Month-jun               90.85366 13.5208711 13.1753364
## month=jun                       90.85366 13.5208711 13.1753364
## f.jobsituation=Self-employed    91.32321  9.5508167  9.2588873
## f.job=Job-management            85.13120  6.6243194  6.8889335
## job=management                  85.13120  6.6243194  6.8889335
## poutcome=Pout-failure           85.33605  9.5054446  9.8614180
## f.month=Month-dec               63.15789  0.2722323  0.3816027
## month=dec                       63.15789  0.2722323  0.3816027
## f.age=f.age-(50,95]             85.12881 16.4927405 17.1520386
## education=Edu-university.degree 86.07595 27.7676951 28.5599518
## f.age=f.age-[17,30]             84.50226 16.9464610 17.7545692
## f.job=Job-retired               76.88172  3.2441016  3.7356899
## job=retired                     76.88172  3.2441016  3.7356899
## f.marital=f.single              85.14570 27.1778584 28.2586865
## marital=single                  85.14570 27.1778584 28.2586865
## f.month=Month-apr               78.57143  5.7395644  6.4671621
## month=apr                       78.57143  5.7395644  6.4671621
## f.season=Aut-Win                81.84569 12.2731397 13.2757582
```

```
## f.jobsituation=Other            84.91004 33.1896552 34.6053424
## default=no                      86.94544 77.3593466 78.7708375
## f.job=Job-student               59.59596  1.3384755  1.9883511
## job=student                     59.59596  1.3384755  1.9883511
## f.month=Month-sep               50.00000  0.7486388  1.3255674
## f.month=Month-mar               50.00000  0.7486388  1.3255674
## month=sep                       50.00000  0.7486388  1.3255674
## month=mar                       50.00000  0.7486388  1.3255674
## f.month=Month-oct               50.64935  0.8847550  1.5464953
## month=oct                       50.64935  0.8847550  1.5464953
## f.contact=f.cellular            85.02522 61.1842105 63.7075718
## contact=cellular                85.02522 61.1842105 63.7075718
## f.poutcome=f.Pout-success       38.54167  1.6787659  3.8561960
## poutcome=Pout-success           38.54167  1.6787659  3.8561960
## f.prev_contacted=Contacted      39.32039  1.8375681  4.1373770
##                                      p.value     v.test
## f.prev_contacted=No-contacted   1.227915e-68  17.508783
## f.poutcome=f.Pout-failure       1.666964e-65  17.093224
## poutcome=NA                     5.763783e-38  12.880929
## f.contact=f.telephone           2.440539e-27  10.831526
## contact=telephone               2.440539e-27  10.831526
## f.month=Month-may               6.034473e-14   7.507332
## month=may                       6.034473e-14   7.507332
## default=NA                      4.251760e-13   7.247295
## job=blue-collar                 1.334762e-12   7.090658
## f.job=Job-blue-collar           1.422485e-12   7.081844
## f.jobsituation=Worker           9.925677e-06   4.418786
## f.marital=f.married             2.858318e-04   3.627813
## marital=married                 4.111959e-04   3.532792
## f.age=f.age-(30,40]             1.478138e-03   3.178942
## education=Edu-basic.9y          1.493774e-03   3.175890
## f.age=f.age-(40,50]             1.761035e-03   3.127827
## f.education=Mandatory           5.915694e-03   2.752418
## f.month=Month-nov               2.035659e-02   2.319710
## month=nov                       2.035659e-02   2.319710
## f.season=Summer                 2.628277e-02   2.222008
## f.month=Month-jun               4.135002e-02   2.040003
## month=jun                       4.135002e-02   2.040003
## f.jobsituation=Self-employed    4.326162e-02   2.021175
## f.job=Job-management            4.686185e-02  -1.987547
## job=management                  4.686185e-02  -1.987547
## poutcome=Pout-failure           2.293362e-02  -2.274539
## f.month=Month-dec               4.353220e-03  -2.851363
## month=dec                       4.353220e-03  -2.851363
## f.age=f.age-(50,95]             8.677261e-04  -3.330235
## education=Edu-university.degree 7.167173e-04  -3.383103
## f.age=f.age-[17,30]             6.154673e-05  -4.006801
## f.job=Job-retired               4.756560e-06  -4.575248
## job=retired                     4.756560e-06  -4.575248
## f.marital=f.single              4.173805e-06  -4.602534
## marital=single                  4.173805e-06  -4.602534
## f.month=Month-apr               1.145794e-07  -5.301939
## month=apr                       1.145794e-07  -5.301939
## f.season=Aut-Win                4.630214e-08  -5.464956
```

```
## f.jobsituation=Other            9.853123e-09  -5.733238
## default=no                      4.251760e-13  -7.247295
## f.job=Job-student               9.483114e-14  -7.447909
## job=student                     9.483114e-14  -7.447909
## f.month=Month-sep               8.048922e-15  -7.766807
## f.month=Month-mar               8.048922e-15  -7.766807
## month=sep                       8.048922e-15  -7.766807
## month=mar                       8.048922e-15  -7.766807
## f.month=Month-oct               1.184930e-16  -8.284614
## month=oct                       1.184930e-16  -8.284614
## f.contact=f.cellular            2.440539e-27 -10.831526
## contact=cellular                2.440539e-27 -10.831526
## f.poutcome=f.Pout-success       1.666964e-65 -17.093224
## poutcome=Pout-success           1.666964e-65 -17.093224
## f.prev_contacted=Contacted      1.227915e-68 -17.508783
##
## $yes
##                                   Cla/Mod   Mod/Cla     Global
## f.prev_contacted=Contacted      60.679612 21.891419  4.1373770
## f.poutcome=f.Pout-success       61.458333 20.665499  3.8561960
## poutcome=Pout-success           61.458333 20.665499  3.8561960
## f.contact=f.cellular            14.974779 83.187391 63.7075718
## contact=cellular                14.974779 83.187391 63.7075718
## f.month=Month-oct               49.350649  6.654991  1.5464953
## month=oct                       49.350649  6.654991  1.5464953
## f.month=Month-sep               50.000000  5.779335  1.3255674
## f.month=Month-mar               50.000000  5.779335  1.3255674
## month=sep                       50.000000  5.779335  1.3255674
## month=mar                       50.000000  5.779335  1.3255674
## f.job=Job-student               40.404040  7.005254  1.9883511
## job=student                     40.404040  7.005254  1.9883511
## default=no                      13.054564 89.667250 78.7708375
## f.jobsituation=Other            15.089959 45.534151 34.6053424
## f.season=Aut-Win                18.154312 21.015762 13.2757582
## f.month=Month-apr               21.428571 12.084063  6.4671621
## month=apr                       21.428571 12.084063  6.4671621
## f.marital=f.single              14.854300 36.602452 28.2586865
## marital=single                  14.854300 36.602452 28.2586865
## f.job=Job-retired               23.118280  7.530648  3.7356899
## job=retired                     23.118280  7.530648  3.7356899
## f.age=f.age-[17,30]             15.497738 23.992995 17.7545692
## education=Edu-university.degree 13.924051 34.676007 28.5599518
## f.age=f.age-(50,95]             14.871194 22.241681 17.1520386
## f.month=Month-dec               36.842105  1.225919  0.3816027
## month=dec                       36.842105  1.225919  0.3816027
## poutcome=Pout-failure           14.663951 12.609457  9.8614180
## f.job=Job-management            14.868805  8.931699  6.8889335
## job=management                  14.868805  8.931699  6.8889335
## f.jobsituation=Self-employed     8.676790  7.005254  9.2588873
## f.month=Month-jun                9.146341 10.507881 13.1753364
## month=jun                        9.146341 10.507881 13.1753364
## f.season=Summer                 10.367745 40.980736 45.3303876
## f.month=Month-nov                8.416834  7.355517 10.0220928
## month=nov                        8.416834  7.355517 10.0220928
```

