# LABORATORIO_3

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## hola mundo

los comandos son (usenlo en la terminal, no en la consola):

git pull origin main git add . git commit -m “comentario” git push origin Tu_rama

hacen el pull request

-se pasan a main local -git pull origin main -luego a su rama local -git merge main -git push origin su rama

Laboratorio #2

Librerias y preliminares:

```
#librerias
library(readxl)
library(FactoMineR)
library(ggplot2)
library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(dplyr)
```

```
##
## Adjuntando el paquete: 'dplyr'

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

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

```
#base de datos
ciudades <- read_xlsx("Ciudades.xlsx")
summary(ciudades)
```

```
##    CIUDADES             RH_1              RH_2               RH_5
##  Length:22          Min.   :  66675   Min.   :0.003442   Min.   :0.07600
##  Class :character   1st Qu.: 293614   1st Qu.:0.007955   1st Qu.:0.09168
##  Mode  :character   Median : 397274   Median :0.011264   Median :0.10480
##                     Mean   : 888022   Mean   :0.014011   Mean   :0.11606
##                     3rd Qu.: 580057   3rd Qu.:0.015599   3rd Qu.:0.12362
##                     Max.   :7050228   Max.   :0.048184   Max.   :0.27130
##       RH_6              RH_7              RH_8            RH_9
##  Min.   :0.8025   Min.   :0.1072   Min.   :20.35   Min.   :0.1587
##  1st Qu.:1.0230   1st Qu.:0.1478   1st Qu.:22.20   1st Qu.:0.2158
##  Median :1.0977   Median :0.1802   Median :22.59   Median :0.2817
##  Mean   :1.0889   Mean   :0.2130   Mean   :23.27   Mean   :0.2807
##  3rd Qu.:1.1463   3rd Qu.:0.2607   3rd Qu.:24.44   3rd Qu.:0.3233
##  Max.   :1.2280   Max.   :0.5379   Max.   :26.25   Max.   :0.4467
##      RH_10             RH_11             RH_12            RH_13
##  Min.   : 626.8   Min.   :0.4559   Min.   : 7.373   Min.   : 0.1787
##  1st Qu.: 972.1   1st Qu.:0.6435   1st Qu.:11.147   1st Qu.: 1.5734
##  Median :1225.9   Median :0.7494   Median :13.104   Median : 2.1820
##  Mean   :1349.5   Mean   :0.7640   Mean   :14.075   Mean   : 3.6637
##  3rd Qu.:1689.9   3rd Qu.:0.8593   3rd Qu.:15.613   3rd Qu.: 2.9879
##  Max.   :3037.5   Max.   :1.0000   Max.   :28.369   Max.   :35.5630
##      RH_14             RH_15            RH_16             CYT_17
##  Min.   : 1.360   Min.   :1.142   Min.   :0.0000   Min.   :0.00000
##  1st Qu.: 2.238   1st Qu.:3.184   1st Qu.:0.0642   1st Qu.:0.01106
##  Median : 4.767   Median :4.266   Median :0.1243   Median :0.04945
##  Mean   : 6.975   Mean   :4.633   Mean   :0.3068   Mean   :0.04994
##  3rd Qu.: 9.759   3rd Qu.:5.441   3rd Qu.:0.2221   3rd Qu.:0.06771
##  Max.   :26.544   Max.   :9.613   Max.   :3.1744   Max.   :0.15164
##      CYT_18            CYT_19             CYT_20            CYT_21
##  Min.   :0.0284   Min.   :0.000000   Min.   :0.07305   Min.   :0.00000
##  1st Qu.:0.1664   1st Qu.:0.000000   1st Qu.:0.33756   1st Qu.:0.08091
##  Median :0.2093   Median :0.002367   Median :0.59178   Median :0.13895
##  Mean   :0.2667   Mean   :0.004347   Mean   :0.94779   Mean   :0.14608
##  3rd Qu.:0.3485   3rd Qu.:0.007257   3rd Qu.:1.32754   3rd Qu.:0.20210
##  Max.   :0.6793   Max.   :0.017689   Max.   :3.46134   Max.   :0.34505
##     INFRA_25          INFRA_26        INFRA_27          INFRA_28
##  Min.   : 450.9   Min.   :1611   Min.   : 100.3   Min.   : 100.3
##  1st Qu.:1098.0   1st Qu.:2124   1st Qu.:1513.5   1st Qu.:1389.4
##  Median :1453.7   Median :2264   Median :1941.3   Median :1868.1
##  Mean   :1565.4   Mean   :2268   Mean   :1897.4   Mean   :1773.1
##  3rd Qu.:2036.6   3rd Qu.:2403   3rd Qu.:2152.3   3rd Qu.:1999.0
##  Max.   :2677.4   Max.   :2895   Max.   :4307.5   Max.   :4261.7
##     INFRA_30          INFRA_31          INFRA_32          INFRA_33
##  Min.   : 787.5   Min.   : 3.124   Min.   :0.4441   Min.   :  2.791
##  1st Qu.:1252.3   1st Qu.:10.030   1st Qu.:0.7001   1st Qu.: 18.008
##  Median :1571.1   Median :14.897   Median :0.8915   Median : 49.115
##  Mean   :1506.6   Mean   :15.638   Mean   :0.9226   Mean   :145.075
##  3rd Qu.:1718.3   3rd Qu.:21.656   3rd Qu.:1.1721   3rd Qu.:115.243
##  Max.   :2247.6   Max.   :26.891   Max.   :1.5335   Max.   :857.593
##     INFRA_37          INFRA_38           FIN_39           FIN_40
##  Min.   :173.5   Min.   :0.03262   Min.   :0.4894   Min.   :0.4648
##  1st Qu.:266.7   1st Qu.:0.20708   1st Qu.:0.8002   1st Qu.:0.6750
##  Median :337.5   Median :0.29693   Median :0.9929   Median :0.7283
##  Mean   :423.2   Mean   :0.30459   Mean   :1.1242   Mean   :0.8617
```

```
##  3rd Qu.:509.6   3rd Qu.:0.33737   3rd Qu.:1.4698   3rd Qu.:0.9127
##  Max.   :951.9   Max.   :0.89989   Max.   :2.2304   Max.   :1.9744
##      FIN_41           FIN_42           FIN_43           FIN_44
##  Min.   : 771.5   Min.   : 73324   Min.   : 30.92   Min.   :1.107
##  1st Qu.:1408.7   1st Qu.:121849   1st Qu.:145.88   1st Qu.:1.359
##  Median :2228.7   Median :154105   Median :219.39   Median :1.498
##  Mean   :3066.2   Mean   :174939   Mean   :311.71   Mean   :1.751
##  3rd Qu.:3508.4   3rd Qu.:194868   3rd Qu.:402.03   3rd Qu.:1.878
##  Max.   :8313.3   Max.   :638924   Max.   :975.65   Max.   :4.472
##      FIN_45           FIN_46              MAM_54             MAM_55
##  Min.   :0.1904   Min.   :-0.002799   Min.   : 0.00000   Min.   :   424
##  1st Qu.:0.3642   1st Qu.: 0.015930   1st Qu.: 0.03234   1st Qu.:309821
##  Median :0.4355   Median : 0.024419   Median : 0.14541   Median :430114
##  Mean   :0.4181   Mean   : 0.055164   Mean   : 1.37252   Mean   :404761
##  3rd Qu.:0.4917   3rd Qu.: 0.043929   3rd Qu.: 0.62138   3rd Qu.:531856
##  Max.   :0.5752   Max.   : 0.582504   Max.   :21.87284   Max.   :657741
##      MAM_56            MAM_57           FOR_58            FOR_59
##  Min.   :  0.1336   Min.   :0.00000   Min.   :0.005264   Min.   :2482836
##  1st Qu.:161.8653   1st Qu.:0.00000   1st Qu.:0.017893   1st Qu.:3439451
##  Median :190.2525   Median :0.01166   Median :0.028316   Median :4564542
##  Mean   :186.6248   Mean   :0.02884   Mean   :0.029084   Mean   :4801167
##  3rd Qu.:222.4529   3rd Qu.:0.03226   3rd Qu.:0.040180   3rd Qu.:5707809
##  Max.   :393.4024   Max.   :0.13158   Max.   :0.050310   Max.   :9560314
##      FOR_60            FOR_61           FOR_62            FOR_63
##  Min.   :-0.04329   Min.   : 9.164   Min.   :0.7382   Min.   :0.0003248
##  1st Qu.: 0.03569   1st Qu.:12.351   1st Qu.:0.8611   1st Qu.:0.0239305
##  Median : 0.05695   Median :17.177   Median :0.9393   Median :0.0648047
##  Mean   : 0.07161   Mean   :21.939   Mean   :0.9144   Mean   :0.3536606
##  3rd Qu.: 0.09476   3rd Qu.:28.327   3rd Qu.:0.9709   3rd Qu.:0.2848872
##  Max.   : 0.22170   Max.   :48.427   Max.   :0.9978   Max.   :1.6163243
##      FOR_64            FOR_65            INT_66              INT_67
##  Min.   : 0.00000   Min.   :0.09119   Min.   :-1.0349412   Min.   :0.0000059
##  1st Qu.: 0.01456   1st Qu.:0.40347   1st Qu.:-0.0002516   1st Qu.:0.0067385
##  Median : 0.27849   Median :0.71826   Median : 0.0067080   Median :0.0313431
##  Mean   : 2.85579   Mean   :0.77750   Mean   :-0.0645599   Mean   :0.2018613
##  3rd Qu.: 1.72449   3rd Qu.:1.15468   3rd Qu.: 0.0299713   3rd Qu.:0.2996094
##  Max.   :26.49058   Max.   :1.37826   Max.   : 0.0879379   Max.   :1.3184643
##      INT_68             INT_69            INT_70             GOB_74
##  Min.   :5.950e-06   Min.   :0.000238   Min.   :0.04278   Min.   :0.000000
##  1st Qu.:5.876e-03   1st Qu.:0.015952   1st Qu.:0.16711   1st Qu.:0.006238
##  Median :2.425e-02   Median :0.042566   Median :0.28342   Median :0.008936
##  Mean   :6.865e-02   Mean   :0.054695   Mean   :0.33082   Mean   :0.013484
##  3rd Qu.:1.165e-01   3rd Qu.:0.087581   3rd Qu.:0.44920   3rd Qu.:0.016532
##  Max.   :2.843e-01   Max.   :0.175542   Max.   :0.80214   Max.   :0.053252
##      GOB_75            GOB_76            GOB_77             GOB_78
##  Min.   :0.8873   Min.   :0.04049   Min.   :0.004651   Min.   :0.09047
##  1st Qu.:1.0907   1st Qu.:0.09455   1st Qu.:0.014482   1st Qu.:0.25046
##  Median :1.1977   Median :0.13337   Median :0.028373   Median :0.27097
##  Mean   :1.1876   Mean   :0.16528   Mean   :0.036862   Mean   :0.28937
##  3rd Qu.:1.2690   3rd Qu.:0.20216   3rd Qu.:0.052901   3rd Qu.:0.31358
##  Max.   :1.5433   Max.   :0.44556   Max.   :0.160744   Max.   :0.70329
##      GOB_79            GOB_80            GOB_81             GOB_82
##  Min.   :0.3763   Min.   :0.01023   Min.   :0.004244   Min.   :0.06318
##  1st Qu.:0.5743   1st Qu.:0.03316   1st Qu.:0.139275   1st Qu.:0.33979
```

```
##  Median :0.6272   Median :0.06080   Median :0.170576   Median :0.40347
##  Mean   :0.6269   Mean   :0.09029   Mean   :0.182202   Mean   :0.38549
##  3rd Qu.:0.7067   3rd Qu.:0.11406   3rd Qu.:0.188444   3rd Qu.:0.45303
##  Max.   :0.8012   Max.   :0.28845   Max.   :0.583512   Max.   :0.54280
##      GOB_83           GOB_84
##  Min.   :0.6220   Min.   :29.05
##  1st Qu.:0.7022   1st Qu.:62.14
##  Median :0.7848   Median :65.25
##  Mean   :0.7596   Mean   :64.65
##  3rd Qu.:0.8238   3rd Qu.:72.39
##  Max.   :0.8831   Max.   :78.15
```

```
str(ciudades)
```

```
## tibble [22 x 66] (S3: tbl_df/tbl/data.frame)
##  $ CIUDADES: chr [1:22] "Armenia" "Barranquilla" "Bogotá, D.C." "Bucaramanga" ...
##  $ RH_1    : num [1:22] 284120 1163007 7050228 520080 2169801 ...
##  $ RH_2    : num [1:22] 0.00565 0.00721 0.01513 0.00344 0.01163 ...
##  $ RH_5    : num [1:22] 0.088 0.0922 0.0973 0.076 0.0831 ...
##  $ RH_6    : num [1:22] 1.095 1.083 0.999 1.192 1.019 ...
##  $ RH_7    : num [1:22] 0.266 0.306 0.538 0.326 0.223 ...
##  $ RH_8    : num [1:22] 22.4 22.5 22.6 22.2 22 ...
##  $ RH_9    : num [1:22] 0.354 0.218 0.447 0.378 0.313 ...
##  $ RH_10   : num [1:22] 3038 1054 1042 1068 627 ...
##  $ RH_11   : num [1:22] 0.628 0.859 0.705 1 0.859 ...
##  $ RH_12   : num [1:22] 15.7 15.5 13.8 11.2 12 ...
##  $ RH_13   : num [1:22] 3.646 0.468 2.207 3.858 1.501 ...
##  $ RH_14   : num [1:22] 5.31 3.06 1.96 11.65 10.01 ...
##  $ RH_15   : num [1:22] 5.13 4.3 2.66 3.84 8.66 ...
##  $ RH_16   : num [1:22] 0.0354 0.0779 0.216 0.135 0.1725 ...
##  $ CYT_17  : num [1:22] 0.0425 0.051 0.1411 0.0126 0.0677 ...
##  $ CYT_18  : num [1:22] 0.166 0.157 0.243 0.193 0.201 ...
##  $ CYT_19  : num [1:22] 0 0.00791 0.01104 0.0053 0.00369 ...
##  $ CYT_20  : num [1:22] 0.49 0.922 1.227 1.361 0.966 ...
##  $ CYT_21  : num [1:22] 0.14 0.145 0.205 0.345 0.169 ...
##  $ INFRA_25: num [1:22] 1892 1358 2476 2092 2148 ...
##  $ INFRA_26: num [1:22] 2624 2055 2208 2180 2219 ...
##  $ INFRA_27: num [1:22] 2498 1787 1987 1970 2052 ...
##  $ INFRA_28: num [1:22] 2498 1690 1962 1962 1998 ...
##  $ INFRA_30: num [1:22] 1263 1739 1846 2033 1603 ...
##  $ INFRA_31: num [1:22] 12.8 12.6 11.9 24.4 16.6 ...
##  $ INFRA_32: num [1:22] 0.735 0.999 0.699 1.534 1.221 ...
##  $ INFRA_33: num [1:22] 36.5 342.2 830.6 70.9 189.8 ...
##  $ INFRA_37: num [1:22] 495 551 769 952 511 ...
##  $ INFRA_38: num [1:22] 0.4576 0.1376 0.0326 0.25 0.1106 ...
##  $ FIN_39  : num [1:22] 0.95 1.43 1.63 2.23 1.48 ...
##  $ FIN_40  : num [1:22] 0.7 1.47 1.37 1.97 1.38 ...
##  $ FIN_41  : num [1:22] 2119 6008 8313 6182 5697 ...
##  $ FIN_42  : num [1:22] 214861 169266 638924 129661 206053 ...
##  $ FIN_43  : num [1:22] 274 385 976 651 465 ...
##  $ FIN_44  : num [1:22] 1.62 1.11 1.37 1.49 1.45 ...
##  $ FIN_45  : num [1:22] 0.435 0.422 0.377 0.436 0.35 ...
##  $ FIN_46  : num [1:22] 0.0246 0.0412 0.0811 0.0448 0.0371 ...
##  $ MAM_54  : num [1:22] 0.03539 0.2425 0.00432 0.19292 0.0979 ...
```

```
##  $ MAM_55  : num [1:22] 563191 524072 400565 534450 589239 ...
##  $ MAM_56  : num [1:22] 160 333 248 217 226 ...
##  $ MAM_57  : num [1:22] 0.03226 0.00271 0.04975 0 0.08645 ...
##  $ FOR_58  : num [1:22] 0.0148 0.0278 0.0289 0.0391 0.0178 ...
##  $ FOR_59  : num [1:22] 3811687 4945029 9560314 7865297 6343576 ...
##  $ FOR_60  : num [1:22] 0.0454 0.0984 0.0558 0.0836 0.0464 ...
##  $ FOR_61  : num [1:22] 12.9 17.69 9.16 11.31 11.01 ...
##  $ FOR_62  : num [1:22] 0.973 0.996 0.998 0.986 0.983 ...
##  $ FOR_63  : num [1:22] 0.303 1.513 1.408 1.194 0.83 ...
##  $ FOR_64  : num [1:22] 0 1.73 2 26.49 1.59 ...
##  $ FOR_65  : num [1:22] 0.552 1.358 0.943 1.253 1.184 ...
##  $ INT_66  : num [1:22] 0.00684 -0.20138 0.04927 0.03087 0.03644 ...
##  $ INT_67  : num [1:22] 0.00724 0.46078 0.40791 0.03541 0.15041 ...
##  $ INT_68  : num [1:22] 0.00704 0.1297 0.22859 0.03314 0.09342 ...
##  $ INT_69  : num [1:22] 0.0207 0.131 0.0561 0.0178 0.1112 ...
##  $ INT_70  : num [1:22] 0.31 0.54 0.802 0.46 0.684 ...
##  $ GOB_74  : num [1:22] 0.01443 0.02832 0.04068 0.00498 0.05325 ...
##  $ GOB_75  : num [1:22] 1.08 1.18 1.09 1.28 1.1 ...
##  $ GOB_76  : num [1:22] 0.148 0.203 0.446 0.192 0.208 ...
##  $ GOB_77  : num [1:22] 0.0226 0.0132 0.0321 0.0109 0.0546 ...
##  $ GOB_78  : num [1:22] 0.324 0.265 0.25 0.253 0.191 ...
##  $ GOB_79  : num [1:22] 0.673 0.568 0.376 0.605 0.434 ...
##  $ GOB_80  : num [1:22] 0.2818 0.0256 0.0419 0.021 0.1165 ...
##  $ GOB_81  : num [1:22] 0.18579 0.17004 0.00424 0.14172 0.1891 ...
##  $ GOB_82  : num [1:22] 0.359 0.358 0.369 0.406 0.251 ...
##  $ GOB_83  : num [1:22] 0.782 0.763 0.646 0.755 0.765 ...
##  $ GOB_84  : num [1:22] 69.5 65.5 68.5 78.2 72.3 ...
```

```
View(ciudades)
```

Se realizaràn los distintos ACP con las variables de RH e INFRA

```
#base de datos RH+INFRA
ciudadest<-ciudades[,c(2:15,21:30)]
str(ciudadest)
```

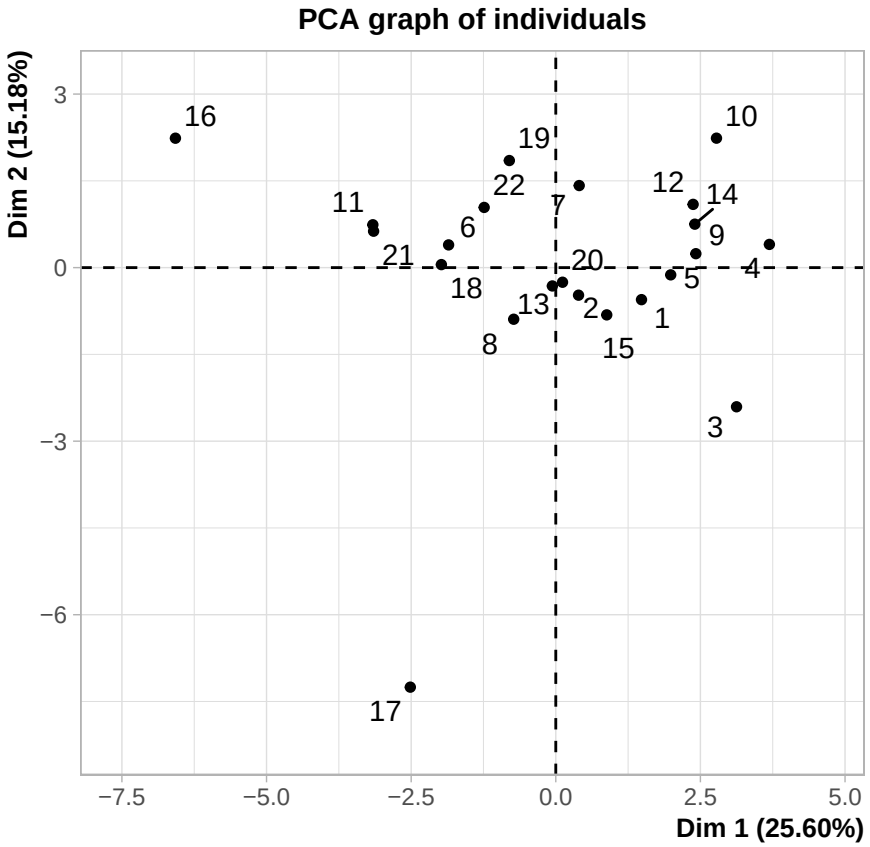
```
## tibble [22 x 24] (S3: tbl_df/tbl/data.frame)
##  $ RH_1    : num [1:22] 284120 1163007 7050228 520080 2169801 ...
##  $ RH_2    : num [1:22] 0.00565 0.00721 0.01513 0.00344 0.01163 ...
##  $ RH_5    : num [1:22] 0.088 0.0922 0.0973 0.076 0.0831 ...
##  $ RH_6    : num [1:22] 1.095 1.083 0.999 1.192 1.019 ...
##  $ RH_7    : num [1:22] 0.266 0.306 0.538 0.326 0.223 ...
##  $ RH_8    : num [1:22] 22.4 22.5 22.6 22.2 22 ...
##  $ RH_9    : num [1:22] 0.354 0.218 0.447 0.378 0.313 ...
##  $ RH_10   : num [1:22] 3038 1054 1042 1068 627 ...
##  $ RH_11   : num [1:22] 0.628 0.859 0.705 1 0.859 ...
##  $ RH_12   : num [1:22] 15.7 15.5 13.8 11.2 12 ...
##  $ RH_13   : num [1:22] 3.646 0.468 2.207 3.858 1.501 ...
##  $ RH_14   : num [1:22] 5.31 3.06 1.96 11.65 10.01 ...
##  $ RH_15   : num [1:22] 5.13 4.3 2.66 3.84 8.66 ...
##  $ RH_16   : num [1:22] 0.0354 0.0779 0.216 0.135 0.1725 ...
##  $ INFRA_25: num [1:22] 1892 1358 2476 2092 2148 ...
##  $ INFRA_26: num [1:22] 2624 2055 2208 2180 2219 ...
```

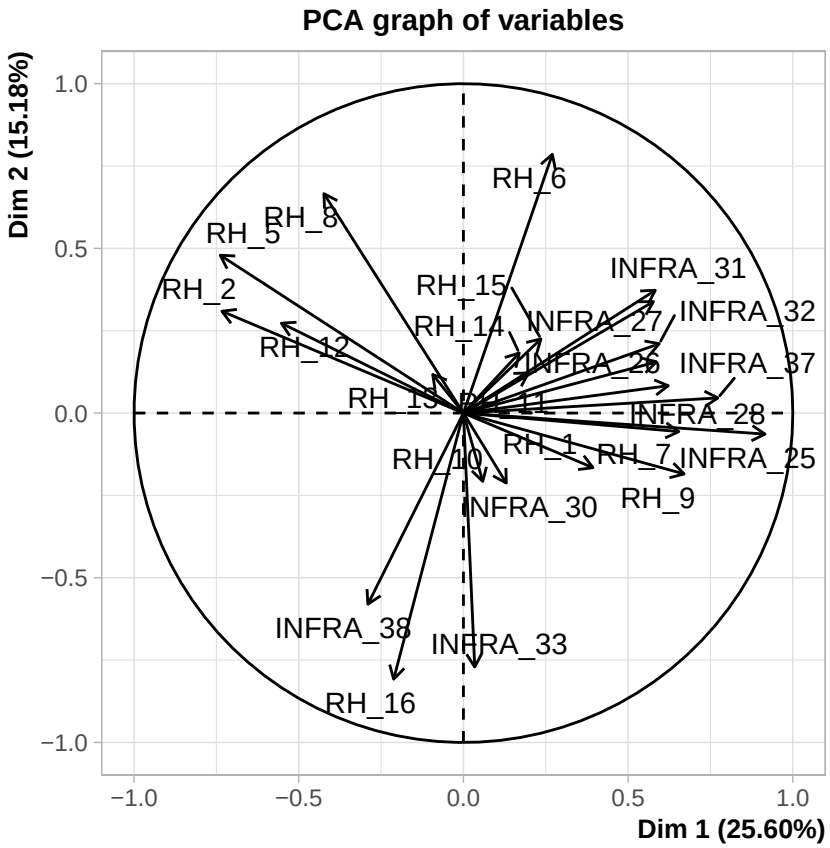
```
##  $ INFRA_27: num [1:22] 2498 1787 1987 1970 2052 ...
##  $ INFRA_28: num [1:22] 2498 1690 1962 1962 1998 ...
##  $ INFRA_30: num [1:22] 1263 1739 1846 2033 1603 ...
##  $ INFRA_31: num [1:22] 12.8 12.6 11.9 24.4 16.6 ...
##  $ INFRA_32: num [1:22] 0.735 0.999 0.699 1.534 1.221 ...
##  $ INFRA_33: num [1:22] 36.5 342.2 830.6 70.9 189.8 ...
##  $ INFRA_37: num [1:22] 495 551 769 952 511 ...
##  $ INFRA_38: num [1:22] 0.4576 0.1376 0.0326 0.25 0.1106 ...
```

```
View(ciudadest)
```

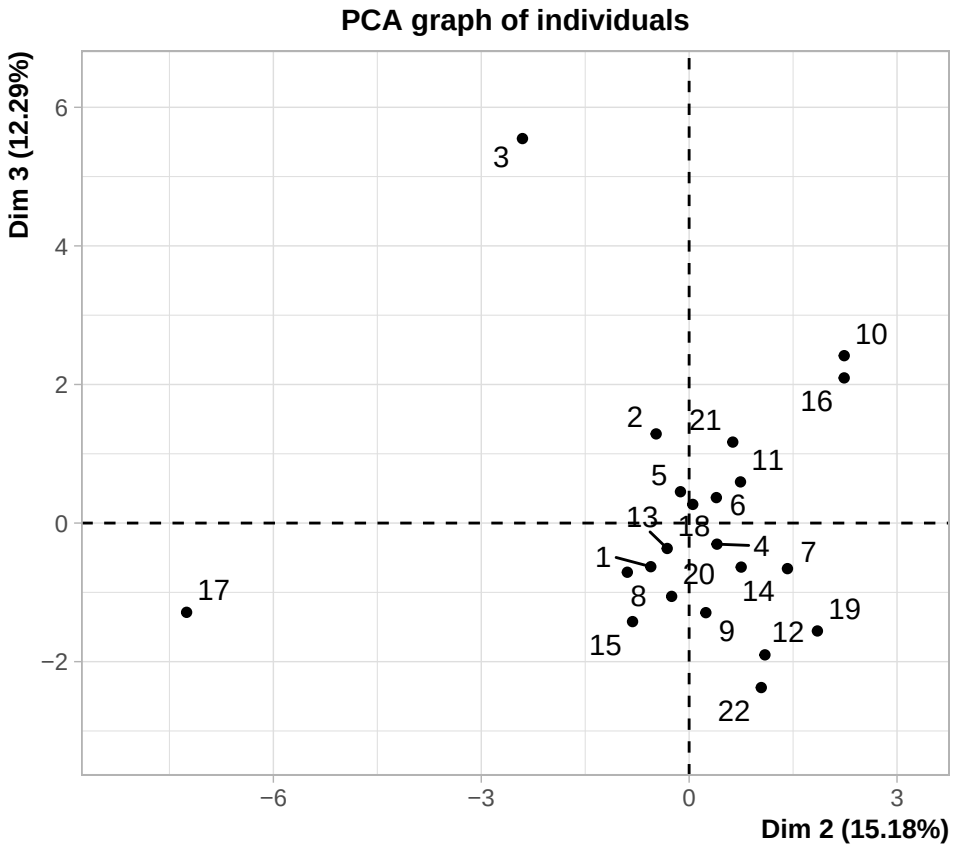
PRIMER PUNTO

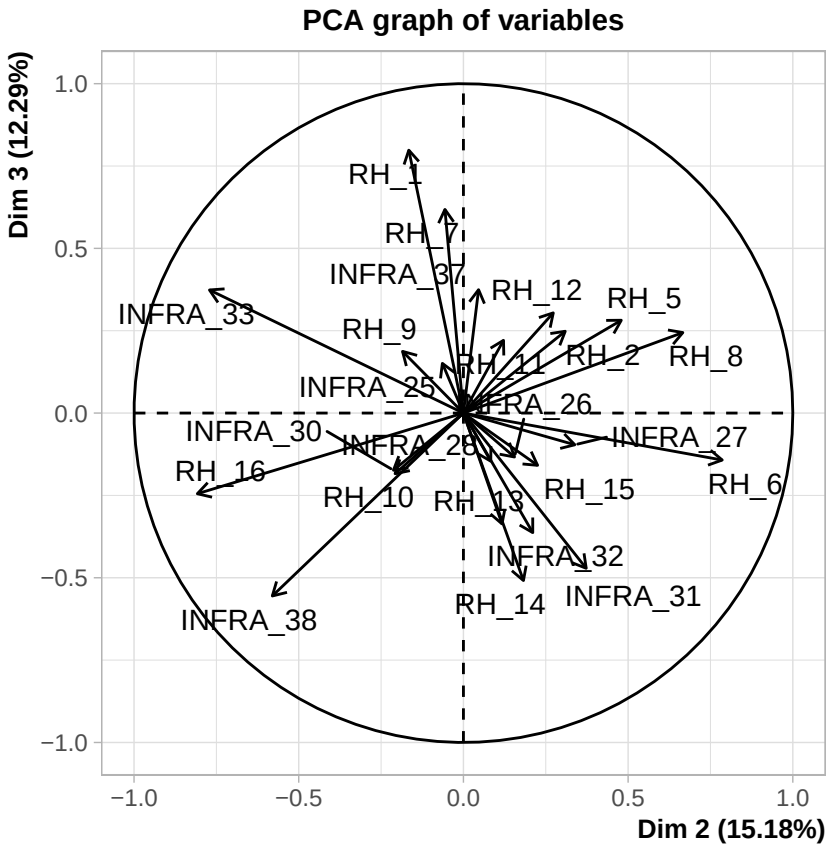
```
#ACP todas las variables que le corresponden####
acp1<-PCA(ciudadest,ncp = 7)
```





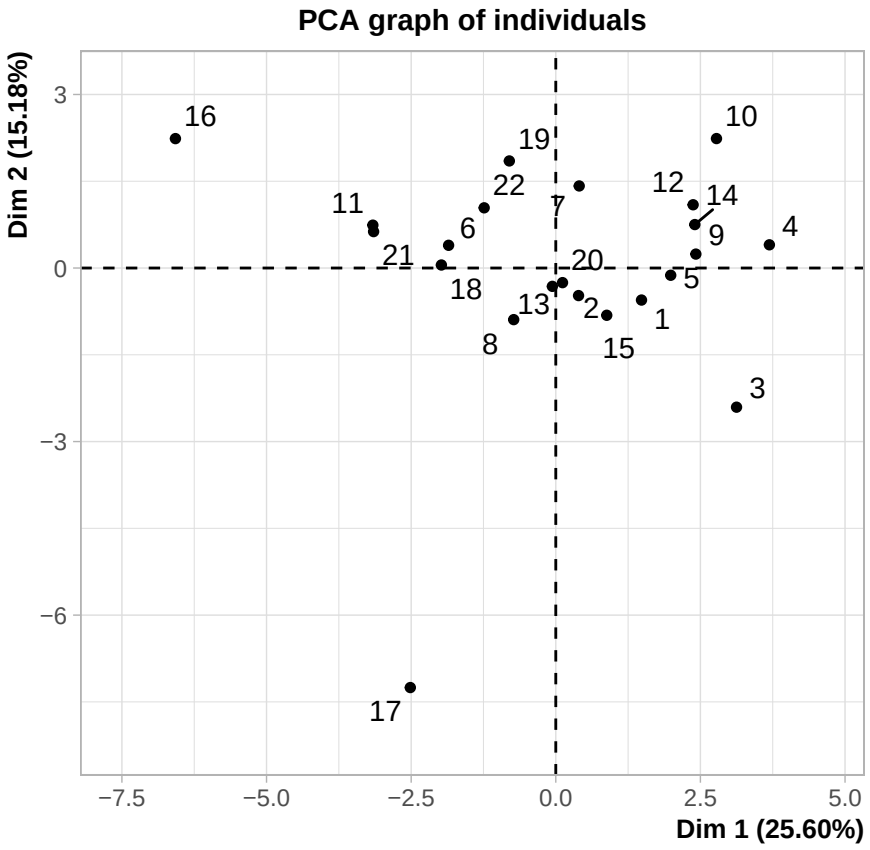