```
## f.education=Mandatory           10.316574 48.511384 53.9264913
## f.age=f.age-(40,50]              9.069021 19.789842 25.0251054
## education=Edu-basic.9y           8.190225 10.858144 15.2038562
## f.age=f.age-(30,40]              9.724311 33.975482 40.0682868
## marital=married                 10.172300 53.765324 60.6145812
## f.marital=f.married             10.142055 53.765324 60.7953404
## f.jobsituation=Worker            9.695886 47.460595 56.1357702
## f.job=Job-blue-collar            6.042553 12.434326 23.5991163
## job=blue-collar                  5.979203 12.084063 23.1773448
## default=NA                       5.581835 10.332750 21.2291625
## f.month=Month-may                6.873879 20.140105 33.6011247
## month=may                        6.873879 20.140105 33.6011247
## f.contact=f.telephone            5.312673 16.812609 36.2924282
## contact=telephone                5.312673 16.812609 36.2924282
## poutcome=NA                      8.868715 66.725044 86.2823860
## f.poutcome=f.Pout-failure        9.463129 79.334501 96.1438040
## f.prev_contacted=No-contacted    9.344228 78.108581 95.8626230
##                                      p.value     v.test
## f.prev_contacted=Contacted      1.227915e-68  17.508783
## f.poutcome=f.Pout-success       1.666964e-65  17.093224
## poutcome=Pout-success           1.666964e-65  17.093224
## f.contact=f.cellular            2.440539e-27  10.831526
## contact=cellular                2.440539e-27  10.831526
## f.month=Month-oct               1.184930e-16   8.284614
## month=oct                       1.184930e-16   8.284614
## f.month=Month-sep               8.048922e-15   7.766807
## f.month=Month-mar               8.048922e-15   7.766807
## month=sep                       8.048922e-15   7.766807
## month=mar                       8.048922e-15   7.766807
## f.job=Job-student               9.483114e-14   7.447909
## job=student                     9.483114e-14   7.447909
## default=no                      4.251760e-13   7.247295
## f.jobsituation=Other            9.853123e-09   5.733238
## f.season=Aut-Win                4.630214e-08   5.464956
## f.month=Month-apr               1.145794e-07   5.301939
## month=apr                       1.145794e-07   5.301939
## f.marital=f.single              4.173805e-06   4.602534
## marital=single                  4.173805e-06   4.602534
## f.job=Job-retired               4.756560e-06   4.575248
## job=retired                     4.756560e-06   4.575248
## f.age=f.age-[17,30]             6.154673e-05   4.006801
## education=Edu-university.degree 7.167173e-04   3.383103
## f.age=f.age-(50,95]             8.677261e-04   3.330235
## f.month=Month-dec               4.353220e-03   2.851363
## month=dec                       4.353220e-03   2.851363
## poutcome=Pout-failure           2.293362e-02   2.274539
## f.job=Job-management            4.686185e-02   1.987547
## job=management                  4.686185e-02   1.987547
## f.jobsituation=Self-employed    4.326162e-02  -2.021175
## f.month=Month-jun               4.135002e-02  -2.040003
## month=jun                       4.135002e-02  -2.040003
## f.season=Summer                 2.628277e-02  -2.222008
## f.month=Month-nov               2.035659e-02  -2.319710
## month=nov                       2.035659e-02  -2.319710
```

```
## f.education=Mandatory           5.915694e-03  -2.752418
## f.age=f.age-(40,50]             1.761035e-03  -3.127827
## education=Edu-basic.9y          1.493774e-03  -3.175890
## f.age=f.age-(30,40]             1.478138e-03  -3.178942
## marital=married                 4.111959e-04  -3.532792
## f.marital=f.married             2.858318e-04  -3.627813
## f.jobsituation=Worker           9.925677e-06  -4.418786
## f.job=Job-blue-collar           1.422485e-12  -7.081844
## job=blue-collar                 1.334762e-12  -7.090658
## default=NA                      4.251760e-13  -7.247295
## f.month=Month-may               6.034473e-14  -7.507332
## month=may                       6.034473e-14  -7.507332
## f.contact=f.telephone           2.440539e-27 -10.831526
## contact=telephone               2.440539e-27 -10.831526
## poutcome=NA                     5.763783e-38 -12.880929
## f.poutcome=f.Pout-failure       1.666964e-65 -17.093224
## f.prev_contacted=No-contacted   1.227915e-68 -17.508783
##
##
## Link between the cluster variable and the quantitative variables
## ================================================================
##                       Eta2       P-value
## duration       0.160738690 1.169792e-191
## nr.employed    0.120745600 2.760101e-141
## euribor3m      0.087576045 3.394474e-101
## emp.var.rate   0.081696867  3.070308e-94
## previous       0.042285141  1.108497e-48
## missings       0.030232449  4.294241e-35
## cons.price.idx 0.017977169  2.070129e-21
## cons.conf.idx  0.008055104  2.236211e-10
## campaign       0.005633367  1.143924e-07
## outliers       0.002285655  7.393671e-04
##
## Description of each cluster by quantitative variables
## ======================================================
## $no
##                    v.test Mean in category  Overall mean sd in category
## nr.employed     24.516762    5177.09015426 5168.16794537     63.4164811
## euribor3m       20.879501       3.82261162    3.63896766      1.6252539
## emp.var.rate    20.166482       0.26197822    0.10236995      1.4608943
## missings        12.267727       2.51610708    2.44004820      1.1967189
## cons.price.idx   9.459934      93.61071461   93.58315164      0.5520673
## campaign         5.295555       2.31459362    2.27063047      1.6629733
## outliers        -3.373128       0.03924682    0.04277967      0.1976554
## cons.conf.idx   -6.332323     -40.74344374  -40.59754971      4.2611089
## previous       -14.508461       0.11734053    0.14694311      0.3499570
## duration       -28.287050     222.56442831  256.63908415    194.8113004
##                   Overall sd       p.value
## nr.employed     71.3410455 9.788565e-133
## euribor3m        1.7241963  8.224659e-97
## emp.var.rate     1.5515130  1.928802e-90
## missings         1.2153909  1.349895e-34
## cons.price.idx   0.5711736  3.081386e-21
## campaign         1.6274493  1.186556e-07
```

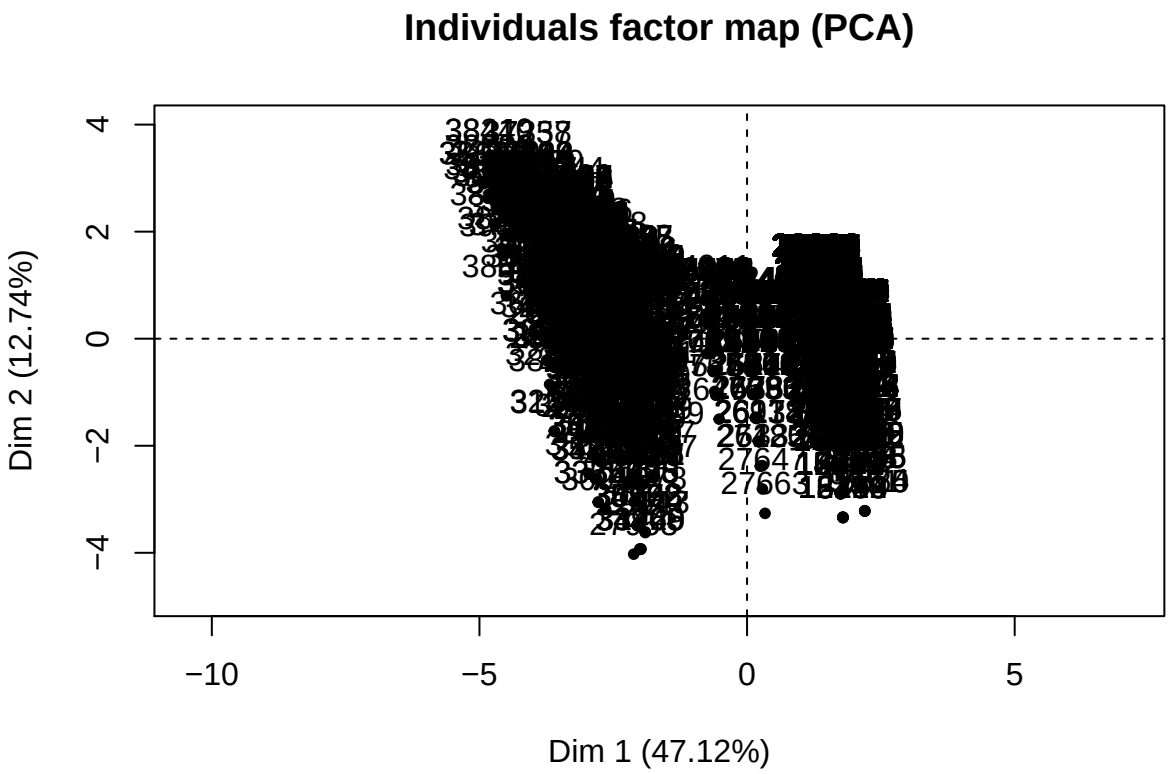
```
## outliers         0.2053159  7.431944e-04
## cons.conf.idx    4.5165276  2.414979e-10
## previous         0.3999801  1.070970e-47
## duration       236.1424174 4.987506e-176
##
## $yes
##                    v.test Mean in category  Overall mean sd in category
## duration        28.287050     519.68826620  256.63908415    339.2762889
## previous        14.508461       0.37546879    0.14694311      0.6249775
## cons.conf.idx    6.332323     -39.47127846  -40.59754971      6.0227719
## outliers         3.373128       0.07005254    0.04277967      0.2552355
## campaign        -5.295555       1.93124423    2.27063047      1.2712707
## cons.price.idx  -9.459934      93.37037128   93.58315164      0.6639079
## missings       -12.267727       1.85288967    2.44004820      1.1981032
## emp.var.rate   -20.166482      -1.12977233    0.10236995      1.6732331
## euribor3m      -20.879501       2.22127496    3.63896766      1.8058259
## nr.employed    -24.516762    5099.29036778 5168.16794537     89.3017729
##                  Overall sd       p.value
## duration       236.1424174 4.987506e-176
## previous         0.3999801  1.070970e-47
## cons.conf.idx    4.5165276  2.414979e-10
## outliers         0.2053159  7.431944e-04
## campaign         1.6274493  1.186556e-07
## cons.price.idx   0.5711736  3.081386e-21
## missings         1.2153909  1.349895e-34
## emp.var.rate     1.5515130  1.928802e-90
## euribor3m        1.7241963  8.224659e-97
## nr.employed     71.3410455 9.788565e-133
```

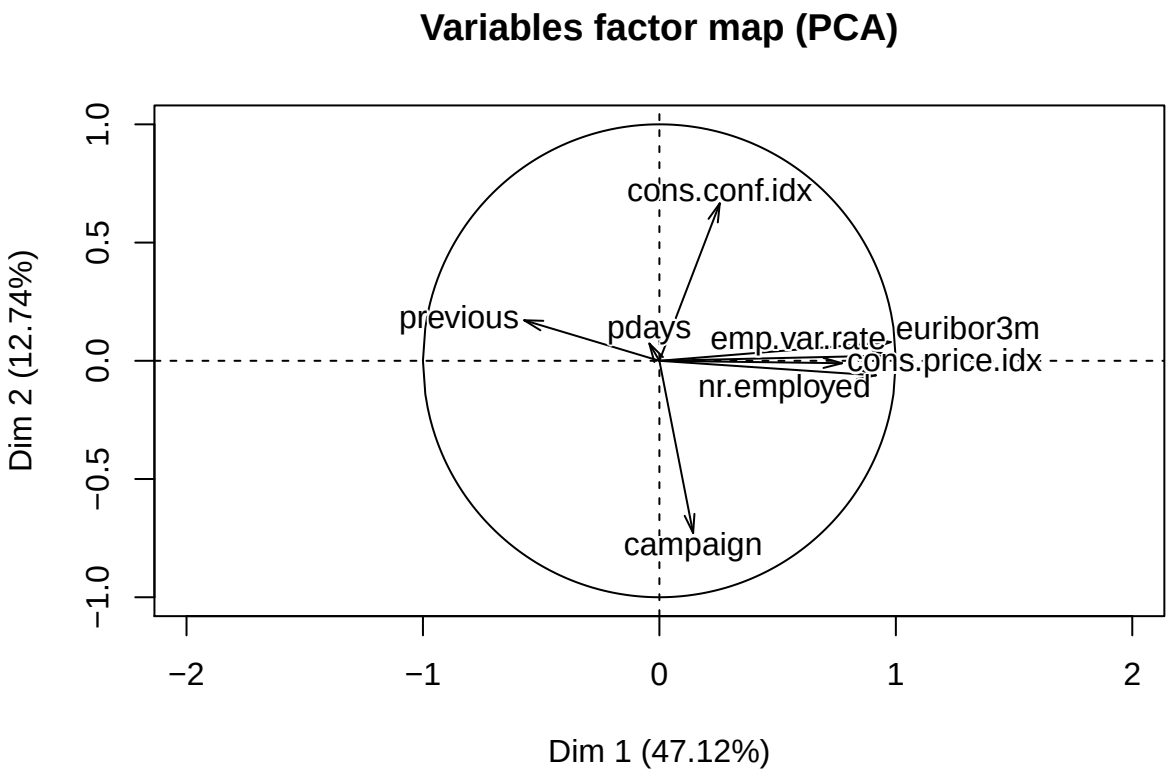
12 Deliverable II: PCA, CA and Clustering

12.1 PCA analysis

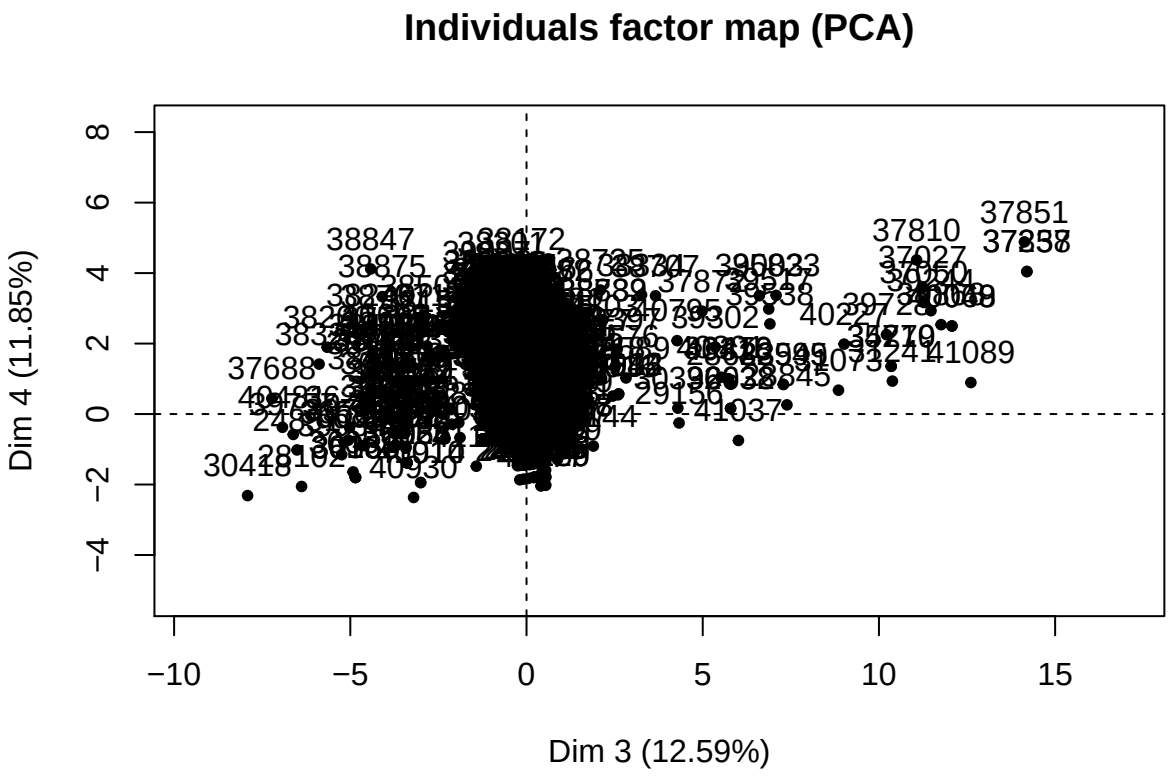
12.1.1 Eigenvalues and dominant axes analysis

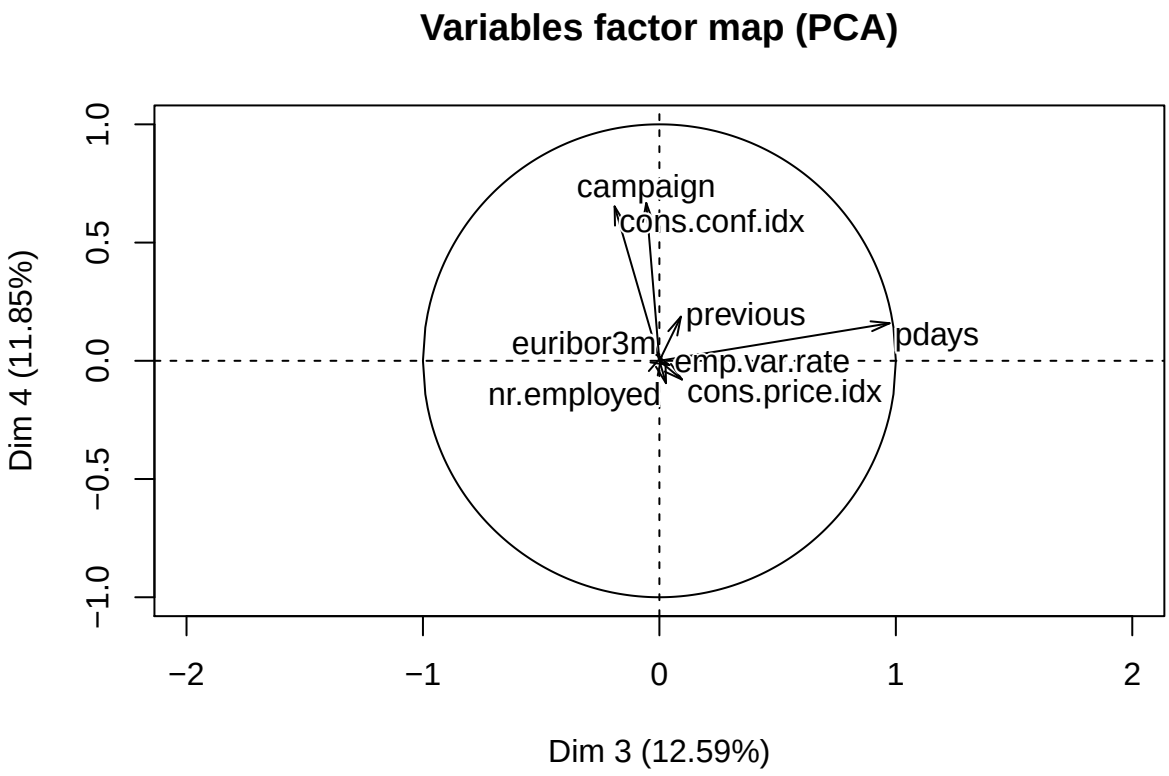
```
#PCA Y analysis (11)
vfact <- names(df[c(23,25:29,31:34)])
vnum <- names(df[c(12:14,16:20)])
res.pca <- PCA(df[,vnum])
```


Individuals factor map (PCA)
Dim 2 (12.74%)
Dim 1 (47.12%)
4
2
0
−2
−4
−10
−5
0
5