```
PCA(ciudadest,ncp = 7,axes = c(2,3))
```

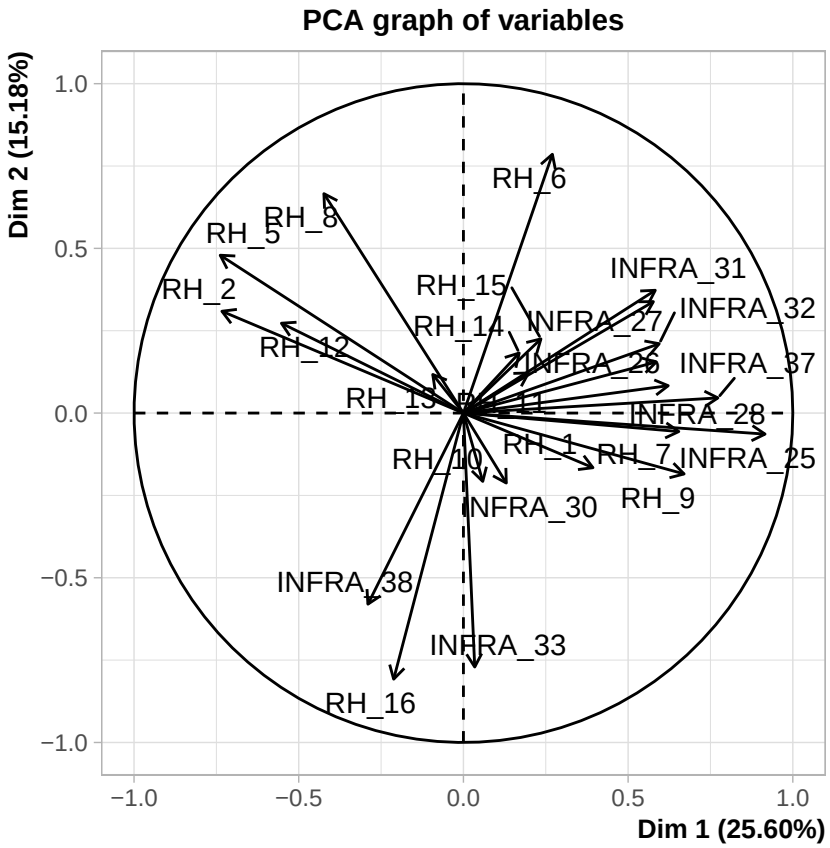

PCA graph of individuals
Dim 3 (12.29%)
Dim 2 (15.18%)
6
4
2
0
−2
−6
−3
0
3
3
10
16
2
21
11
5
6
13
18
4
7
1
20
14
17
8
19
9
12
15
22

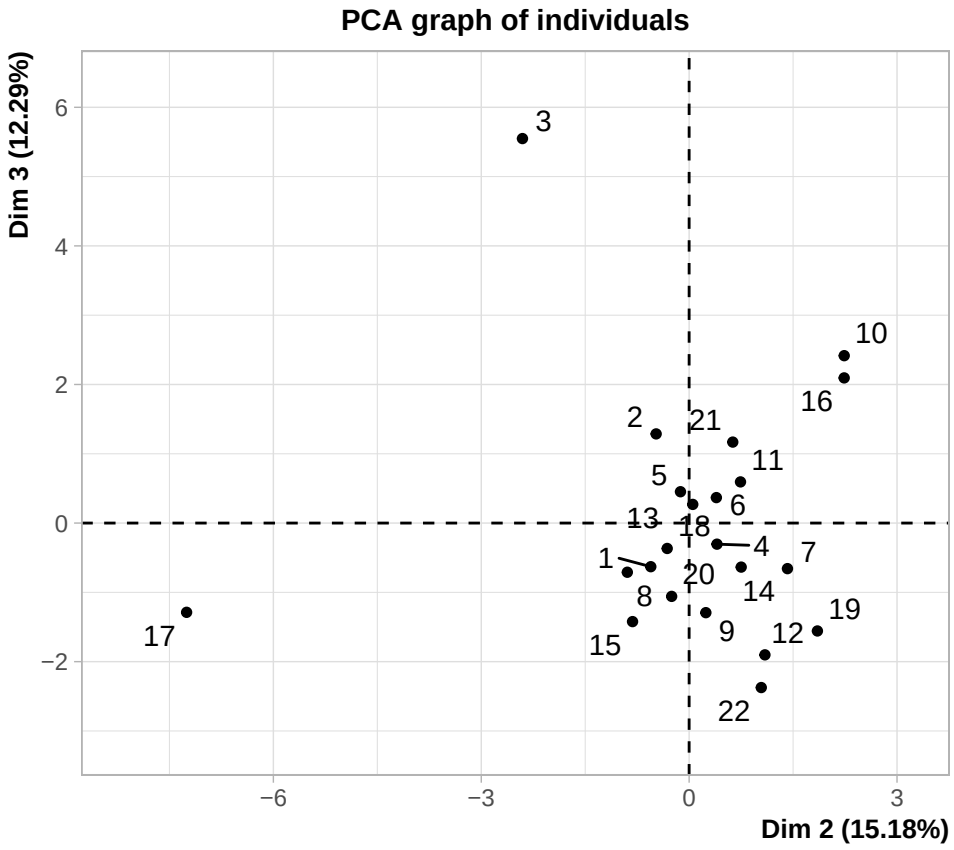


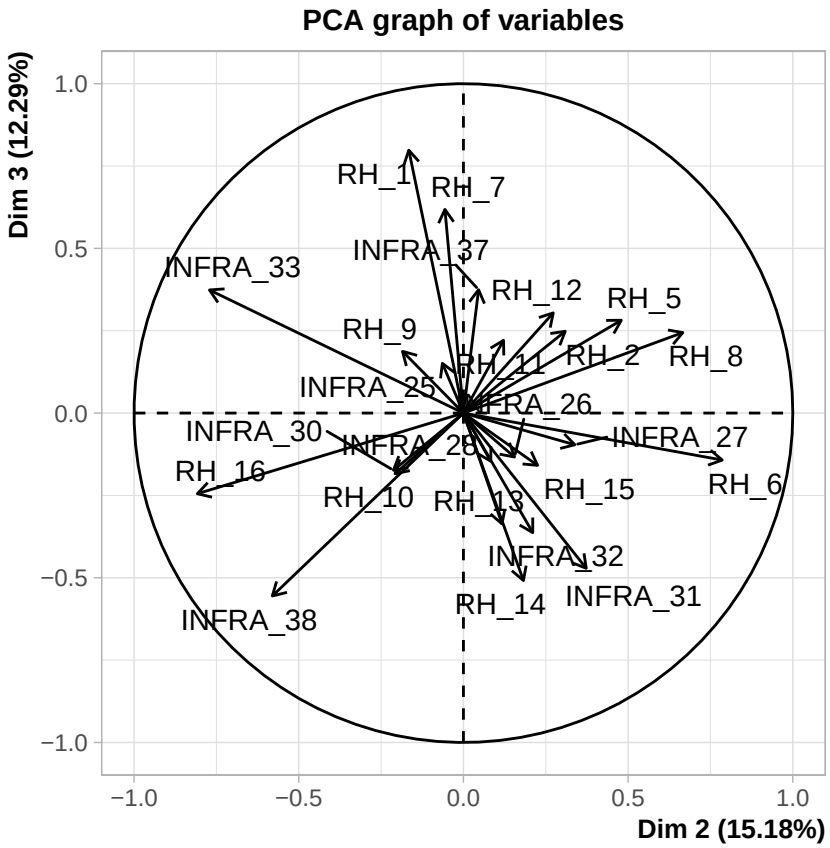

```
## **Results for the Principal Component Analysis (PCA)**
## The analysis was performed on 22 individuals, described by 24 variables
## *The results are available in the following objects:
##
##    name               description
## 1  "$eig"             "eigenvalues"
## 2  "$var"             "results for the variables"
## 3  "$var$coord"       "coord. for the variables"
## 4  "$var$cor"         "correlations variables - dimensions"
## 5  "$var$cos2"        "cos2 for the variables"
## 6  "$var$contrib"     "contributions of the variables"
## 7  "$ind"             "results for the individuals"
## 8  "$ind$coord"       "coord. for the individuals"
## 9  "$ind$cos2"        "cos2 for the individuals"
## 10 "$ind$contrib"     "contributions of the individuals"
## 11 "$call"            "summary statistics"
## 12 "$call$centre"     "mean of the variables"
## 13 "$call$ecart.type" "standard error of the variables"
## 14 "$call$row.w"      "weights for the individuals"
## 15 "$call$col.w"      "weights for the variables"
```

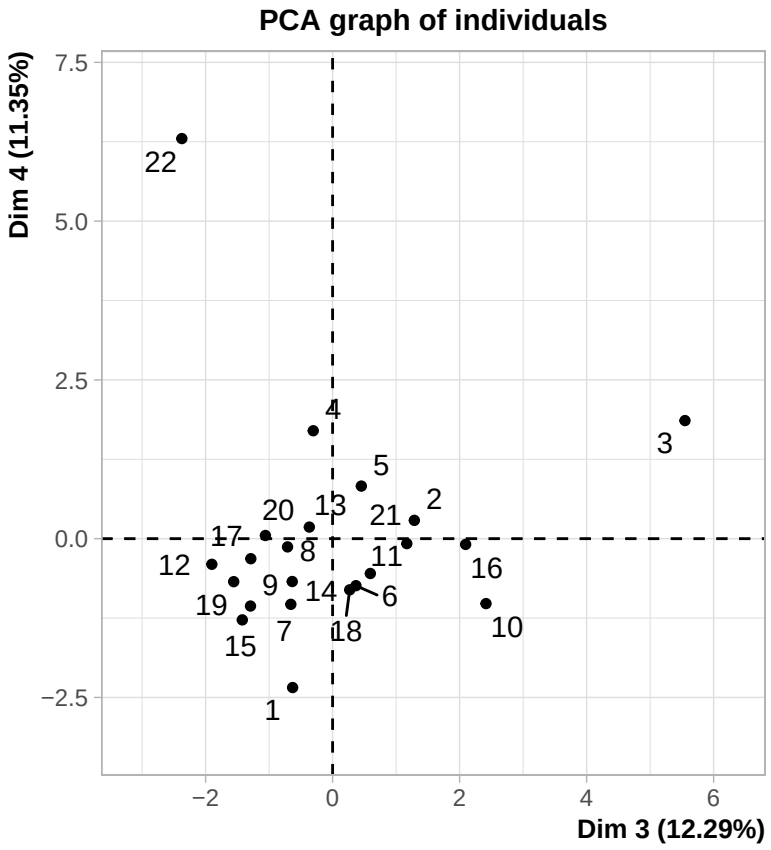
```
for (i in 1:7) {
  if (i+1<=7) {
    PCA(ciudadest,ncp = 7,axes = c(i,i+1))
  }
}
```

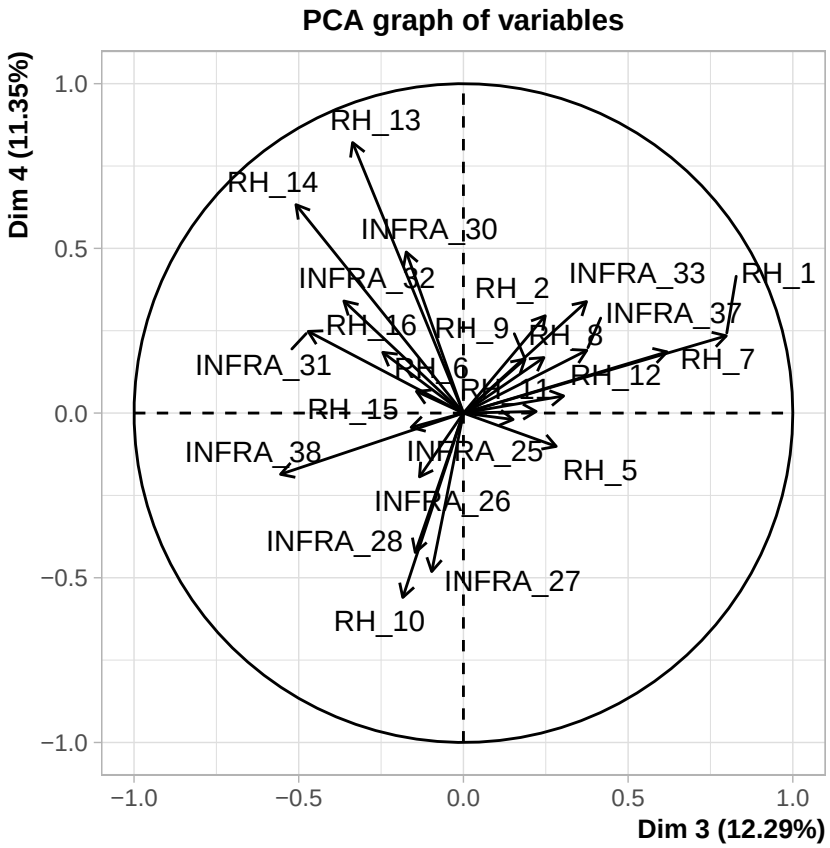

PCA graph of individuals
Dim 2 (15.18%)
Dim 1 (25.60%)
3
0
−3
−6
−7.5
−5.0
−2.5
0.0
2.5
5.0
16
19
10
22
12
14
11
7
9
4
6
21
20
5
18
13
2
1
8
15
3
17

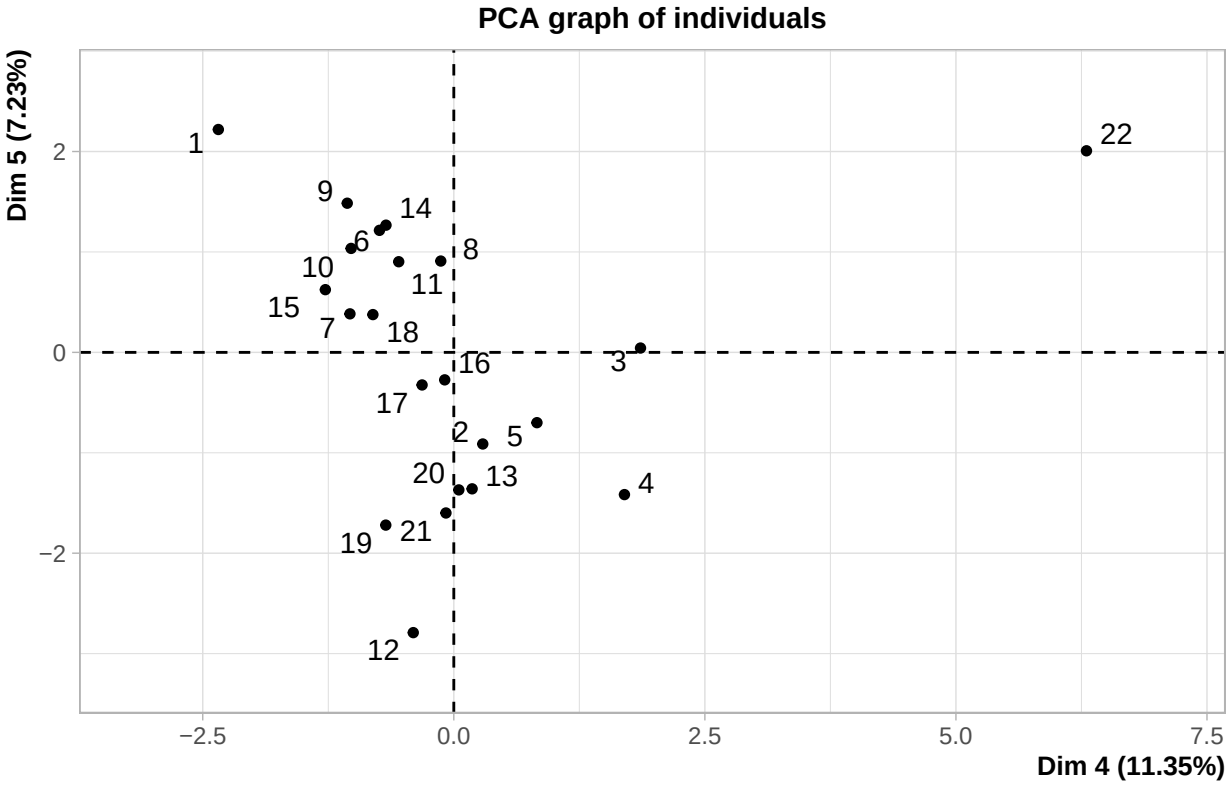

PCA graph of variables
Dim 2 (15.18%)
Dim 1 (25.60%)
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
RH_6
RH_8
RH_5
RH_2
RH_15
INFRA_31
INFRA_32
RH_14
INFRA_27
RH_12
INFRA_26
INFRA_37
RH_13
RH_11
INFRA_28
RH_1
RH_7
INFRA_25
RH_10
RH_9
INFRA_30
INFRA_38
INFRA_33
RH_16


PCA graph of individuals
Dim 3 (12.29%)
Dim 2 (15.18%)
6
4
2
0
−2
−6
−3
0
3
3
10
16
2
21
11
5
6
13
18
4
7
1
20
14
8
19
17
9
12
15
22

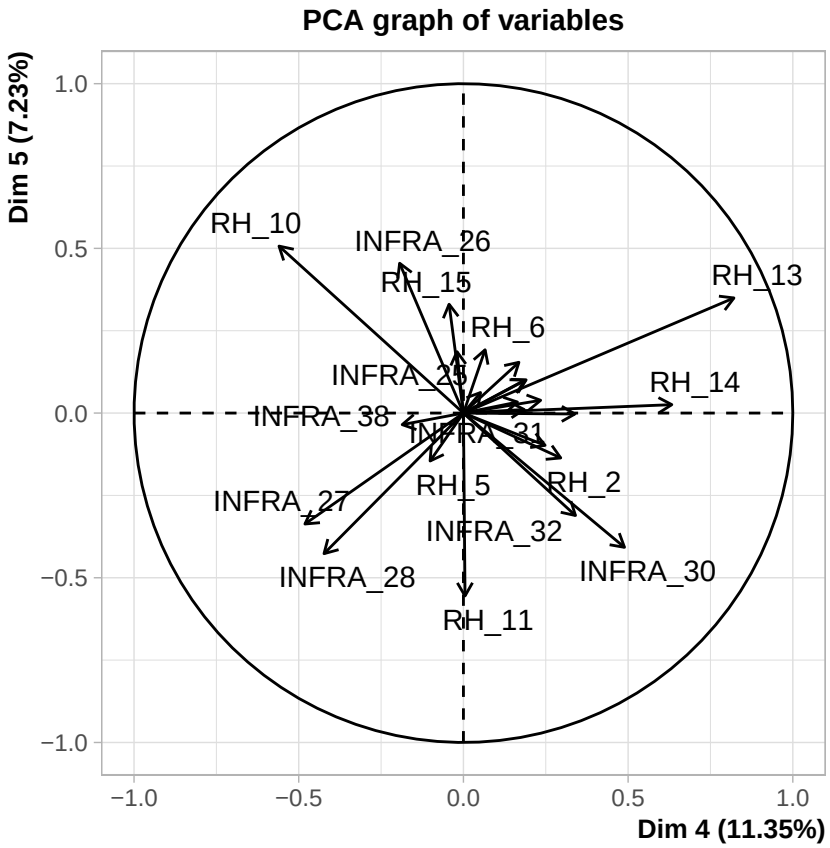

PCA graph of variables
Dim 3 (12.29%)
Dim 2 (15.18%)
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
RH_1
RH_7
INFRA_37
INFRA_33
RH_12
RH_5
RH_9
RH_11
RH_2
RH_8
INFRA_25
INFRA_26
INFRA_30
INFRA_28
INFRA_27
RH_16
RH_10
RH_13
RH_15
RH_6
INFRA_32
INFRA_31
RH_14
INFRA_38

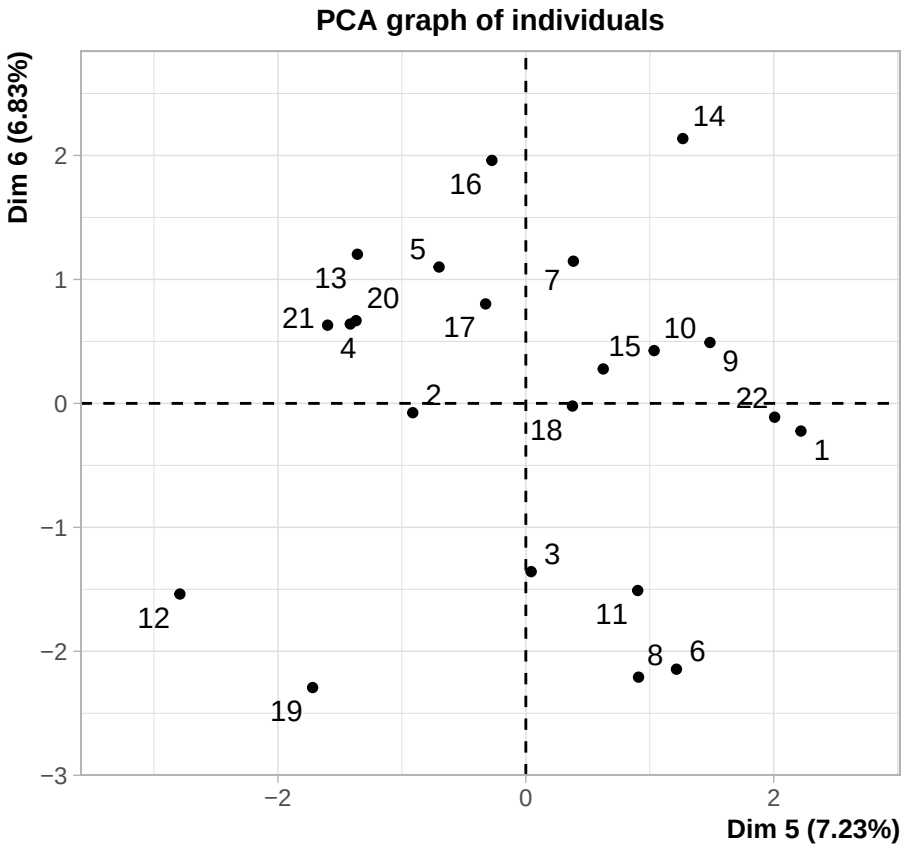

PCA graph of individuals
Dim 4 (11.35%)
Dim 3 (12.29%)
7.5
5.0
2.5
0.0
−2.5
−2
0
2
4
6
22
4
3
5
20
13
21
2
17
8
11
12
16
9
14
6
19
7
18
10
15
1


PCA graph of variables
Dim 4 (11.35%)
Dim 3 (12.29%)
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
RH_13
RH_14
INFRA_30
INFRA_32
RH_2
INFRA_33
RH_1
INFRA_37
RH_16
RH_9
RH_8
INFRA_31
RH_6
RH_7
RH_12
RH_15
INFRA_38
INFRA_25
RH_5
INFRA_26
INFRA_28
INFRA_27
RH_10

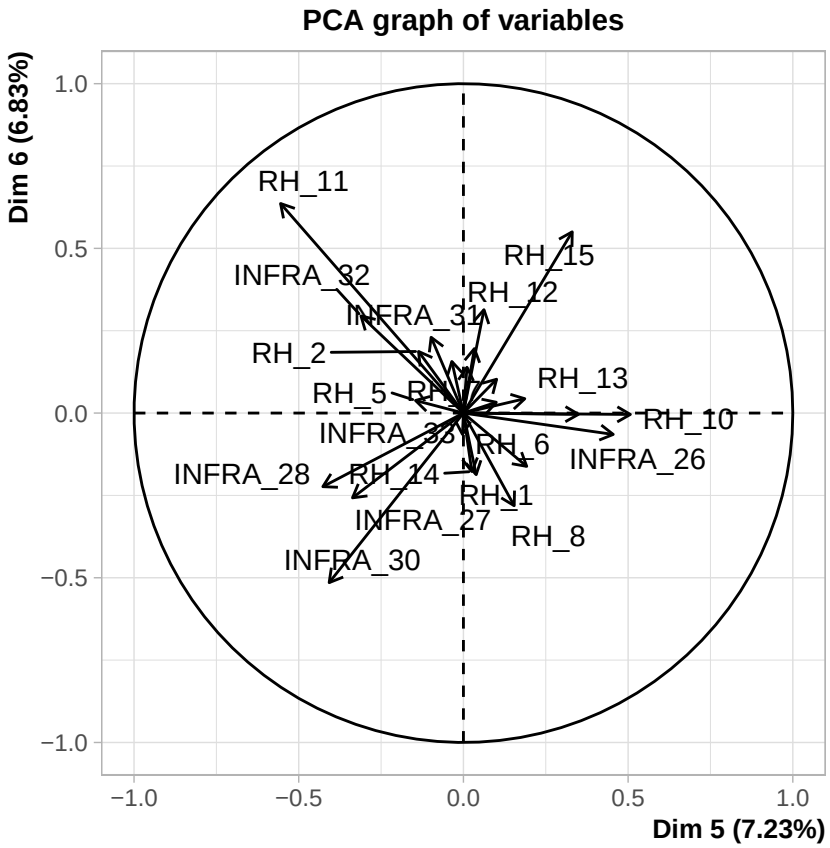


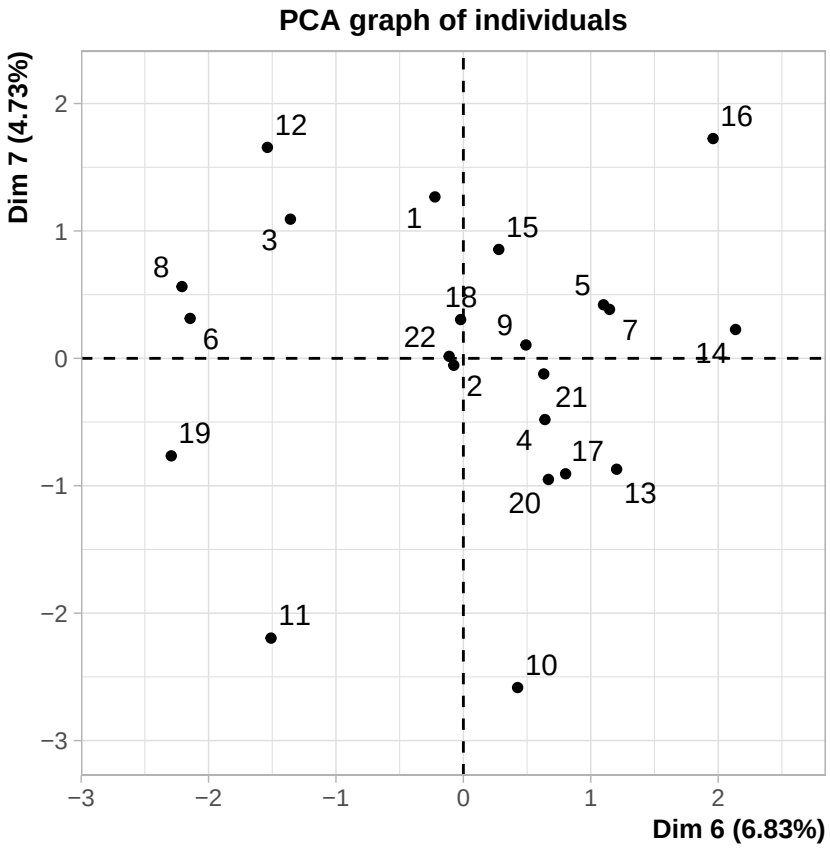

```
## Warning: ggrepel: 8 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```


PCA graph of variables
Dim 5 (7.23%)
Dim 4 (11.35%)
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
RH_10
INFRA_26
RH_15
RH_13
RH_6
INFRA_25
RH_14
INFRA_38
INFRA_31
RH_5
RH_2
INFRA_27
INFRA_32
INFRA_28
INFRA_30
RH_11

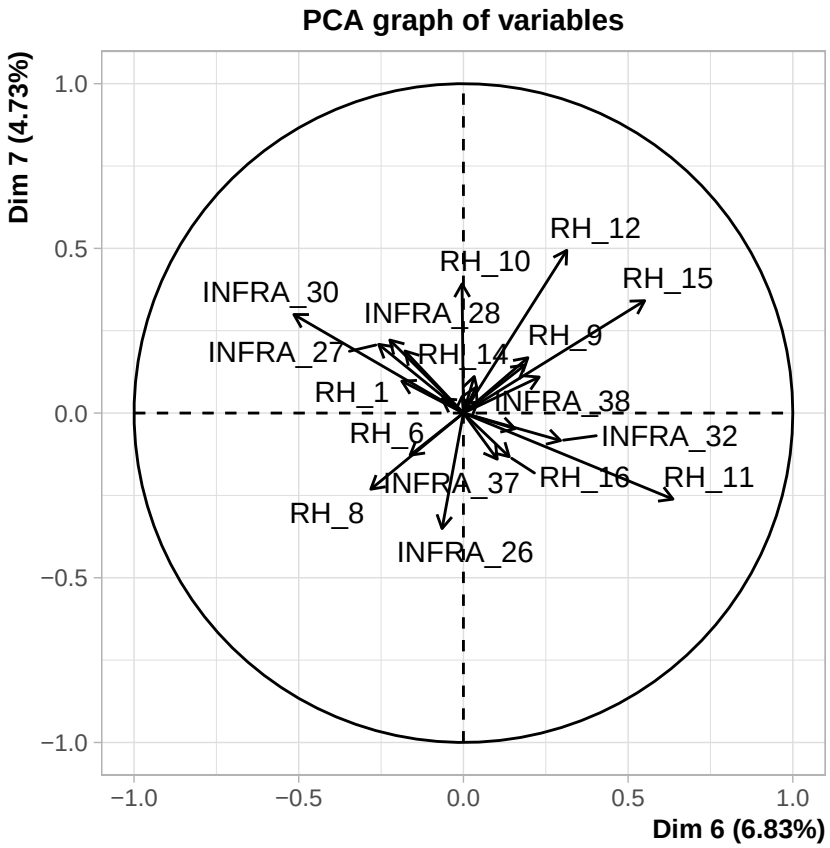



```
## Warning: ggrepel: 5 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```


PCA graph of variables
Dim 6 (6.83%)
Dim 5 (7.23%)
1.0
0.5
0.0
−0.5
−1.0
RH_11
RH_15
INFRA_32
RH_12
INFRA_31
RH_2
RH_13
RH_5
RH_10
INFRA_33
RH_6
INFRA_26
INFRA_28
RH_14
RH_1
INFRA_27
RH_8
INFRA_30