```
res.pca <-PCA(df[,vnum], axes=c(3,4))
```


Individuals factor map (PCA)
Dim 4 (11.85%)
Dim 3 (12.59%)
−10
−5
0
5
10
15
−4
−2
0
2
4
6
8
38847
37851
37810
37027
37688
30418
40930
41037
41089

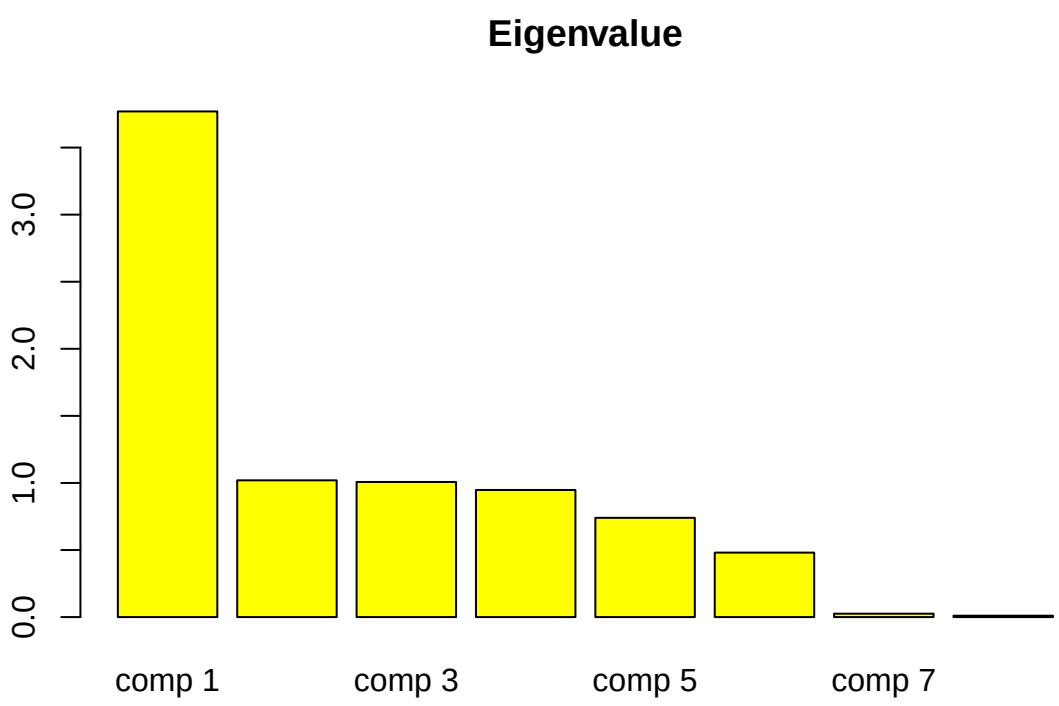



```
summary(res.pca, nb.dec = 2, nbelements = 10)
```

```
##
## Call:
## PCA(X = df[, vnum], axes = c(3, 4))
##
##
## Eigenvalues
##                        Dim.1  Dim.2  Dim.3  Dim.4  Dim.5  Dim.6  Dim.7
## Variance                3.77   1.02   1.01   0.95   0.74   0.48   0.03
## % of var.              47.12  12.74  12.59  11.85   9.25   6.01   0.32
## Cumulative % of var.   47.12  59.86  72.45  84.30  93.55  99.55  99.87
##                        Dim.8
## Variance                0.01
## % of var.               0.13
## Cumulative % of var. 100.00
##
## Individuals (the 10 first)
##                   Dist   Dim.1    ctr  cos2   Dim.2    ctr  cos2   Dim.3
## 4              |  1.77 |  1.29  0.01  0.53 |  1.16  0.03  0.43 | -0.06
## 9              |  1.78 |  1.29  0.01  0.52 |  1.17  0.03  0.43 |  0.09
## 22             |  1.78 |  1.29  0.01  0.53 |  1.15  0.03  0.41 | -0.20
## 47             |  1.78 |  1.29  0.01  0.53 |  1.14  0.03  0.41 | -0.22
## 55             |  1.61 |  1.34  0.01  0.69 |  0.70  0.01  0.19 | -0.24
## 56             |  1.78 |  1.29  0.01  0.53 |  1.15  0.03  0.41 | -0.20
## 62             |  1.78 |  1.29  0.01  0.53 |  1.15  0.03  0.42 | -0.16
```

```
## 71             |  1.77 |  1.29  0.01  0.53 |  1.16  0.03  0.43 | -0.07
## 77             |  1.78 |  1.29  0.01  0.53 |  1.15  0.03  0.41 | -0.20
## 79             |  1.78 |  1.29  0.01  0.53 |  1.15  0.03  0.41 | -0.20
##                 ctr  cos2
## 4              0.00  0.00 |
## 9              0.00  0.00 |
## 22             0.00  0.01 |
## 47             0.00  0.02 |
## 55             0.00  0.02 |
## 56             0.00  0.01 |
## 62             0.00  0.01 |
## 71             0.00  0.00 |
## 77             0.00  0.01 |
## 79             0.00  0.01 |
##
## Variables
##                  Dim.1   ctr  cos2   Dim.2   ctr  cos2   Dim.3   ctr  cos2
## campaign       |  0.14  0.54  0.02 | -0.73 52.04  0.53 | -0.06  0.31  0.00
## pdays          | -0.04  0.05  0.00 |  0.07  0.52  0.01 |  0.97 94.13  0.95
## previous       | -0.57  8.68  0.33 |  0.17  2.88  0.03 |  0.09  0.82  0.01
## emp.var.rate   |  0.98 25.52  0.96 |  0.02  0.05  0.00 |  0.04  0.18  0.00
## cons.price.idx |  0.77 15.83  0.60 | -0.01  0.01  0.00 |  0.10  0.91  0.01
## cons.conf.idx  |  0.26  1.73  0.07 |  0.67 43.50  0.44 | -0.19  3.57  0.04
## euribor3m      |  0.98 25.40  0.96 |  0.08  0.62  0.01 |  0.01  0.01  0.00
## nr.employed    |  0.92 22.25  0.84 | -0.06  0.37  0.00 |  0.03  0.08  0.00
##
## campaign       |
## pdays          |
## previous       |
## emp.var.rate   |
## cons.price.idx |
## cons.conf.idx  |
## euribor3m      |
## nr.employed    |
```

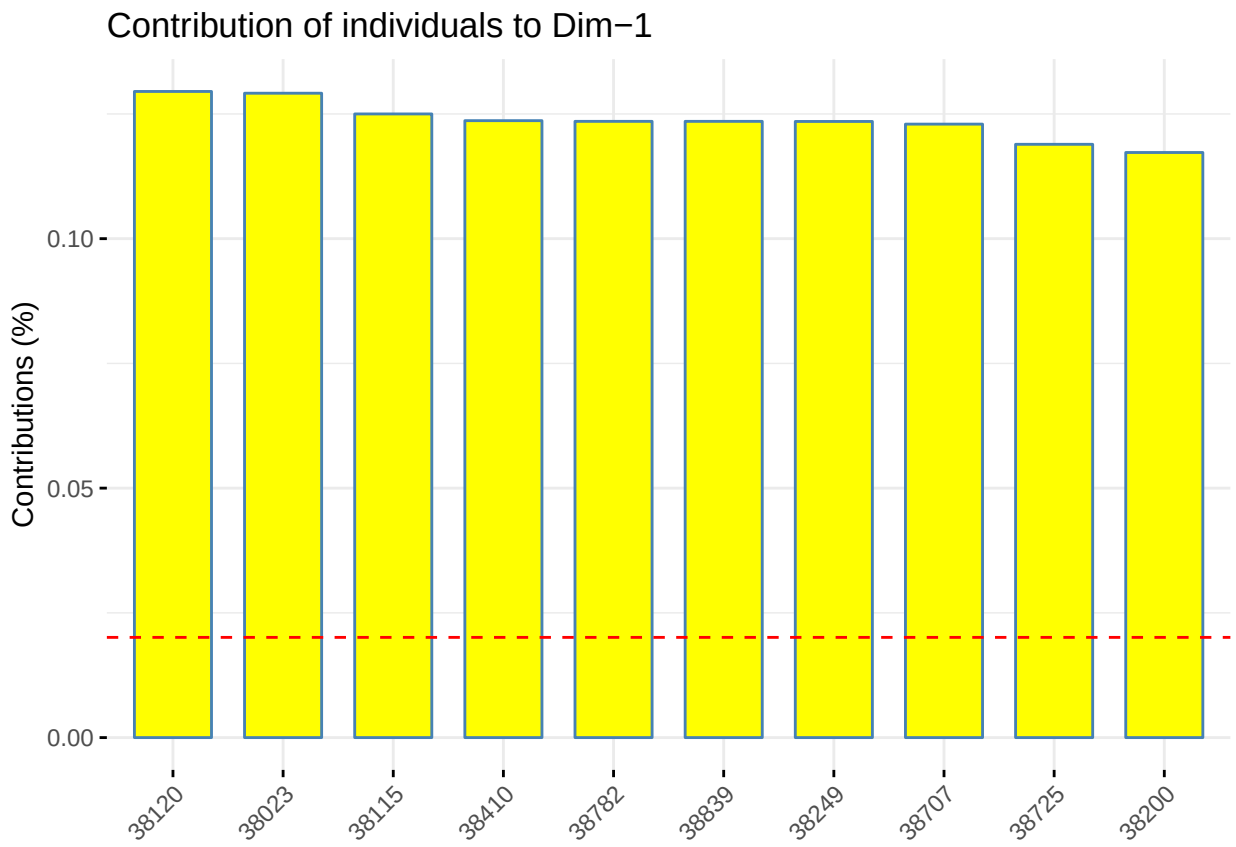
```r
#Segons criteri de Khaiser realitzarem la interpretació de les 3 primeres dimensions, ja que la quarta
barplot(res.pca$eig[,1], col = "yellow", main= "Eigenvalue")
```



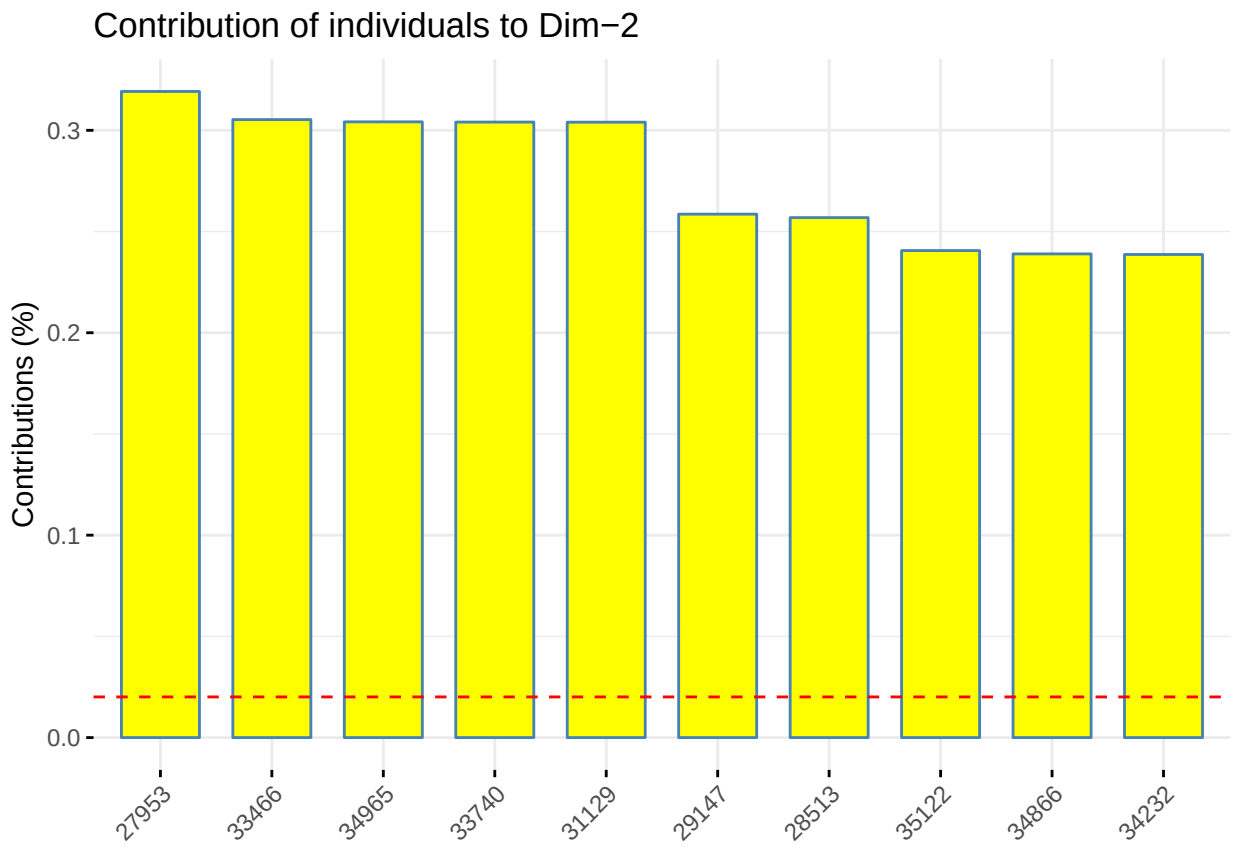