```
## Warning: ggrepel: 7 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```




```
#contiene los auto valores correspondientes a los componentes principales
acp1$eig
```

```
##          eigenvalue percentage of variance cumulative percentage of variance
## comp 1  6.143979350            25.59991396                           25.59991
## comp 2  3.644318791            15.18466163                           40.78458
## comp 3  2.950521777            12.29384074                           53.07842
## comp 4  2.723578886            11.34824536                           64.42666
## comp 5  1.735004053             7.22918355                           71.65585
## comp 6  1.639276649             6.83031937                           78.48616
## comp 7  1.134367266             4.72653028                           83.21269
## comp 8  0.952165621             3.96735675                           87.18005
## comp 9  0.845039806             3.52099919                           90.70105
## comp 10 0.568206619             2.36752758                           93.06858
## comp 11 0.496018133             2.06674222                           95.13532
## comp 12 0.366954836             1.52897848                           96.66430
## comp 13 0.306467492             1.27694788                           97.94125
## comp 14 0.226007063             0.94169610                           98.88294
## comp 15 0.100129109             0.41720462                           99.30015
## comp 16 0.057199198             0.23832999                           99.53848
## comp 17 0.042294765             0.17622819                           99.71471
## comp 18 0.031711599             0.13213166                           99.84684
## comp 19 0.021900878             0.09125366                           99.93809
## comp 20 0.010023059             0.04176275                           99.97985
## comp 21 0.004835049             0.02014604                          100.00000
```

```r
#al sumar la columna de los eigenvalue da 24
sum(acp1$eig[,1])
```

```
## [1] 24
```

```r
#la coluna de porcentages de varianza acumulados
#nos muestra que tan importantes son los primeros componentes
# y es notable como con los primeros 7 ya se acumula
# el 83 porciento de la varianza
acp1$eig[,3]
```

```
##    comp 1    comp 2    comp 3    comp 4    comp 5    comp 6    comp 7    comp 8
##  25.59991  40.78458  53.07842  64.42666  71.65585  78.48616  83.21269  87.18005
##    comp 9   comp 10   comp 11   comp 12   comp 13   comp 14   comp 15   comp 16
##  90.70105  93.06858  95.13532  96.66430  97.94125  98.88294  99.30015  99.53848
##   comp 17   comp 18   comp 19   comp 20   comp 21
##  99.71471  99.84684  99.93809  99.97985 100.00000
```

```r
#coordenadas de las variables
acp1$var$coord
```

```
##                Dim.1       Dim.2       Dim.3        Dim.4       Dim.5
## RH_1       0.39326416 -0.16582617  0.79808707  0.234443904  0.03870311
## RH_2      -0.73318056  0.30910863  0.24834687  0.295451362 -0.13622339
## RH_5      -0.73829548  0.47923668  0.28171147 -0.101211477 -0.14542959
## RH_6       0.27009928  0.78569503 -0.14262801  0.065820983  0.19208678
## RH_7       0.65391553 -0.05609103  0.61819704  0.185758272  0.09978721
## RH_8      -0.42353084  0.66615482  0.24434105  0.168470217  0.15409973
## RH_9       0.67000755 -0.18481789  0.18727088  0.164122673  0.03335124
## RH_10      0.05867078 -0.20747753 -0.18407648 -0.559808670  0.50690189
## RH_11      0.19745370  0.12168754  0.22078089  0.004902492 -0.55512379
## RH_12     -0.55248164  0.27277774  0.30421092  0.051980537  0.06233117
## RH_13     -0.09305287  0.11713539 -0.33640969  0.821218569  0.34941540
## RH_14      0.16938965  0.18224626 -0.50837225  0.632713120  0.02554166
## RH_15      0.23534090  0.22514611 -0.15862851 -0.043439229  0.33033865
## RH_16     -0.21174190 -0.80781025 -0.24491096  0.184368443  0.01087989
## INFRA_25   0.91574462 -0.06385140  0.15085539 -0.019583543  0.18640140
## INFRA_26   0.58559310  0.15503623 -0.13338967 -0.193634112  0.45484585
## INFRA_27   0.57675110  0.33826657 -0.09625905 -0.481188041 -0.33679031
## INFRA_28   0.62174339  0.08309287 -0.14615670 -0.423228096 -0.42681853
## INFRA_30   0.13008484 -0.21238227 -0.17355059  0.489006179 -0.40760158
## INFRA_31   0.58251848  0.37273449 -0.47121912  0.247924906 -0.09799203
## INFRA_32   0.59448410  0.21046931 -0.36289112  0.340194841 -0.31102191
## INFRA_33   0.03432868 -0.77093458  0.37373834  0.338405521 -0.00279060
## INFRA_37   0.77264888  0.04596188  0.37454936  0.190432249  0.10077022
## INFRA_38  -0.28993642 -0.58012722 -0.55526987 -0.185891591 -0.03510750
##                Dim.6       Dim.7
## RH_1      -0.186970829  0.09711721
## RH_2       0.187059555  0.14579669
## RH_5       0.038259715  0.07840561
## RH_6      -0.161775467 -0.12790827
## RH_7       0.032767999  0.11098763
```

```
## RH_8     -0.281247035 -0.23116490
## RH_9      0.195707854  0.16811725
## RH_10    -0.004230834  0.39212288
## RH_11     0.636168752 -0.26133285
## RH_12     0.313790688  0.49403548
## RH_13    -0.003822078  0.05054391
## RH_14    -0.177522243  0.18840110
## RH_15     0.550233297  0.34119418
## RH_16     0.139008709 -0.13241458
## INFRA_25  0.043531483  0.03401149
## INFRA_26 -0.064865708 -0.35067018
## INFRA_27 -0.257353066  0.20863439
## INFRA_28 -0.223418106  0.22175271
## INFRA_30 -0.514782517  0.29924306
## INFRA_31  0.229991839  0.10928353
## INFRA_32  0.294938030 -0.08347409
## INFRA_33 -0.064945043  0.04349121
## INFRA_37  0.102692039 -0.14001836
## INFRA_38  0.156578722 -0.04739415
```

```
#correlaciones variable factor
acp1$var$cor
```

```
##                Dim.1       Dim.2       Dim.3        Dim.4       Dim.5
## RH_1       0.39326416 -0.16582617  0.79808707  0.234443904  0.03870311
## RH_2      -0.73318056  0.30910863  0.24834687  0.295451362 -0.13622339
## RH_5      -0.73829548  0.47923668  0.28171147 -0.101211477 -0.14542959
## RH_6       0.27009928  0.78569503 -0.14262801  0.065820983  0.19208678
## RH_7       0.65391553 -0.05609103  0.61819704  0.185758272  0.09978721
## RH_8      -0.42353084  0.66615482  0.24434105  0.168470217  0.15409973
## RH_9       0.67000755 -0.18481789  0.18727088  0.164122673  0.03335124
## RH_10      0.05867078 -0.20747753 -0.18407648 -0.559808670  0.50690189
## RH_11      0.19745370  0.12168754  0.22078089  0.004902492 -0.55512379
## RH_12     -0.55248164  0.27277774  0.30421092  0.051980537  0.06233117
## RH_13     -0.09305287  0.11713539 -0.33640969  0.821218569  0.34941540
## RH_14      0.16938965  0.18224626 -0.50837225  0.632713120  0.02554166
## RH_15      0.23534090  0.22514611 -0.15862851 -0.043439229  0.33033865
## RH_16     -0.21174190 -0.80781025 -0.24491096  0.184368443  0.01087989
## INFRA_25   0.91574462 -0.06385140  0.15085539 -0.019583543  0.18640140
## INFRA_26   0.58559310  0.15503623 -0.13338967 -0.193634112  0.45484585
## INFRA_27   0.57675110  0.33826657 -0.09625905 -0.481188041 -0.33679031
## INFRA_28   0.62174339  0.08309287 -0.14615670 -0.423228096 -0.42681853
## INFRA_30   0.13008484 -0.21238227 -0.17355059  0.489006179 -0.40760158
## INFRA_31   0.58251848  0.37273449 -0.47121912  0.247924906 -0.09799203
## INFRA_32   0.59448410  0.21046931 -0.36289112  0.340194841 -0.31102191
## INFRA_33   0.03432868 -0.77093458  0.37373834  0.338405521 -0.00279060
## INFRA_37   0.77264888  0.04596188  0.37454936  0.190432249  0.10077022
## INFRA_38  -0.28993642 -0.58012722 -0.55526987 -0.185891591 -0.03510750
##                Dim.6       Dim.7
## RH_1      -0.186970829  0.09711721
## RH_2       0.187059555  0.14579669
## RH_5       0.038259715  0.07840561
## RH_6      -0.161775467 -0.12790827
## RH_7       0.032767999  0.11098763
```

```
## RH_8     -0.281247035 -0.23116490
## RH_9      0.195707854  0.16811725
## RH_10    -0.004230834  0.39212288
## RH_11     0.636168752 -0.26133285
## RH_12     0.313790688  0.49403548
## RH_13    -0.003822078  0.05054391
## RH_14    -0.177522243  0.18840110
## RH_15     0.550233297  0.34119418
## RH_16     0.139008709 -0.13241458
## INFRA_25  0.043531483  0.03401149
## INFRA_26 -0.064865708 -0.35067018
## INFRA_27 -0.257353066  0.20863439
## INFRA_28 -0.223418106  0.22175271
## INFRA_30 -0.514782517  0.29924306
## INFRA_31  0.229991839  0.10928353
## INFRA_32  0.294938030 -0.08347409
## INFRA_33 -0.064945043  0.04349121
## INFRA_37  0.102692039 -0.14001836
## INFRA_38  0.156578722 -0.04739415
```

```
#basicamente estas covarianzas nos habla de como las variables
#se relacionan con los factores y en que medida los construye

#cosenos cuadrados de las variables
acp1$var$cos2
```

```
##               Dim.1       Dim.2       Dim.3        Dim.4        Dim.5
## RH_1     0.154656696 0.027498320 0.636942970 5.496394e-02 1.497931e-03
## RH_2     0.537553740 0.095548146 0.061676169 8.729151e-02 1.855681e-02
## RH_5     0.545080211 0.229667800 0.079361355 1.024376e-02 2.114977e-02
## RH_6     0.072953619 0.617316674 0.020342749 4.332402e-03 3.689733e-02
## RH_7     0.427605517 0.003146204 0.382167574 3.450614e-02 9.957487e-03
## RH_8     0.179378374 0.443762241 0.059702551 2.838221e-02 2.374673e-02
## RH_9     0.448910111 0.034157653 0.035070381 2.693625e-02 1.112305e-03
## RH_10    0.003442260 0.043046925 0.033884152 3.133857e-01 2.569495e-01
## RH_11    0.038987965 0.014807857 0.048744202 2.403443e-05 3.081624e-01
## RH_12    0.305235968 0.074407698 0.092544286 2.701976e-03 3.885175e-03
## RH_13    0.008658837 0.013720700 0.113171481 6.743999e-01 1.220911e-01
## RH_14    0.028692855 0.033213700 0.258442348 4.003259e-01 6.523765e-04
## RH_15    0.055385341 0.050690770 0.025163006 1.886967e-03 1.091236e-01
## RH_16    0.044834631 0.652557406 0.059981380 3.399172e-02 1.183720e-04
## INFRA_25 0.838588204 0.004077001 0.022757348 3.835152e-04 3.474548e-02
## INFRA_26 0.342919275 0.024036232 0.017792805 3.749417e-02 2.068847e-01
## INFRA_27 0.332641828 0.114424269 0.009265805 2.315419e-01 1.134277e-01
## INFRA_28 0.386564841 0.006904425 0.021361782 1.791220e-01 1.821741e-01
## INFRA_30 0.016922066 0.045106228 0.030119807 2.391270e-01 1.661390e-01
## INFRA_31 0.339327783 0.138931002 0.222047457 6.146676e-02 9.602439e-03
## INFRA_32 0.353411344 0.044297329 0.131689966 1.157325e-01 9.673463e-02
## INFRA_33 0.001178458 0.594340122 0.139680347 1.145183e-01 7.787447e-06
## INFRA_37 0.596986299 0.002112494 0.140287226 3.626444e-02 1.015464e-02
## INFRA_38 0.084063126 0.336547590 0.308324632 3.455568e-02 1.232536e-03
##                Dim.6       Dim.7
## RH_1     3.495809e-02 0.009431752
## RH_2     3.499128e-02 0.021256673
```

```
## RH_5     1.463806e-03 0.006147439
## RH_6     2.617130e-02 0.016360524
## RH_7     1.073742e-03 0.012318254
## RH_8     7.909989e-02 0.053437209
## RH_9     3.830156e-02 0.028263409
## RH_10    1.789995e-05 0.153760356
## RH_11    4.047107e-01 0.068294856
## RH_12    9.846460e-02 0.244071057
## RH_13    1.460828e-05 0.002554687
## RH_14    3.151415e-02 0.035494976
## RH_15    3.027567e-01 0.116413470
## RH_16    1.932342e-02 0.017533620
## INFRA_25 1.894990e-03 0.001156782
## INFRA_26 4.207560e-03 0.122969575
## INFRA_27 6.623060e-02 0.043528308
## INFRA_28 4.991565e-02 0.049174266
## INFRA_30 2.650010e-01 0.089546408
## INFRA_31 5.289625e-02 0.011942891
## INFRA_32 8.698844e-02 0.006967923
## INFRA_33 4.217859e-03 0.001891486
## INFRA_37 1.054565e-02 0.019605140
## INFRA_38 2.451690e-02 0.002246205
```

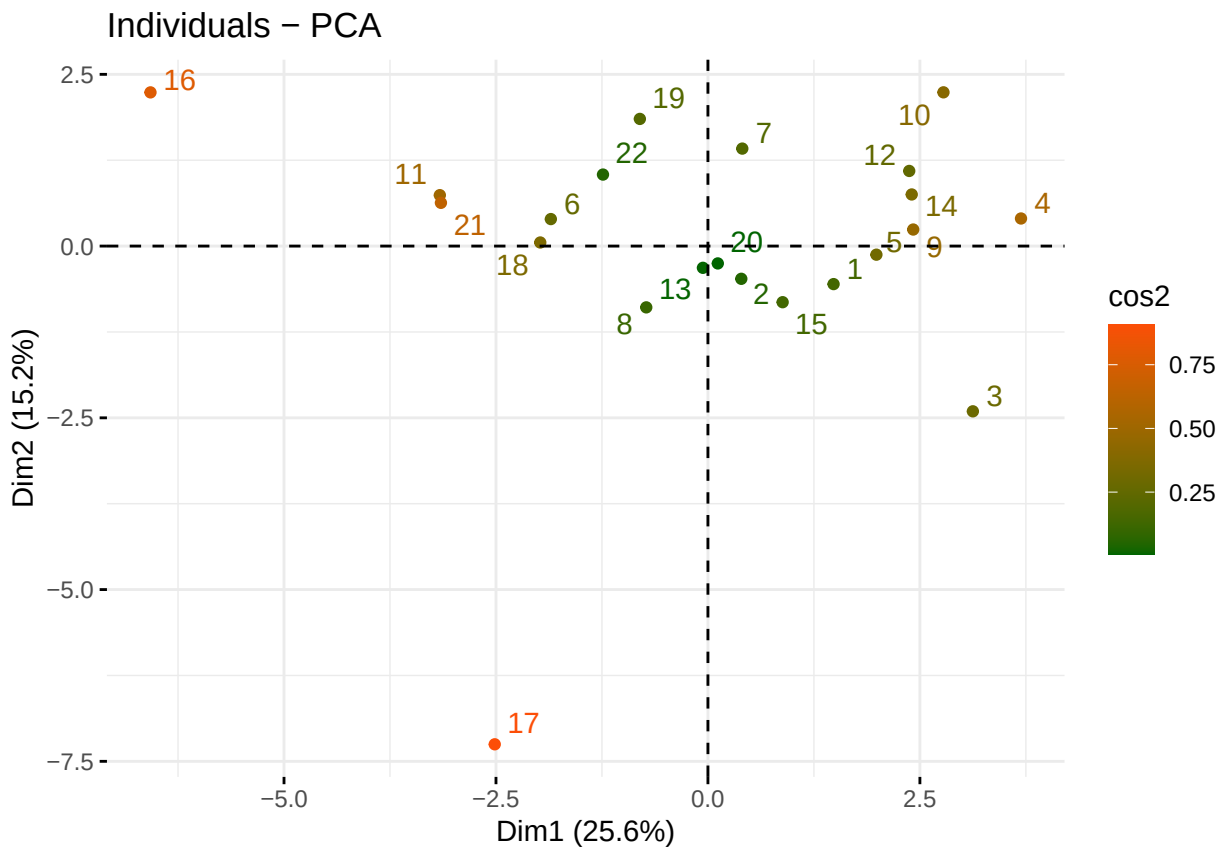
```
acp1$ind$cos2
```

```
##           Dim.1        Dim.2       Dim.3        Dim.4        Dim.5        Dim.6
## 1  0.1206007640 0.0168217787 0.021779358 0.3019426841 0.2704638532 2.735963e-03
## 2  0.0207042054 0.0303278245 0.221422032 0.0111212344 0.1113213530 7.571316e-04
## 3  0.1794727575 0.1063446968 0.565927253 0.0635298004 0.0000340343 3.386988e-02
## 4  0.5427631819 0.0064187423 0.003692434 0.1149305948 0.0798545780 1.631924e-02
## 5  0.3067947356 0.0012145212 0.015892489 0.0532729664 0.0380979951 9.401429e-02
## 6  0.2475537126 0.0111368877 0.009736382 0.0395270649 0.1064509824 3.315980e-01
## 7  0.0143461211 0.1760205372 0.037801400 0.0934816370 0.0128602994 1.150180e-01
## 8  0.0417699395 0.0628401251 0.039752977 0.0013292354 0.0652762285 3.851752e-01
## 9  0.4604777790 0.0045658914 0.131313338 0.0884271025 0.1732593714 1.894157e-02
## 10 0.2435365819 0.1580542500 0.184148380 0.0330012039 0.0338069406 5.720053e-03
## 11 0.4781261740 0.0262715389 0.016876090 0.0143838717 0.0389391166 1.089441e-01
## 12 0.2030603529 0.0430952808 0.130305739 0.0058727771 0.2806353428 8.523734e-02
## 13 0.0003247286 0.0092764049 0.012439226 0.0030805639 0.1709345690 1.339590e-01
## 14 0.3206768091 0.0313302849 0.022421798 0.0252986966 0.0890436286 2.533450e-01
## 15 0.0724306380 0.0622295718 0.188675624 0.1526564059 0.0363637558 7.200734e-03
## 16 0.6968575220 0.0806839002 0.070740650 0.0001321617 0.0012093339 6.193703e-02
## 17 0.0974063184 0.8102345341 0.025555710 0.0015368945 0.0016235918 9.919473e-03
## 18 0.3572210137 0.0002494462 0.006624299 0.0592938844 0.0129169731 4.206732e-05
## 19 0.0315000405 0.1674191579 0.118486166 0.0224166858 0.1445611772 2.568069e-01
## 20 0.0011011321 0.0051722166 0.090891738 0.0002022689 0.1522900451 3.616425e-02
## 21 0.6180701531 0.0247042873 0.085100124 0.0003829994 0.1594315528 2.481085e-02
## 22 0.0291402485 0.0205999297 0.107140924 0.7545828937 0.0765873993 2.363053e-04
##           Dim.7
## 1  8.819147e-02
## 2  3.946223e-04
## 3  2.193132e-02
## 4  9.188270e-03
## 5  1.374251e-02
```

```
## 6  7.089978e-03
## 7  1.290014e-02
## 8  2.506309e-02
## 9  8.690660e-04
## 10 2.106959e-01
## 11 2.305072e-01
## 12 9.877403e-02
## 13 7.011103e-02
## 14 2.850348e-03
## 15 6.817677e-02
## 16 4.796880e-02
## 17 1.264737e-02
## 18 8.464990e-03
## 19 2.861832e-02
## 20 7.332659e-02
## 21 9.329342e-04
## 22 4.819520e-06
```

Gràficos primer punto

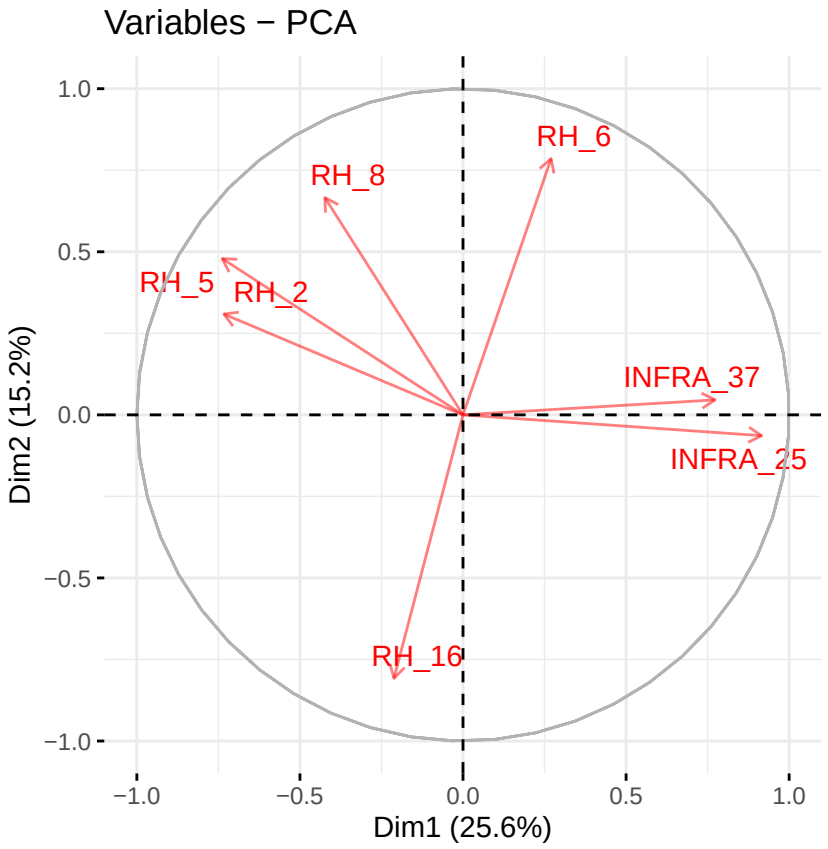
```
#  Gráfico de individuos
G11<-fviz_pca_ind(acp1,
             col.ind = "cos2",  # calidad de representación
             gradient.cols = c("darkgreen",  "#FC4E07"),
             repel = TRUE
)
G11
```