```
#En canvi, interpretariem 6 dimensions per Elbow's rule ja que notem una baixada considerable en a part
```

12.1.2 Individuals point of view

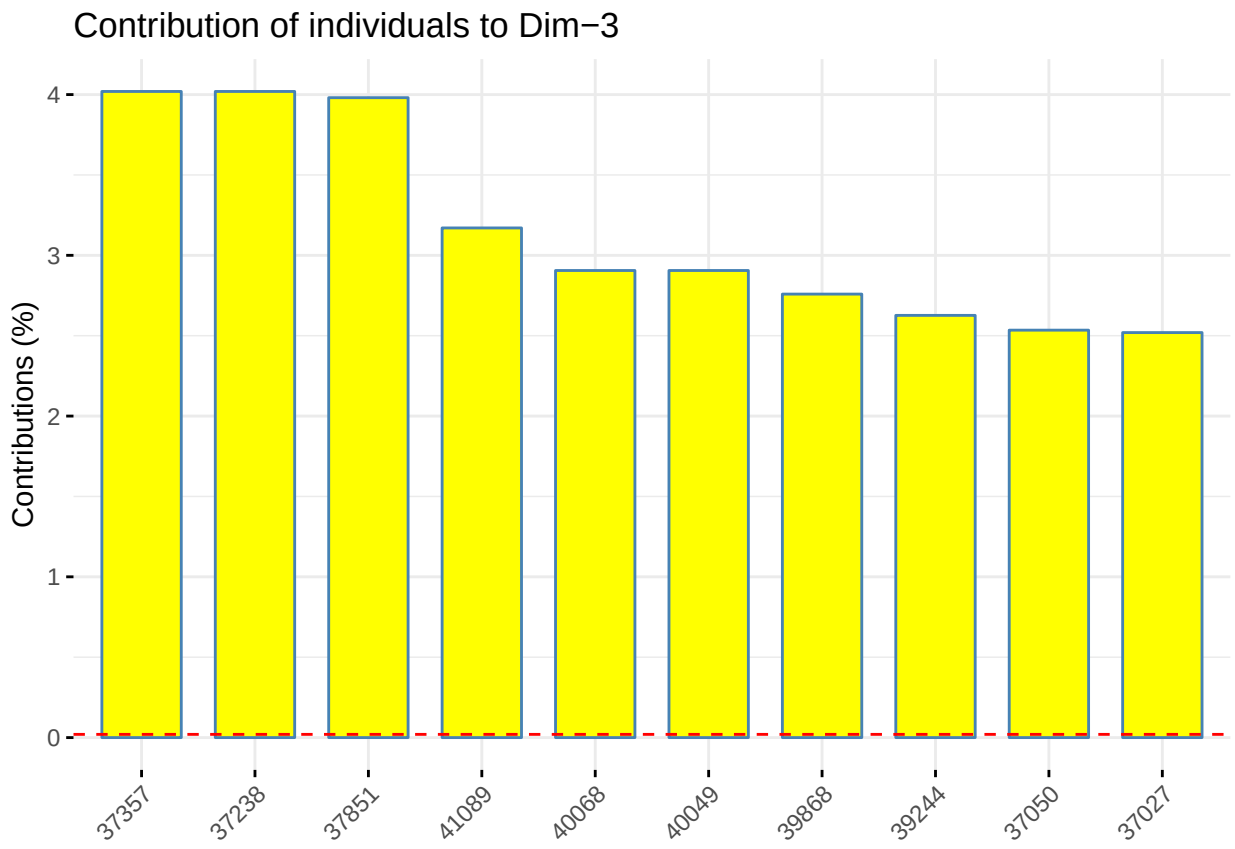
```
#Individus que contribuieixen més a la dimensió 1
fviz_contrib(res.pca, choice = "ind", top = 10, fill = "yellow", axes = 1); # Dimensió 1
```



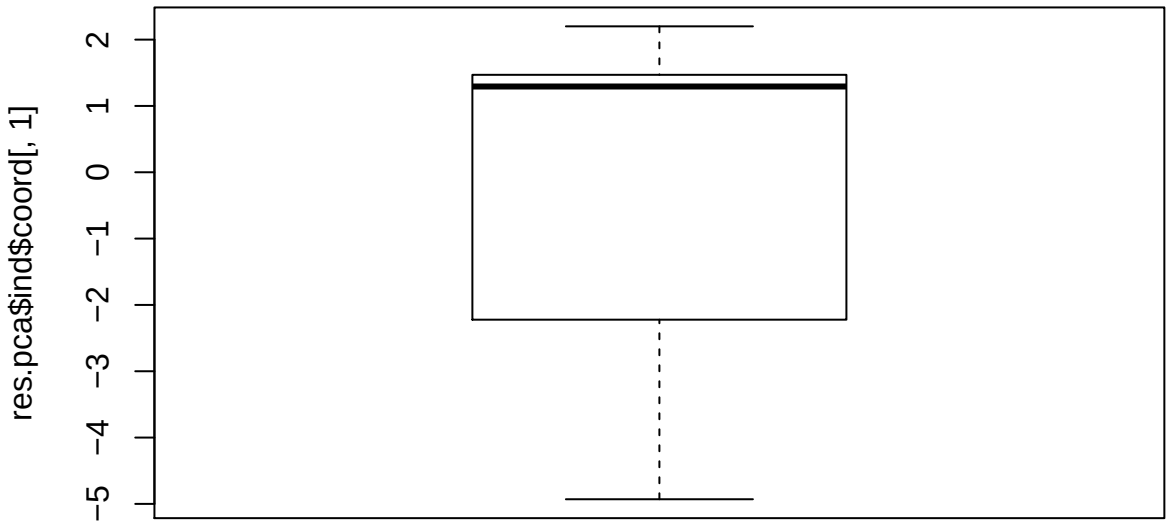

```
#Individus que contribuieixen més a la dimensió 2
fviz_contrib(res.pca, choice = "ind", top = 10, fill = "yellow", axes = 2); # Dimensió 2
```




```
#Individus que contribuieixen més a la dimensió 3
fviz_contrib(res.pca, choice = "ind", top = 10, fill = "yellow", axes = 3); # Dimensió 3
```




```
#Ara observem els individus més extrems del nostre data frame.
indiv_out.d1<-Boxplot(res.pca$ind$coord[,1]); indiv_out.d1; # Dimensió 1
```




```
## NULL
```

```
#En la dimensió 1 no trobem cap extrem
```

```
# Dimensió 2
indiv_out.d2<-Boxplot(res.pca$ind$coord[,2]); indiv_out.d2;
```

```
##  [1] 3394 4068 4246 4099 3786 3535 3464 4264 4231 4152 4662 4641 4547 4535
## [15] 4699 4703 4634 4615 4650 4680
```

```
q1 = quantile(res.pca$ind$coord[,1])[2];q1;
```

```
##       25%
## -2.222655
```

```
q3 = quantile(res.pca$ind$coord[,1])[4];q3;
```

```
##      75%
## 1.469477
```

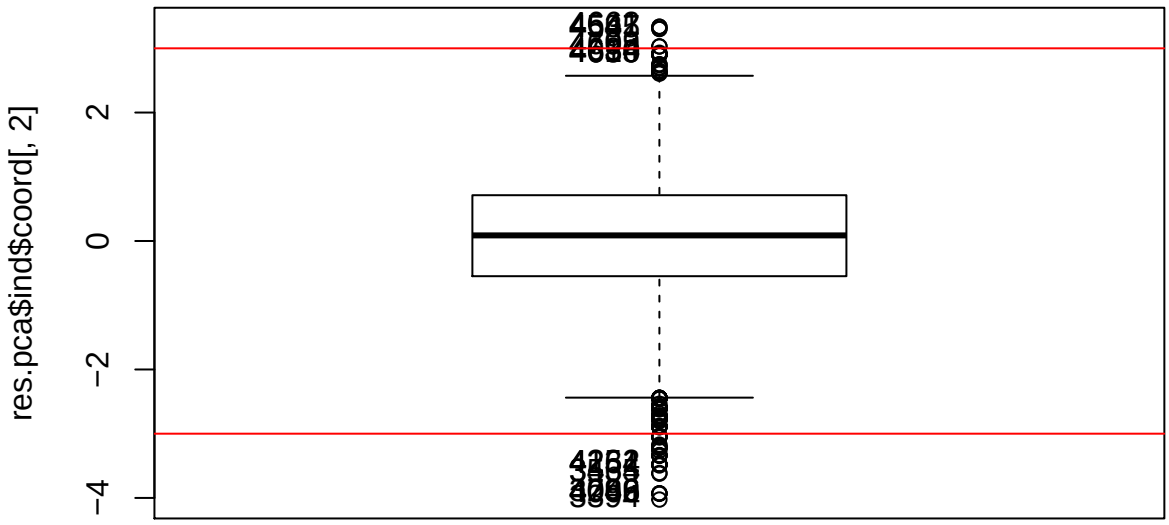
```
mild.threshold.upper = (q3-q1) * 1.5 + q3;mild.threshold.upper;
```

```
##      75%
## 7.007677
```

```
mild.threshold.lower = q1 -(q3-q1) * 1.5;mild.threshold.lower;
```

```
##       25%
## -7.760854
```

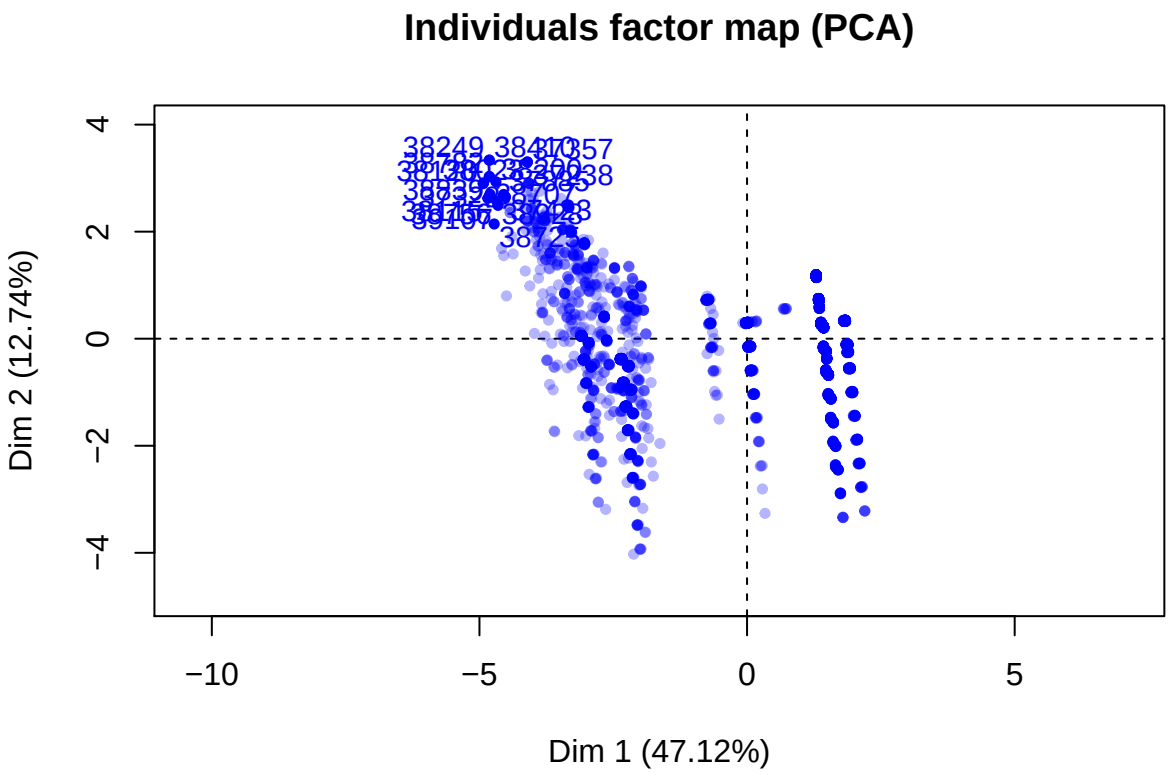
```r
abline(h=c(3, -3), col = "red")
```




```r
indiv_sup.d2 <- which(res.pca$ind$coord[,2] >= 3 | res.pca$ind$coord[,2] <= -3);
aux <- sort(indiv_sup.d2, decreasing= TRUE)
df[aux[1:5], vfact]
```

```
##       f.season f.jobsituation f.prev_contacted   f.education f.housing
## 38839  Aut-Win         Worker        Contacted Non-Mandatory      f.no
## 38782  Aut-Win          Other        Contacted Non-Mandatory      f.no
## 38410  Aut-Win          Other     No-contacted Non-Mandatory      f.no
## 38249  Aut-Win         Worker     No-contacted Non-Mandatory      f.no
## 37357   Summer          Other        Contacted Non-Mandatory      f.no
##        f.marital f.loan  f.contact     f.day         f.age
## 38839   f.single   f.no f.cellular f.day.mon f.age-(30,40]
## 38782   f.single   f.no f.cellular f.day.thu f.age-(30,40]
## 38410   f.single  f.yes f.cellular f.day.wed f.age-(30,40]
## 38249 f.divorced  f.yes f.cellular f.day.tue f.age-(30,40]
## 37357   f.single   f.no f.cellular f.day.tue f.age-[17,30]
```

```r
#En la dimensió 2 podem veure una petita mostra  que les coordenades més extremes ens apareixen en indi
plot.PCA(res.pca,choix=c("ind"),cex=0.95, col.ind="blue",select = "contrib 18")
```




```
#Dimensió 3
indiv_out.d3<-Boxplot(res.pca$ind$coord[,3]); indiv_out.d3;
```

```
##  [1] 3699 4578 4901 4818 3013 3415 4651 4634 4844 4451 4547 4535 4597 4969
## [15] 4856 4853 4828 4745 4512 4510
```

```
q1 = quantile(res.pca$ind$coord[,1])[2];q1;
```

```
##       25%
## -2.222655
```

```
q3 = quantile(res.pca$ind$coord[,1])[4];q3;
```

```
##      75%
## 1.469477
```

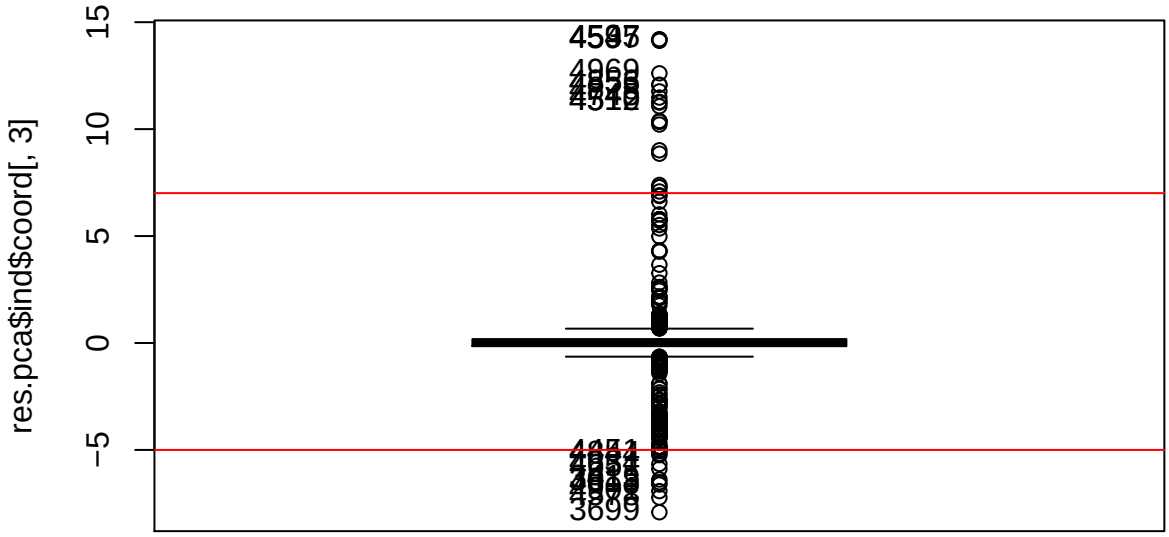
```
mild.threshold.upper = (q3-q1) * 1.5 + q3;mild.threshold.upper;
```