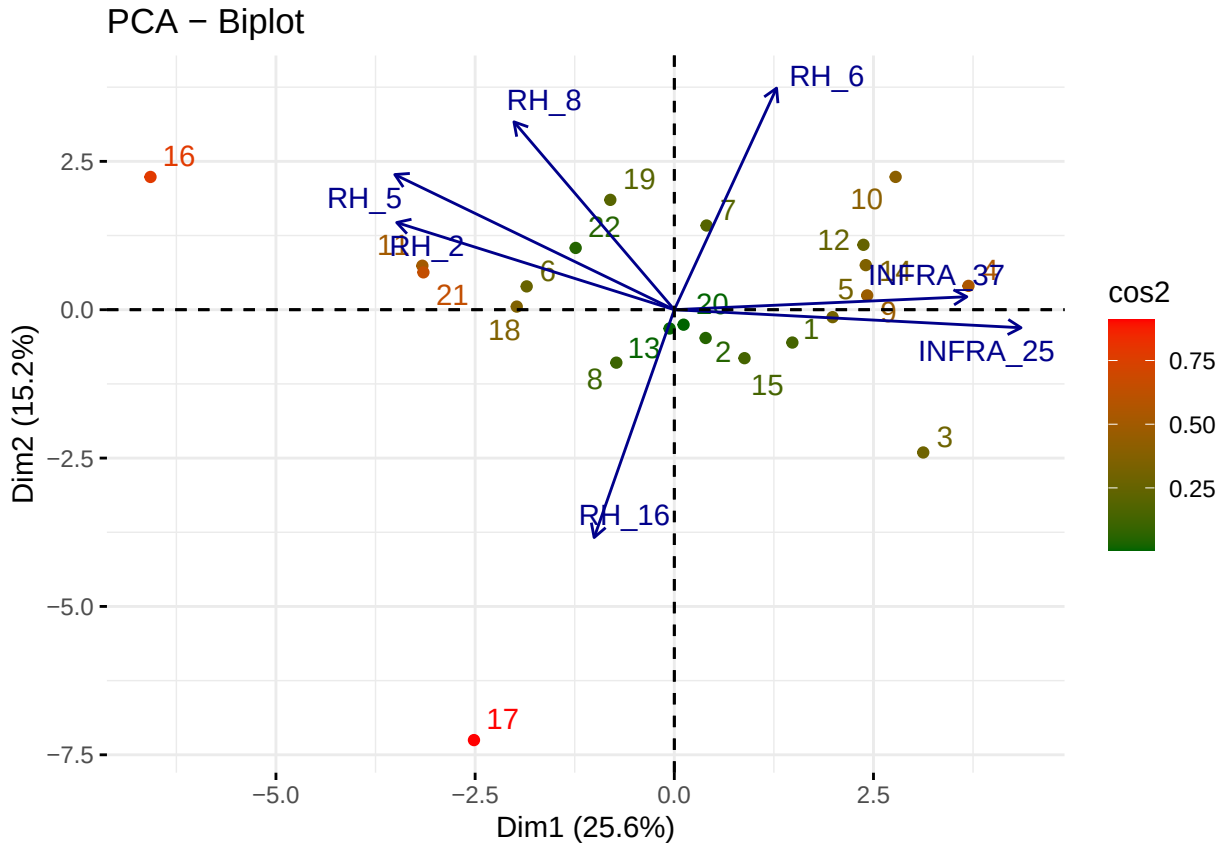

```
# Supongamos que 'acp1' es el resultado de tu análisis PCA
# y que 'otro_dataframe' es el otro dataframe con el que quieres asociar los individuos.
# Este 'otro_dataframe' debería tener al menos una columna que corresponda
# al número de fila o a algún identificador de los individuos en 'ciudadest'.
# Asumiremos que esta columna se llama 'ID_Individuo'.

# 1. Obtener la matriz de cosenos cuadrados de los individuos
#cos2_ind <- as.data.frame(acp1$ind$cos2)

# 2. Crear una columna con el número de fila (que actuará como ID inicial)
#cos2_ind <- cos2_ind %>%
 # mutate(Fila = row_number())

# 3. Crear una función para obtener los 3 valores más altos y sus IDs por dimensión
#obtener_top_3 <- function(df, dimension) {
#  top_3 <- df %>%
#    select(Fila, {{ dimension }}) %>%
#    arrange(desc({{ dimension }})) %>%
#    head(3) %>%
#    rename(!!dimension := {{ dimension }}) # Mantener el nombre de la dimensión
#  return(top_3)
#}

# 4. Obtener los nombres de las dimensiones (componentes principales)
#nombres_dimensiones <- names(cos2_ind)[!names(cos2_ind) == "Fila"]
```

```
# 5. Aplicar la función a cada dimensión y combinar los resultados
#lista_top_3 <- lapply(nombres_dimensiones, function(dim) obtener_top_3(cos2_ind, as.name(dim)))
#tabla_top_3_cos2 <- bind_rows(lista_top_3, .id = "Dimension")

# 6. Unir con el otro dataframe para obtener el ID deseado
# Asegúrate de que la columna 'ID_Individuo' en 'otro_dataframe'
# se corresponde con el número de fila en el orden original de tus datos 'ciudadest'.
#tabla_final <- tabla_top_3_cos2 %>%
 # left_join(otro_dataframe, by = c("Fila" = "ID_Individuo")) %>%
  #select(Dimension, Fila, ID_Individuo, everything()) # Reorganizar columnas

# Imprimir la tabla resultante
#print(tabla_final)
```

```
G12<-fviz_pca_var(acp1,
                  col.var = 'red',
                  alpha.var = 0.5,
                  select.var = list(contrib = 7),
                  repel = TRUE,
                  col.quanti.sup = 'darkgrey'
)
G12
```

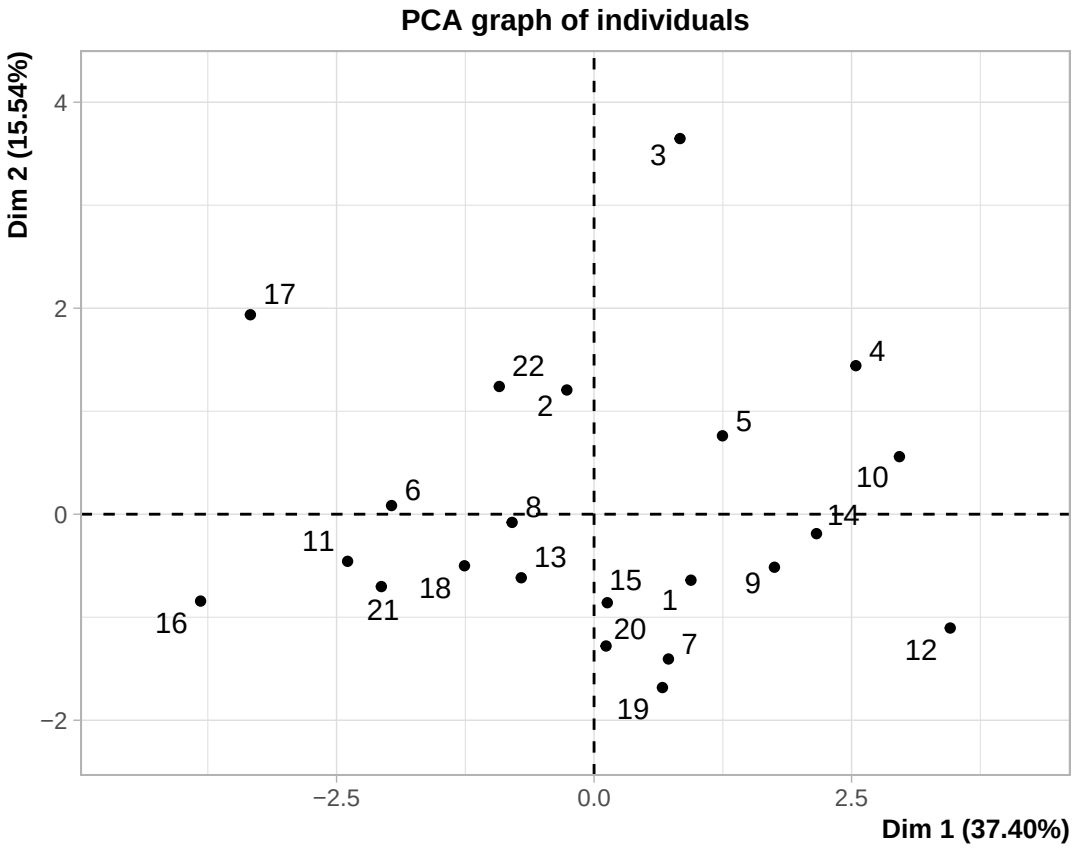


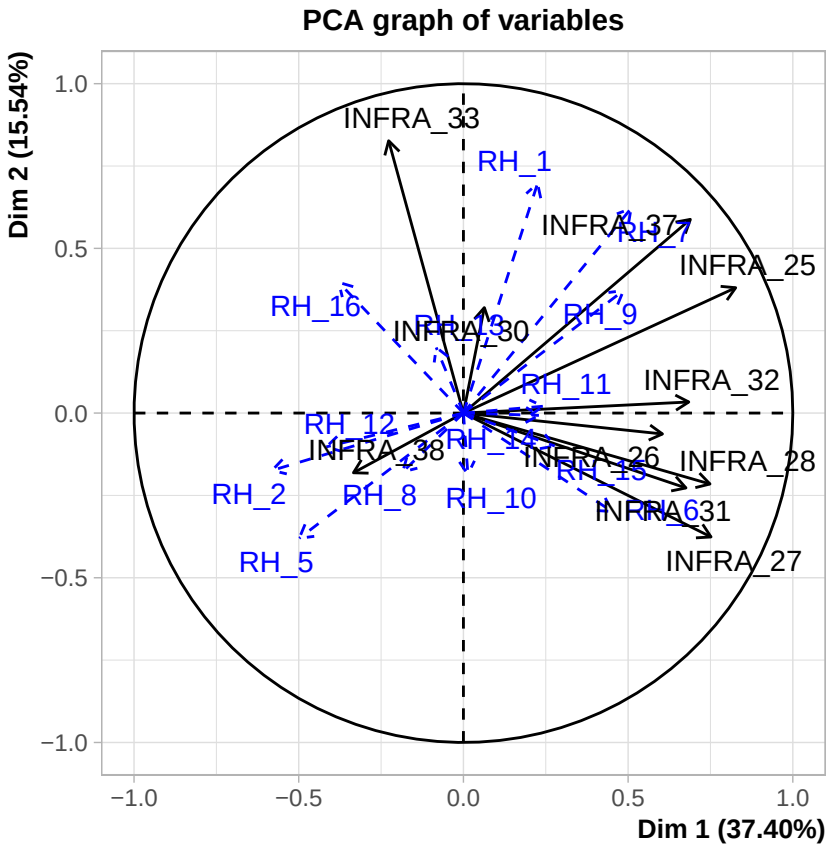
```
# 6. Biplot (variables + individuos)
G13<-fviz_pca_biplot(acp1,
                     col.ind = "cos2",
                     gradient.cols = c("darkgreen",  "red"),
                        col.var = "darkblue",
                        select.var = list(contrib = 7),
                        repel = T,
                        col.quanti.sup = 'darkgrey'
)
G13
```




SEGUNDO PUNTO

```
acp2<-PCA(ciudadest,quanti.sup = c(1:14))
```


PCA graph of individuals
Dim 2 (15.54%)
Dim 1 (37.40%)
4
2
0
−2
−2.5
0.0
2.5
3
17
22
2
4
5
10
6
8
14
11
13
15
1
9
18
21
16
20
7
12
19




```
#Solo las variables INFRA_25 a INFRA_38
#(columnas 15 a 24) serán activas.
#Las variables RH_* (1 a 14) no se usan para
#construir los ejes principales, pero se proyectan
#en el plano factorial para ser interpretadas.

#contiene los auto valores correspondientes a los componentes principales
acp2$eig
```

```
##         eigenvalue percentage of variance cumulative percentage of variance
## comp 1  3.73989557             37.3989557                           37.39896
## comp 2  1.55392842             15.5392842                           52.93824
## comp 3  1.44763393             14.4763393                           67.41458
## comp 4  1.10618953             11.0618953                           78.47647
## comp 5  1.02559925             10.2559925                           88.73247
## comp 6  0.52558475              5.2558475                           93.98831
## comp 7  0.28734095              2.8734095                           96.86172
## comp 8  0.19940455              1.9940455                           98.85577
## comp 9  0.08526143              0.8526143                           99.70838
## comp 10 0.02916163              0.2916163                          100.00000
```

```
#al sumar la columna de los eigenvalue da 10
sum(acp2$eig[,1])
```

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

```r
#la coluna de porcentages de varianza acumulados
#nos muestra que tan importantes son los primeros componentes
# y es notable como con los primeros 5 ya se acumula
# el 88 porciento de la varianza
acp2$eig[c(1:5),c(1,3)]
```

```
##        eigenvalue cumulative percentage of variance
## comp 1   3.739896                           37.39896
## comp 2   1.553928                           52.93824
## comp 3   1.447634                           67.41458
## comp 4   1.106190                           78.47647
## comp 5   1.025599                           88.73247
```

```r
#coordenadas de las variables
acp2$var$coord
```

```
##                Dim.1       Dim.2      Dim.3       Dim.4       Dim.5
## INFRA_25  0.82657707  0.38050074 -0.2133359  0.08213467  0.16151727
## INFRA_26  0.60426012 -0.06343287 -0.5120243 -0.03094806  0.33777561
## INFRA_27  0.75167757 -0.37613407  0.1569072  0.48413257 -0.03703933
## INFRA_28  0.74857470 -0.21533667  0.3277062  0.48501239  0.14985208
## INFRA_30  0.06352942  0.32015548  0.7698038  0.08783533 -0.27664414
## INFRA_31  0.67559759 -0.22729549  0.2420077 -0.54809721 -0.07556691
## INFRA_32  0.68414019  0.03360157  0.3554094 -0.51667260  0.05895429
## INFRA_33 -0.22701374  0.82664856  0.2180315  0.17665952  0.29193043
## INFRA_37  0.68896104  0.58803751 -0.2401200 -0.08573810 -0.07411593
## INFRA_38 -0.33381722 -0.18124393  0.3539277 -0.12340378  0.82774211
```

```r
#correlaciones variable factor
acp2$var$cor
```

```
##                Dim.1       Dim.2      Dim.3       Dim.4       Dim.5
## INFRA_25  0.82657707  0.38050074 -0.2133359  0.08213467  0.16151727
## INFRA_26  0.60426012 -0.06343287 -0.5120243 -0.03094806  0.33777561
## INFRA_27  0.75167757 -0.37613407  0.1569072  0.48413257 -0.03703933
## INFRA_28  0.74857470 -0.21533667  0.3277062  0.48501239  0.14985208
## INFRA_30  0.06352942  0.32015548  0.7698038  0.08783533 -0.27664414
## INFRA_31  0.67559759 -0.22729549  0.2420077 -0.54809721 -0.07556691
## INFRA_32  0.68414019  0.03360157  0.3554094 -0.51667260  0.05895429
## INFRA_33 -0.22701374  0.82664856  0.2180315  0.17665952  0.29193043
## INFRA_37  0.68896104  0.58803751 -0.2401200 -0.08573810 -0.07411593
## INFRA_38 -0.33381722 -0.18124393  0.3539277 -0.12340378  0.82774211
```

```r
#basicamente estas covarianzas nos habla de como las variables
#se relacionan con los factores y en que medida los construye

#cosenos cuadrados de las variables
acp2$var$cos2
```

```
##                Dim.1       Dim.2      Dim.3        Dim.4       Dim.5
## INFRA_25 0.683229645 0.144780812 0.04551221 0.0067461047 0.026087830
```

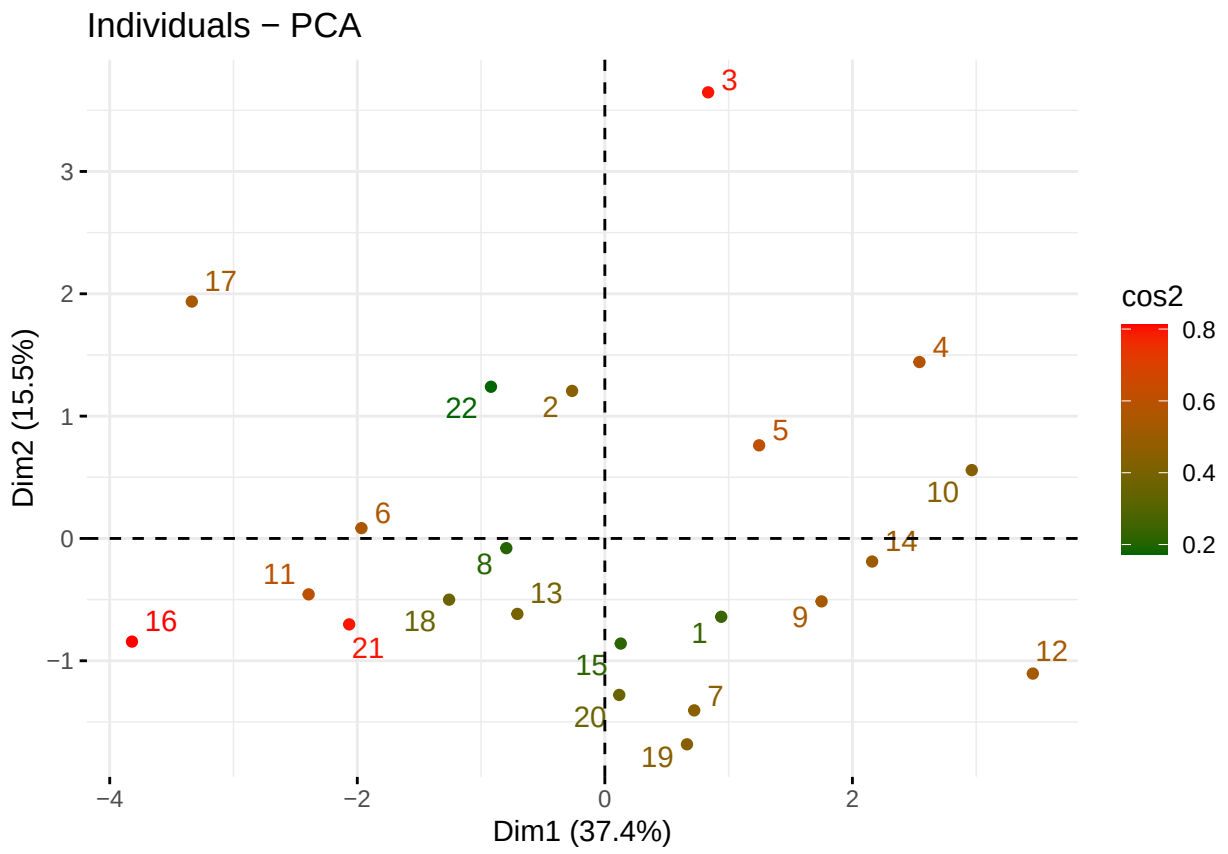
```
## INFRA_26 0.365130298 0.004023729 0.26216891 0.0009577821 0.114092360
## INFRA_27 0.565019166 0.141476835 0.02461986 0.2343843481 0.001371912
## INFRA_28 0.560364077 0.046369880 0.10739136 0.2352370211 0.022455645
## INFRA_30 0.004035987 0.102499532 0.59259786 0.0077150444 0.076531981
## INFRA_31 0.456432105 0.051663240 0.05856772 0.3004105567 0.005710358
## INFRA_32 0.468047795 0.001129065 0.12631586 0.2669505712 0.003475609
## INFRA_33 0.051535239 0.683347846 0.04753774 0.0312085843 0.085223378
## INFRA_37 0.474667317 0.345788119 0.05765760 0.0073510226 0.005493171
## INFRA_38 0.111433937 0.032849363 0.12526482 0.0152284928 0.685157007
```

```
var_contrib <- data.frame(acp2$var$contrib)

top5_vars <- rownames(var_contrib)[order(var_contrib$Dim.1 + var_contrib$Dim.2, decreasing = TRUE)][1:5]
sup_vars <- rownames(acp2$quanti.sup$coord)
all_vars <- c(top5_vars, sup_vars)
s2<-acp2$eig
sum(s2[,1])
```

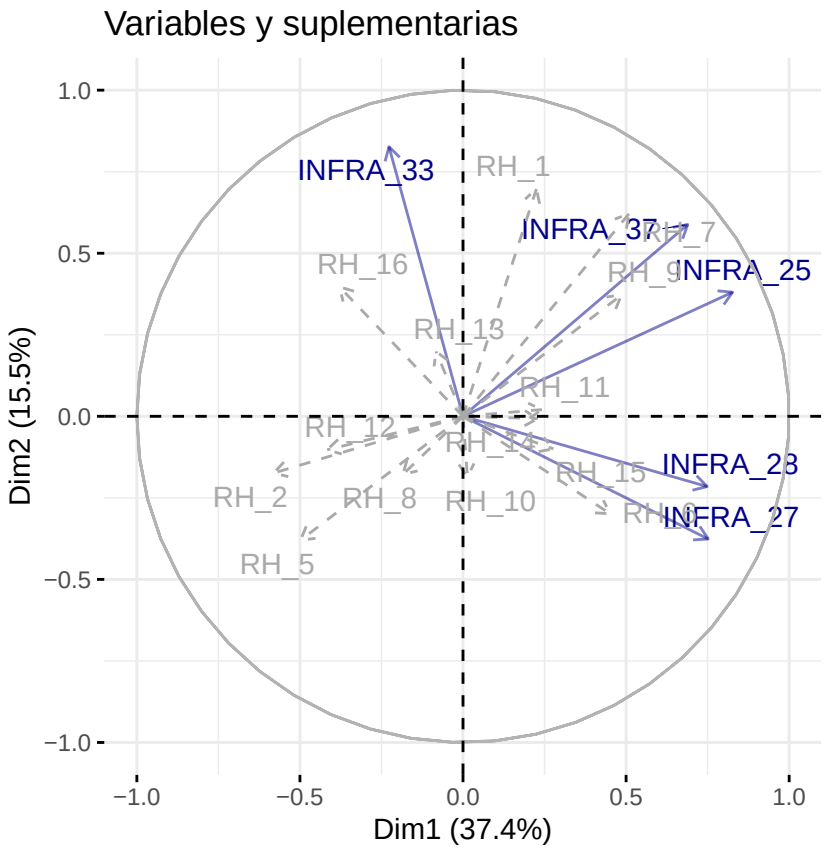
```
## [1] 10
```

Gràficos punto#2:

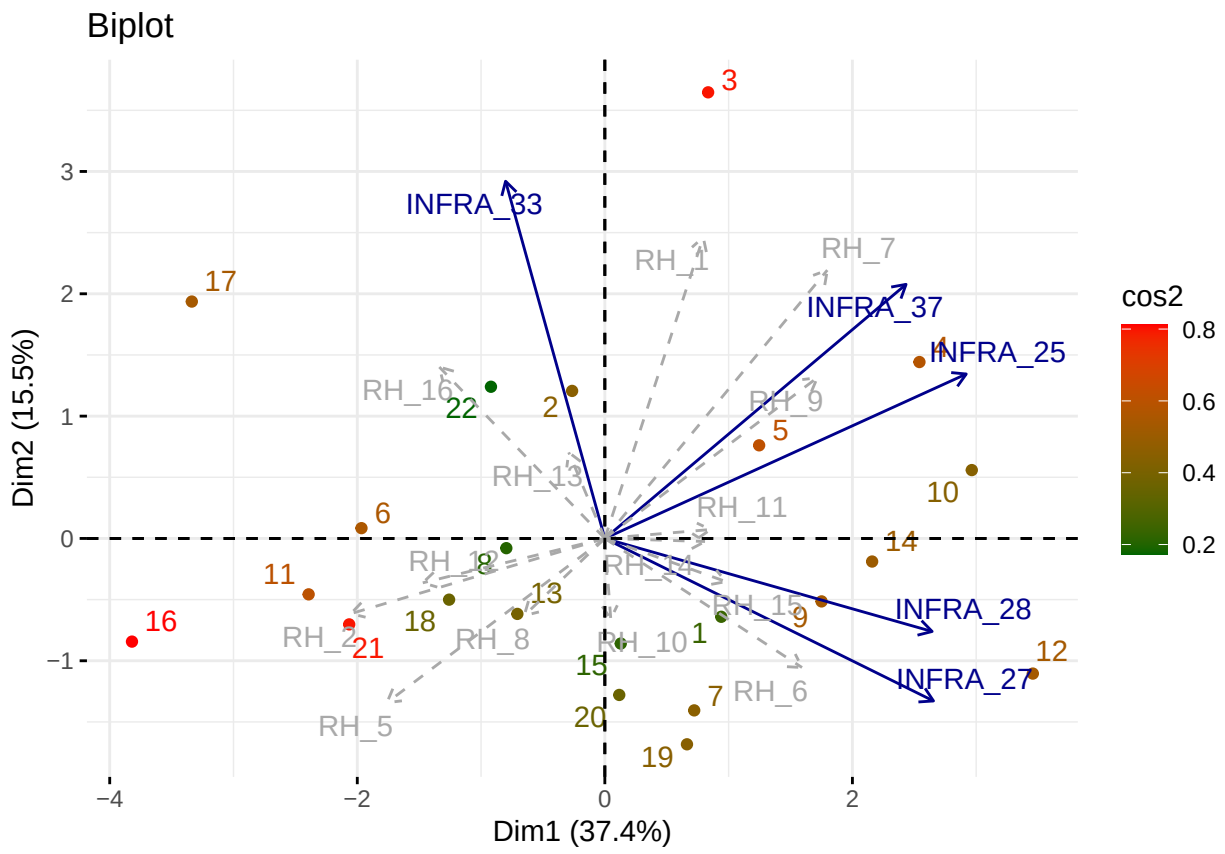
```
#  Gráfico de individuos
G21<-fviz_pca_ind(acp2,
             col.ind = "cos2",  # calidad de representación
             gradient.cols = c("darkgreen",  "red"),
             repel = TRUE
)
G21
```




```
G22<-fviz_pca_var(acp2,
                  col.var = "darkblue",
                  gradient.cols = c("darkgreen", "#E7B800", "red"),
                  alpha.var = 0.5,
                  repel = TRUE,
                  col.quanti.sup = 'darkgrey',
                  select.var = list(name =c(all_vars)),
                  title = 'Variables y suplementarias'
)

G22
```




```
G23<-fviz_pca_biplot(acp2,
                     col.ind = "cos2",
                     gradient.cols = c("darkgreen", "red"),
                     col.var = "darkblue",
                     repel = T,
                     col.quanti.sup = 'darkgrey',
                     select.var = list(name =c(all_vars)),
            title = 'Biplot'
)
G23
```




Al revisar las coordenadas 3 individuos resaltan al ojo, Bogotá (3), San Andrés (17) y Riohacha (16) por ser los individuos más alejados del origen de nuestro plano, esto nos indica singularidades y posibles aspectos a destacar de estás ciudades.

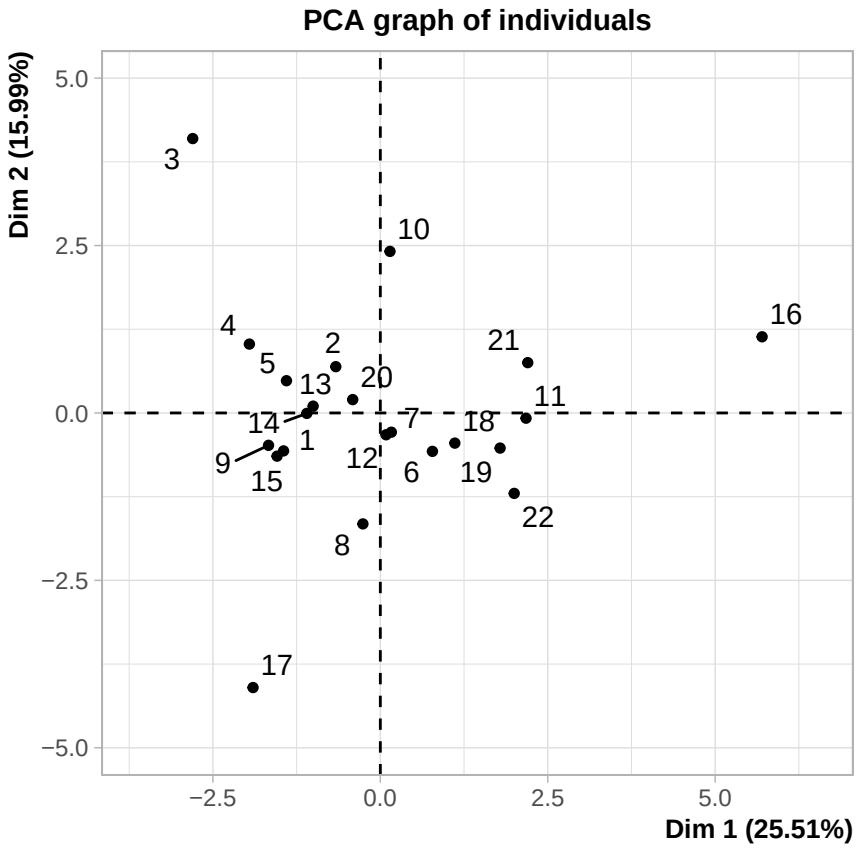
Al revisar a San Andrés vemos que este guarda una relación negativa con las variables INFRA 27/28 ( acueducto y alcantarillado cada 10000 habitantes) esto explicable fácilmente gracias a su baja población y su geografía de isla que dificulta la construcción de infraestructura pública como alcantarillado.

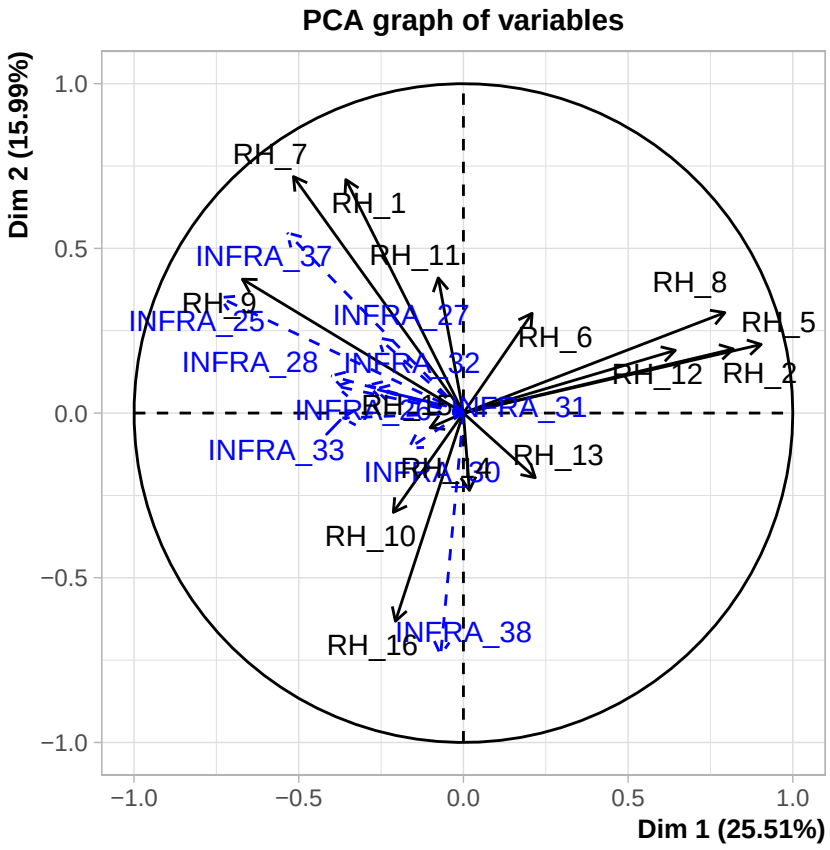
Por el lado de la capital vemos su alto posicionamiento en la dimensión 2, y a pesar que existe una relación destacable con INFRA 37/25 (clientes de internet y líneas telefónicas cada 10000 habitantes), el rasgo más importante de este individuo es su alta posición en el eje Y, explicada en parte gracias a la variable de carga aérea (INFRA 33) dónde Bogota es lider seguido de cerca de San Andrés.