```
##      75%
## 7.007677
```

```
mild.threshold.lower = q1 -(q3-q1) * 1.5;mild.threshold.lower;
```

```
##       25%
## -7.760854
```

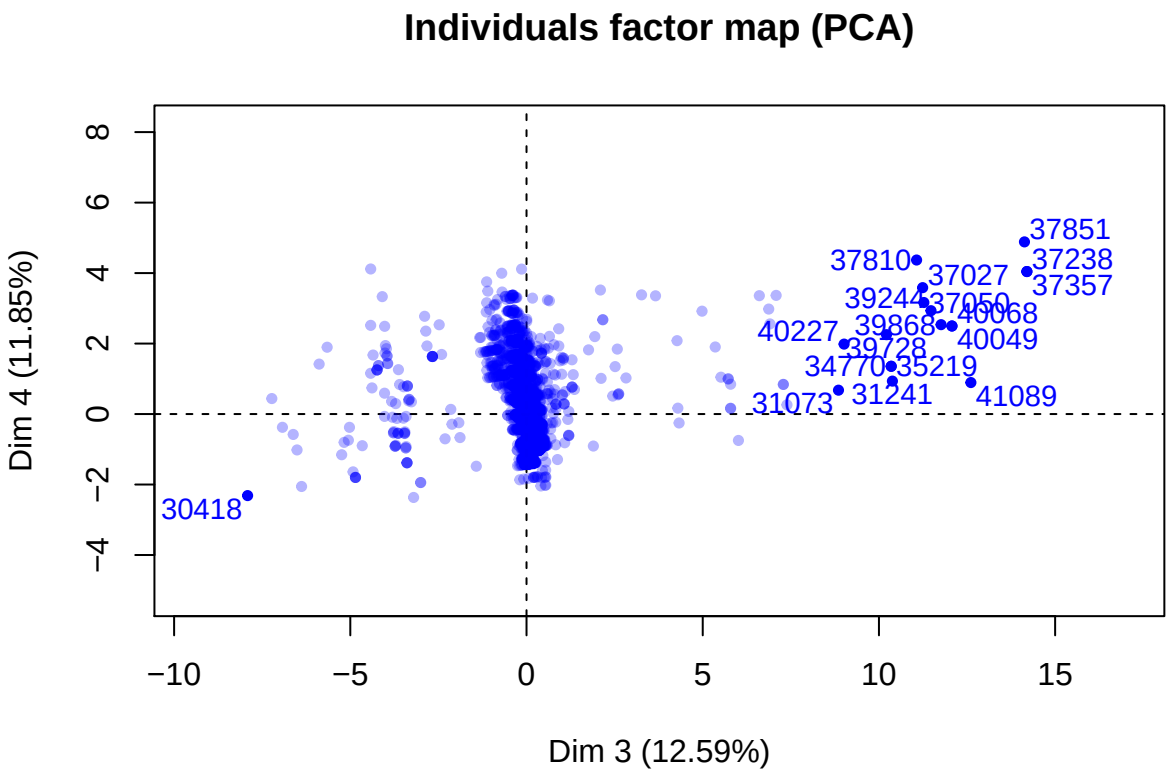
```
abline(h=c(mild.threshold.upper, -5), col = "red")
```




```
indiv_sup.d3 <- which(res.pca$ind$coord[,3] >= mild.threshold.upper | res.pca$ind$coord[,3] <= -5);
aux <- sort(indiv_sup.d3, decreasing= TRUE)
df[aux[1:7], vfact]
```

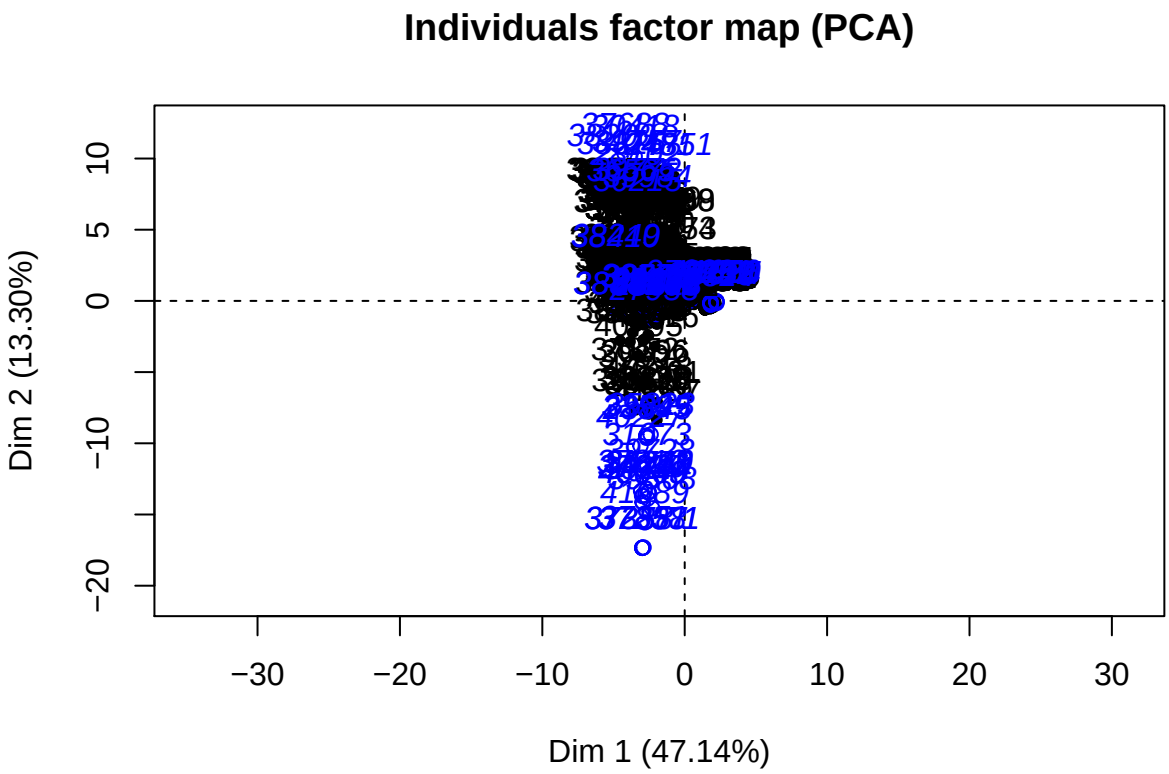
```
##       f.season f.jobsituation f.prev_contacted   f.education f.housing
## 41089  Aut-Win          Other        Contacted     Mandatory     f.yes
## 40481   Summer         Worker        Contacted Non-Mandatory     f.yes
## 40227   Summer         Worker        Contacted     Mandatory     f.yes
## 40068   Summer          Other        Contacted         Other     f.yes
## 40049   Summer          Other        Contacted     Mandatory     f.yes
## 39984   Summer  Self-employed        Contacted     Mandatory      f.no
## 39868   Summer          Other        Contacted     Mandatory     f.yes
##       f.marital f.loan   f.contact     f.day         f.age
## 41089  f.single   f.no f.telephone f.day.tue f.age-[17,30]
## 40481 f.married   f.no  f.cellular f.day.thu f.age-(50,95]
## 40227  f.single   f.no  f.cellular f.day.thu f.age-[17,30]
## 40068  f.single   f.no  f.cellular f.day.thu f.age-[17,30]
## 40049 f.married  f.yes  f.cellular f.day.tue f.age-(40,50]
## 39984 f.married   f.no  f.cellular f.day.tue f.age-(30,40]
## 39868 f.married   f.no  f.cellular f.day.tue f.age-[17,30]
```

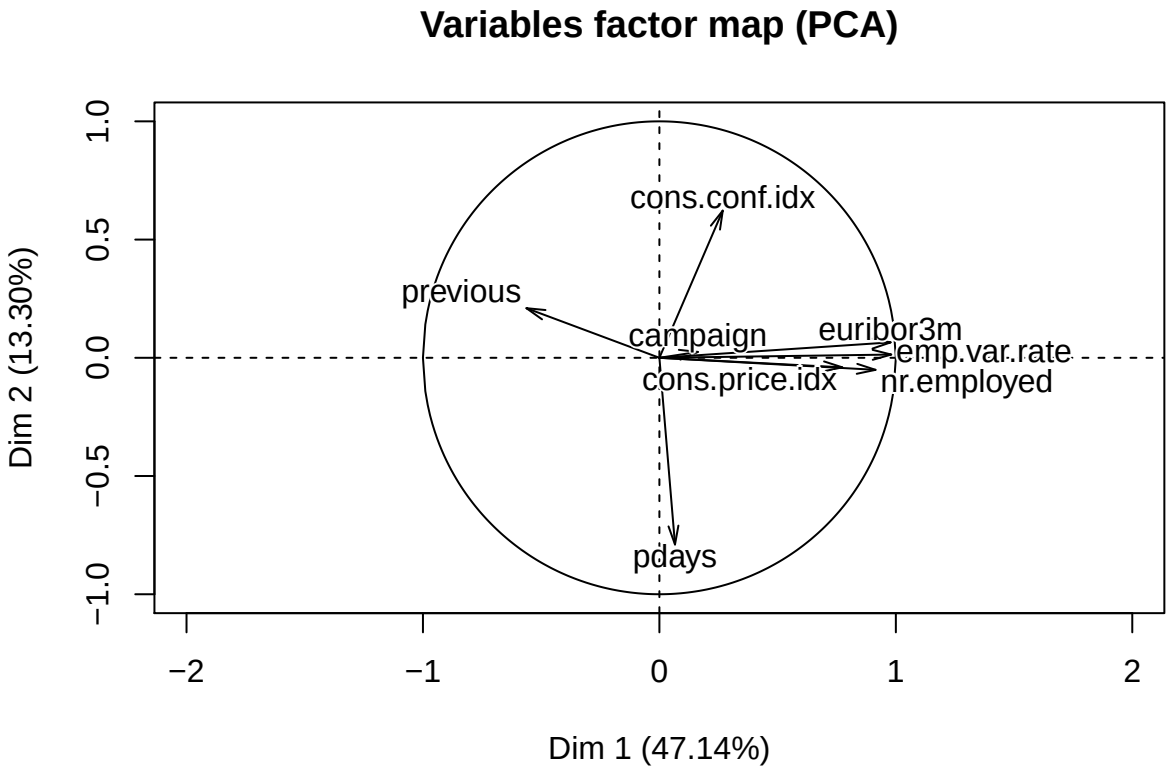
```
#En la dimensió 3 en canvi podem veure que les coordenades més extremes ens apareixen en individus amb
plot.PCA(res.pca,choix=c("ind"),cex=0.95, col.ind="blue",select = "contrib 18", axes = 3:4)
```




```
#Tornem a realitzar el calcul dels PCA ara tenint en compte que els nostres individus considerats outli

newres.pca <- PCA(df[,vnum], ind.sup = c(indiv_sup.d2, indiv_sup.d3))
```


Individuals factor map (PCA)
Dim 2 (13.30%)
10
5
0
−10
−20
−30
−20
−10
0
10
20
30
Dim 1 (47.14%)




```
#Podem veure que en utilizar els otuliers indivius com a individus suplmenetaris els eigenvalues canvie

summary(newres.pca, nb.dec = 2, nbelements = 10)
```

```
##
## Call:
## PCA(X = df[, vnum], ind.sup = c(indiv_sup.d2, indiv_sup.d3))
##
##
## Eigenvalues
##                        Dim.1  Dim.2  Dim.3  Dim.4  Dim.5  Dim.6  Dim.7
## Variance                3.77   1.06   0.98   0.91   0.75   0.48   0.03
## % of var.              47.14  13.30  12.29  11.37   9.40   6.04   0.32
## Cumulative % of var.   47.14  60.44  72.73  84.10  93.50  99.55  99.87
##                        Dim.8
## Variance                0.01
## % of var.               0.13
## Cumulative % of var. 100.00
##
## Individuals (the 10 first)
##                    Dist   Dim.1   ctr  cos2   Dim.2   ctr  cos2   Dim.3
## 4               |  1.76 |  1.27  0.01  0.51 |  0.45  0.00  0.06 | -1.02
## 9               |  1.79 |  1.27  0.01  0.51 |  0.26  0.00  0.02 | -1.04
## 22              |  1.78 |  1.26  0.01  0.50 |  0.63  0.01  0.13 | -0.99
## 47              |  1.78 |  1.26  0.01  0.50 |  0.65  0.01  0.13 | -0.99
## 55              |  1.60 |  1.31  0.01  0.67 |  0.65  0.01  0.17 | -0.36
```

```
## 56             |  1.78 |  1.26  0.01  0.50 |  0.63  0.01  0.13 | -0.99
## 62             |  1.77 |  1.26  0.01  0.51 |  0.58  0.01  0.11 | -1.00
## 71             |  1.76 |  1.26  0.01  0.51 |  0.46  0.00  0.07 | -1.02
## 77             |  1.78 |  1.26  0.01  0.50 |  0.63  0.01  0.13 | -0.99
## 79             |  1.78 |  1.26  0.01  0.50 |  0.63  0.01  0.13 | -0.99
##                 ctr  cos2
## 4              0.02  0.33 |
## 9              0.02  0.34 |
## 22             0.02  0.31 |
## 47             0.02  0.31 |
## 55             0.00  0.05 |
## 56             0.02  0.31 |
## 62             0.02  0.32 |
## 71             0.02  0.33 |
## 77             0.02  0.31 |
## 79             0.02  0.31 |
##
## Supplementary individuals (the 10 first)
##                   Dist   Dim.1  cos2   Dim.2  cos2   Dim.3  cos2
## 9951           |  4.84 |  2.23  0.21 | -0.02  0.00 |  4.20  0.76 |
## 10574          |  4.83 |  2.23  0.21 | -0.15  0.00 |  4.18  0.75 |
## 10825          |  4.83 |  2.23  0.21 | -0.07  0.00 |  4.20  0.75 |
## 11050          |  4.84 |  2.23  0.21 | -0.02  0.00 |  4.20  0.76 |
## 12452          |  4.64 |  1.82  0.15 | -0.13  0.00 |  4.26  0.84 |
## 15324          |  4.63 |  1.82  0.15 | -0.27  0.00 |  4.24  0.84 |
## 16243          |  4.64 |  1.82  0.15 | -0.10  0.00 |  4.26  0.84 |
## 18119          |  4.64 |  1.82  0.15 | -0.09  0.00 |  4.26  0.84 |
## 18738          |  4.63 |  1.82  0.15 | -0.22  0.00 |  4.24  0.84 |
## 27663          |  4.45 |  0.35  0.01 |  0.00  0.00 |  4.31  0.94 |
##
## Variables
##                  Dim.1   ctr  cos2   Dim.2   ctr  cos2   Dim.3   ctr  cos2
## campaign       |  0.16  0.70  0.03 |  0.02  0.06  0.00 |  0.97 95.39  0.94
## pdays          |  0.07  0.12  0.00 | -0.79 58.58  0.62 | -0.11  1.13  0.01
## previous       | -0.56  8.39  0.32 |  0.21  4.13  0.04 |  0.02  0.03  0.00
## emp.var.rate   |  0.98 25.49  0.96 |  0.01  0.02  0.00 | -0.02  0.06  0.00
## cons.price.idx |  0.77 15.87  0.60 | -0.04  0.15  0.00 | -0.02  0.05  0.00
## cons.conf.idx  |  0.27  1.90  0.07 |  0.62 36.41  0.39 | -0.17  3.08  0.03
## euribor3m      |  0.98 25.37  0.96 |  0.07  0.40  0.00 | -0.05  0.26  0.00
## nr.employed    |  0.91 22.16  0.84 | -0.05  0.24  0.00 |  0.00  0.00  0.00
##
## campaign       |
## pdays          |
## previous       |
## emp.var.rate   |
## cons.price.idx |
## cons.conf.idx  |
## euribor3m      |
## nr.employed    |
```

12.1.3 Interpreting the axes

```
#Comprovem de manera més exhaustiva quines variables afecten més als diferents eixos.
```

```r
dimdesc(newres.pca, axes = 1:3)
```

```
## $Dim.1
## $Dim.1$quanti
##                 correlation      p.value
## emp.var.rate     0.98049415 0.000000e+00
## euribor3m        0.97805412 0.000000e+00
## nr.employed      0.91405151 0.000000e+00
## cons.price.idx   0.77352829 0.000000e+00
## cons.conf.idx    0.26799918 1.557909e-81
## campaign         0.16290029 1.506009e-30
## pdays            0.06603261 3.641267e-06
## previous        -0.56248739 0.000000e+00
##
##
## $Dim.2
## $Dim.2$quanti
##                 correlation      p.value
## cons.conf.idx    0.62247943 0.000000e+00
## previous         0.20972163 6.242514e-50
## euribor3m        0.06518106 4.853424e-06
## cons.price.idx  -0.04039870 4.636959e-03
## nr.employed     -0.05103148 3.472055e-04
## pdays           -0.78955218 0.000000e+00
##
##
## $Dim.3
## $Dim.3$quanti
##                correlation      p.value
## campaign        0.96854829 0.000000e+00
## euribor3m      -0.05087184 3.623859e-04
## pdays          -0.10532598 1.371656e-13
## cons.conf.idx  -0.17391113 1.207461e-34
```

```r
#Pel que fa a la primera dimensió, les variables socioeconòmiques son les que ens mostren una major coo

#Pel que fa a la segona dimensió,  el més destacable és la relació inversament proporcional que el sego

#En canvi el tercer eix de dimensions està altament relacionat amb el numero de vegades que un clientha
```