En el tercer cuadrante encontramos a Riohacha, el cual es representado de manera negativa con respecto a nuestras variables de telecomunicaciones siendo este el individuo mas destacable del lado negativo del eje X

TERCER PUNTO

```
acp3<-PCA(ciudadest,quanti.sup = c(15:24),ncp = 6)
```


PCA graph of individuals
Dim 2 (15.99%)
Dim 1 (25.51%)
5.0
2.5
0.0
−2.5
−5.0
−2.5
0.0
2.5
5.0
3
10
16
4
2
21
5
20
13
11
14
7
18
1
12
9
6
19
15
22
8
17




```
#Esto hace lo opuesto: trata las variables de
#infraestructura (15 a 24) como suplementarias y
#las variables RH (1 a 14) como activas.

#contiene los auto valores correspondientes a los componentes principales
acp3$eig
```

```
##         eigenvalue percentage of variance cumulative percentage of variance
## comp 1  3.57145227            25.51037333                            25.51037
## comp 2  2.23904563            15.99318305                            41.50356
## comp 3  2.07159426            14.79710185                            56.30066
## comp 4  1.60270922            11.44792298                            67.74858
## comp 5  1.25832699             8.98804991                            76.73663
## comp 6  1.19179090             8.51279212                            85.24942
## comp 7  0.77121137             5.50865263                            90.75808
## comp 8  0.46142015             3.29585818                            94.05393
## comp 9  0.32761648             2.34011768                            96.39405
## comp 10 0.21525724             1.53755171                            97.93160
## comp 11 0.12879153             0.91993949                            98.85154
## comp 12 0.09416088             0.67257769                            99.52412
## comp 13 0.05382938             0.38449557                            99.90862
## comp 14 0.01279373             0.09138382                           100.00000
```

```
#al sumar la columna de los eigenvalue da 14
sum(acp3$eig[,1])
```

```
## [1] 14
```

```
#la coluna de porcentages de varianza acumulados
#nos muestra que tan importantes son los primeros componentes
# y es notable como con los primeros 6 ya se acumula
# el 85 porciento de la varianza
acp3$eig[c(1:6),c(1,3)]
```

```
##        eigenvalue cumulative percentage of variance
## comp 1   3.571452                          25.51037
## comp 2   2.239046                          41.50356
## comp 3   2.071594                          56.30066
## comp 4   1.602709                          67.74858
## comp 5   1.258327                          76.73663
## comp 6   1.191791                          85.24942
```

```
#coordenadas de las variables
acp3$var$coord
```

```
##             Dim.1       Dim.2       Dim.3       Dim.4        Dim.5       Dim.6
## RH_1  -0.35693798  0.70877743 -0.03696321  0.29065674  0.001408176  0.41343738
## RH_2   0.81930164  0.19450143 -0.10637763  0.37891761  0.192633367  0.05114370
## RH_5   0.90417056  0.20834627 -0.27356525 -0.04550233  0.012177864  0.06451571
## RH_6   0.20854441  0.30278075  0.62998230 -0.55512354 -0.174660976 -0.15421996
## RH_7  -0.51603493  0.71791876  0.10571827  0.09082143  0.134489129  0.25757944
## RH_8   0.79360603  0.30489947  0.26180205 -0.08636297 -0.243592220  0.18660305
## RH_9  -0.67088638  0.40633864  0.14033448  0.13526355  0.237862034 -0.03899100
## RH_10 -0.21282189 -0.30137196 -0.18458694 -0.55364752  0.363134774  0.42626576
## RH_11 -0.07643766  0.41032125 -0.28342113  0.24444158  0.039336194 -0.75902571
## RH_12  0.64325590  0.19044110 -0.21975096  0.06071786  0.619726462  0.06498233
## RH_13  0.21798586 -0.19615992  0.76788389  0.40875032  0.238711523  0.11023355
## RH_14  0.01809994 -0.23469219  0.80072702  0.30237281  0.076254577 -0.06686807
## RH_15 -0.10102305 -0.04451304  0.19453606 -0.33874643  0.687721548 -0.30741848
## RH_16 -0.20644844 -0.63189077 -0.23757449  0.53590502  0.057669955  0.12015151
```

```
#correlaciones variable factor
acp3$var$cor
```

```
##             Dim.1       Dim.2       Dim.3       Dim.4        Dim.5       Dim.6
## RH_1  -0.35693798  0.70877743 -0.03696321  0.29065674  0.001408176  0.41343738
## RH_2   0.81930164  0.19450143 -0.10637763  0.37891761  0.192633367  0.05114370
## RH_5   0.90417056  0.20834627 -0.27356525 -0.04550233  0.012177864  0.06451571
## RH_6   0.20854441  0.30278075  0.62998230 -0.55512354 -0.174660976 -0.15421996
## RH_7  -0.51603493  0.71791876  0.10571827  0.09082143  0.134489129  0.25757944
## RH_8   0.79360603  0.30489947  0.26180205 -0.08636297 -0.243592220  0.18660305
## RH_9  -0.67088638  0.40633864  0.14033448  0.13526355  0.237862034 -0.03899100
## RH_10 -0.21282189 -0.30137196 -0.18458694 -0.55364752  0.363134774  0.42626576
## RH_11 -0.07643766  0.41032125 -0.28342113  0.24444158  0.039336194 -0.75902571
## RH_12  0.64325590  0.19044110 -0.21975096  0.06071786  0.619726462  0.06498233
## RH_13  0.21798586 -0.19615992  0.76788389  0.40875032  0.238711523  0.11023355
## RH_14  0.01809994 -0.23469219  0.80072702  0.30237281  0.076254577 -0.06686807
## RH_15 -0.10102305 -0.04451304  0.19453606 -0.33874643  0.687721548 -0.30741848
## RH_16 -0.20644844 -0.63189077 -0.23757449  0.53590502  0.057669955  0.12015151
```

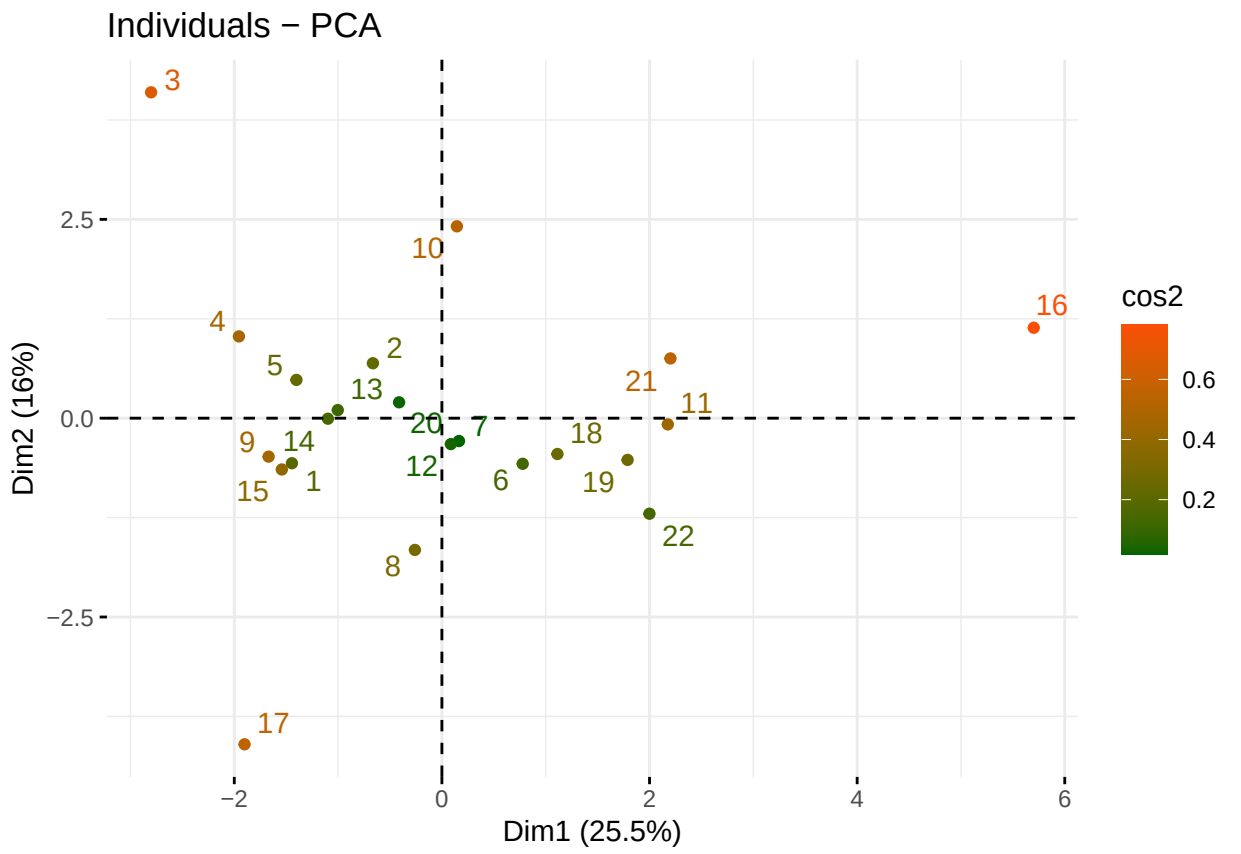
```r
#basicamente estas covarianzas nos habla de como las variables
#se relacionan con los factores y en que medida los construye

#cosenos cuadrados de las variables
acp3$var$cos2
```

```
##              Dim.1      Dim.2       Dim.3       Dim.4        Dim.5       Dim.6
## RH_1  0.1274047208 0.50236545 0.001366279 0.084481342 1.982960e-06 0.170930470
## RH_2  0.6712551732 0.03783081 0.011316201 0.143578559 3.710761e-02 0.002615678
## RH_5  0.8175244042 0.04340817 0.074837947 0.002070462 1.483004e-04 0.004162277
## RH_6  0.0434907701 0.09167619 0.396877693 0.308162144 3.050646e-02 0.023783796
## RH_7  0.2662920502 0.51540735 0.011176352 0.008248532 1.808733e-02 0.066347168
## RH_8  0.6298105273 0.09296368 0.068540314 0.007458562 5.933717e-02 0.034820698
## RH_9  0.4500885389 0.16511109 0.019693767 0.018296227 5.657835e-02 0.001520298
## RH_10 0.0452931572 0.09082506 0.034072337 0.306525573 1.318669e-01 0.181702494
## RH_11 0.0058427156 0.16836353 0.080327536 0.059751685 1.547336e-03 0.576120031
## RH_12 0.4137781496 0.03626781 0.048290484 0.003686659 3.840609e-01 0.004222703
## RH_13 0.0475178359 0.03847871 0.589645668 0.167076823 5.698319e-02 0.012151436
## RH_14 0.0003276077 0.05508042 0.641163760 0.091429319 5.814760e-03 0.004471339
## RH_15 0.0102056570 0.00198141 0.037844280 0.114749141 4.729609e-01 0.094506122
## RH_16 0.0426209586 0.39928594 0.056441641 0.287194189 3.325824e-03 0.014436386
```

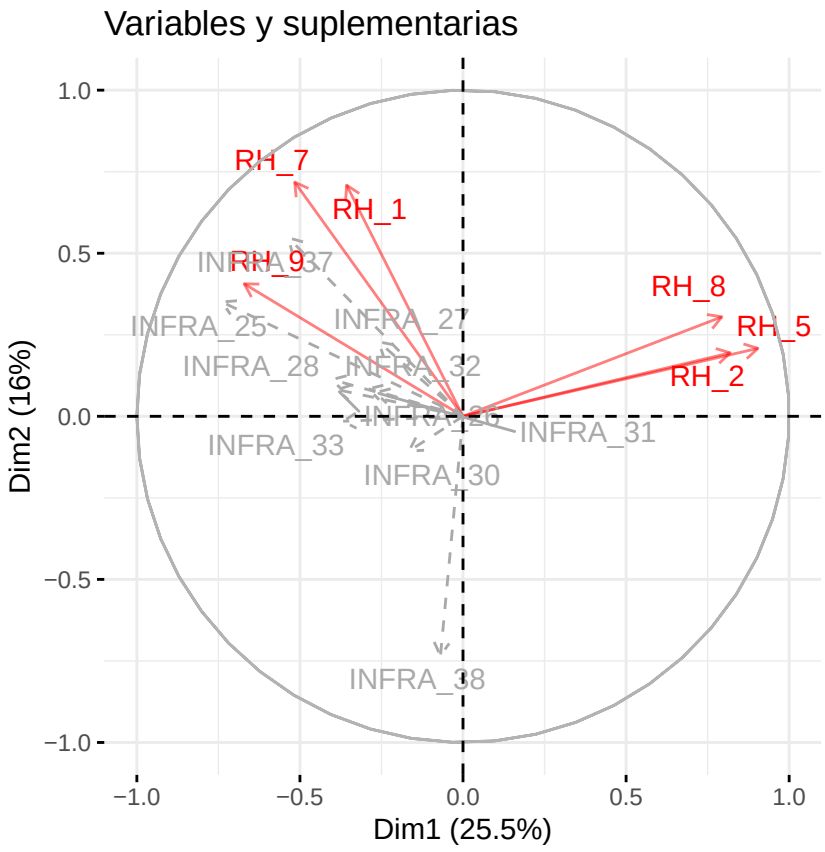
```r
var_contrib3 <- data.frame(acp3$var$contrib)

top5_vars3 <- rownames(var_contrib3)[order(var_contrib3$Dim.1 + var_contrib3$Dim.2, decreasing = TRUE)]
sup_vars3 <- rownames(acp3$quanti.sup$coord)
all_vars3 <- c(top5_vars3, sup_vars3)
```

Gràficos punto #3

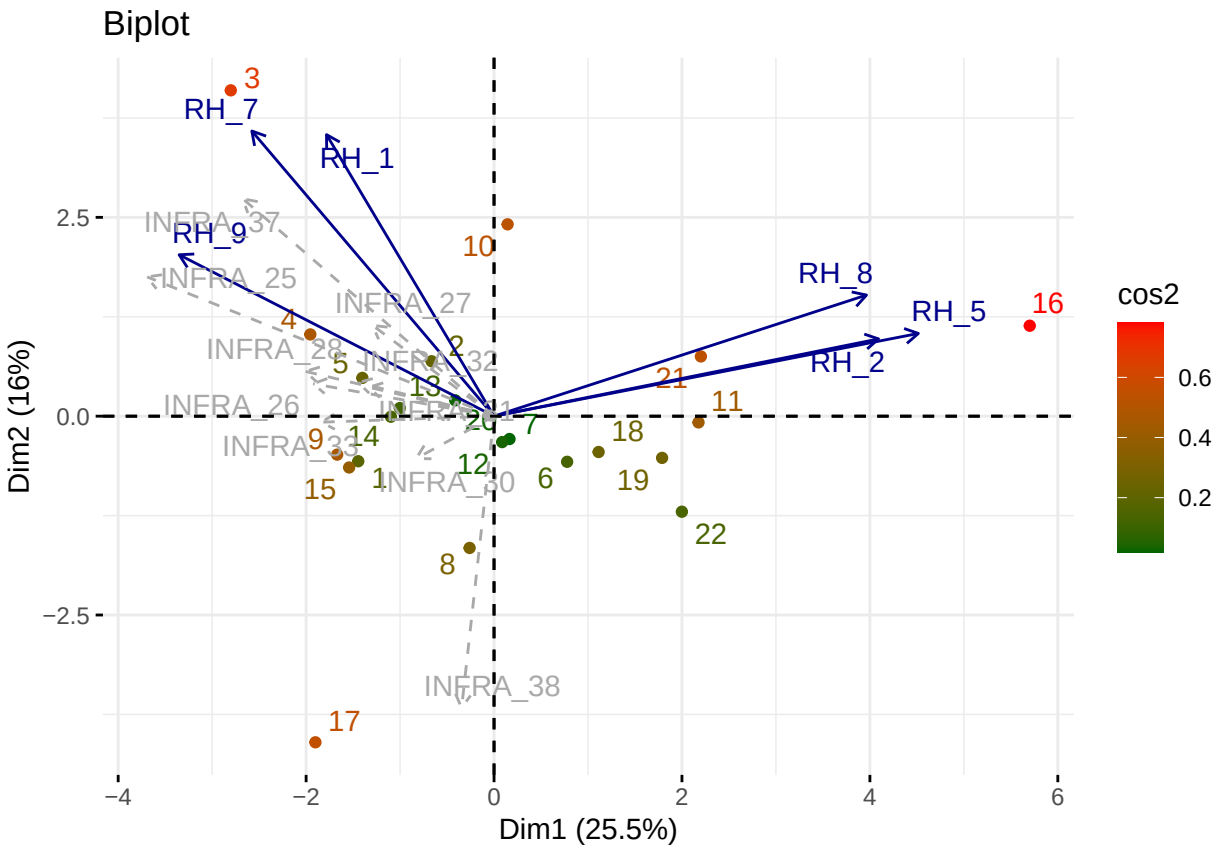
```r
#  Gráfico de individuos
G31<-fviz_pca_ind(acp3,
             col.ind = "cos2",  # calidad de representación
             gradient.cols = c("darkgreen",  "#FC4E07"),
             repel = TRUE
)
G31
```




```
G32<-fviz_pca_var(acp3,
                  col.var = 'red',
                  alpha.var = 0.5,
                  repel = TRUE,
                  col.quanti.sup = 'darkgrey',
                  select.var = list(name =c(all_vars3)),
                  title = 'Variables y suplementarias'
)

G32
```




```
G33<-fviz_pca_biplot(acp3,
                  col.ind = "cos2",
                  gradient.cols = c("darkgreen", "red"),
                     col.var = "darkblue",
                     repel = T,
                     col.quanti.sup = 'darkgrey',
                     select.var = list(name =c(all_vars3)),
             title = 'Biplot'
)
G33
```


Biplot
RH_7
RH_1
RH_9
RH_8
RH_5
RH_2
INFRA_37
INFRA_25
INFRA_27
INFRA_28
INFRA_32
INFRA_26
INFRA_33
INFRA_30
INFRA_38
cos2
0.6
0.4
0.2
Dim2 (16%)
Dim1 (25.5%)
2.5
0.0
−2.5
−4
−2
0
2
4
6