PCA_Bienestar_Happiness.R

jmsar

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```
# MUCD: Tema 3
# Practica PCA - Datos de Felicidad 2017
# Objetivo: Construir un Indice de Bienestar
# http://worldhappiness.report/ed/2017/
```

```
datos<-read.table("happiness.txt",header=T)
names(datos)
```

```
##  [1] "HappinessScore"                "Whisker_high"
##  [3] "Whisker_low"                   "GDP_PC"
##  [5] "Social_support"                "Healthy_life_expectancy"
##  [7] "Freedom_to_make_life_choices" "Generosity"
##  [9] "Perceptions_of_corruption"     "Dystopia_residual"
```

```
# Paquetes
library(ggplot2)
library(ggcorrplot)
library('corrr')
library("FactoMineR")
library("factoextra")
```

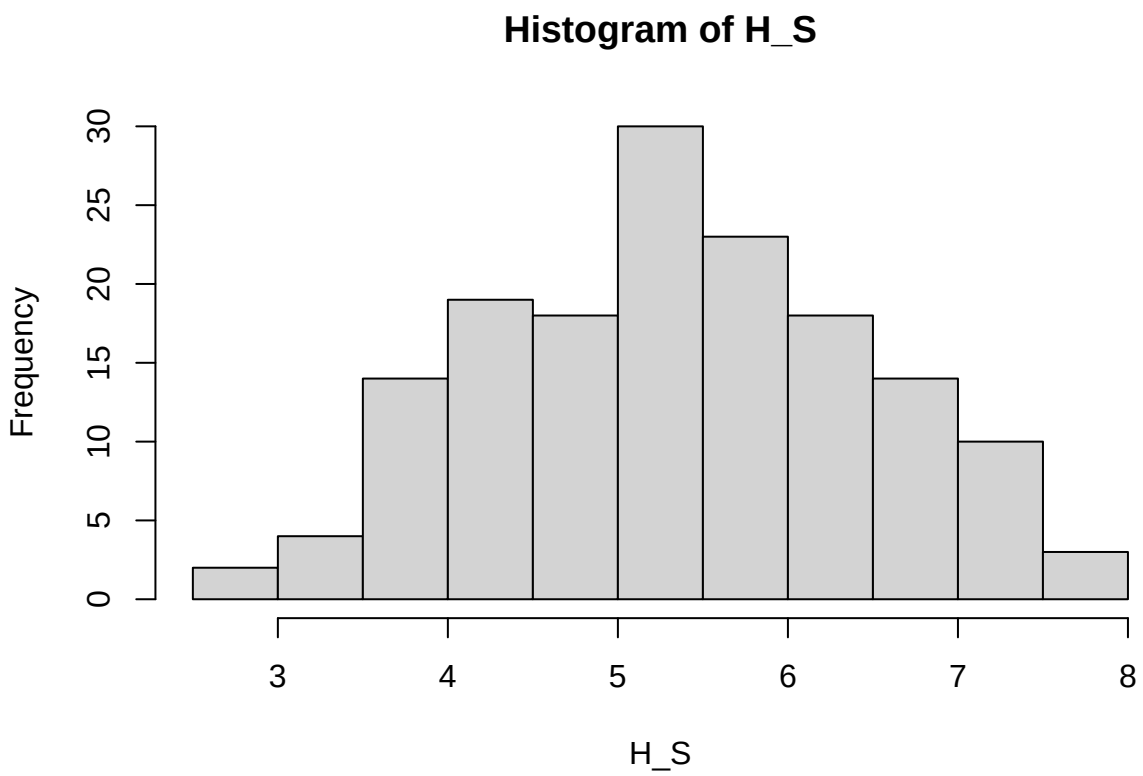
```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
# Comenzamos con Nueva Base de Datos prescindiendo de:
# HappinessScore; Whisker_high; Whisker_low
```

```
H_S<-datos$HappinessScore
summary(H_S)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.693   4.505   5.279   5.354   6.101   7.537
```

```
hist(H_S)
```




```
datos2<-data.frame(datos$HappinessScore,
                   datos$GDP_PC,
                   datos$Social_support,
                   datos$Healthy_life_expectancy,
                   datos$Freedom_to_make_life_choices,
                   datos$Generosity,
                   datos$Perceptions_of_corruption,
                   datos$Dystopia_residual)
datos<-datos2
summary(datos)
```

```
##  datos.HappinessScore  datos.GDP_PC    datos.Social_support
##  Min.   :2.693        Min.   :0.0000   Min.   :0.000
##  1st Qu.:4.505        1st Qu.:0.6635   1st Qu.:1.042
##  Median :5.279        Median :1.0650   Median :1.254
##  Mean   :5.354        Mean   :0.9847   Mean   :1.189
##  3rd Qu.:6.101        3rd Qu.:1.3180   3rd Qu.:1.414
##  Max.   :7.537        Max.   :1.8710   Max.   :1.611
##  datos.Healthy_life_expectancy datos.Freedom_to_make_life_choices
##  Min.   :0.0000                Min.   :0.0000
##  1st Qu.:0.3700                1st Qu.:0.3040
##  Median :0.6060                Median :0.4370
##  Mean   :0.5513                Mean   :0.4088
##  3rd Qu.:0.7230                3rd Qu.:0.5165
##  Max.   :0.9490                Max.   :0.6580
##  datos.Generosity datos.Perceptions_of_corruption datos.Dystopia_residual
```

```
##  Min.   :0.0000   Min.   :0.0000                Min.   :0.378
##  1st Qu.:0.1540   1st Qu.:0.0570                1st Qu.:1.591
##  Median :0.2320   Median :0.0900                Median :1.833
##  Mean   :0.2469   Mean   :0.1231                Mean   :1.850
##  3rd Qu.:0.3235   3rd Qu.:0.1535                3rd Qu.:2.145
##  Max.   :0.8380   Max.   :0.4640                Max.   :3.117
```

```
length(datos)
```

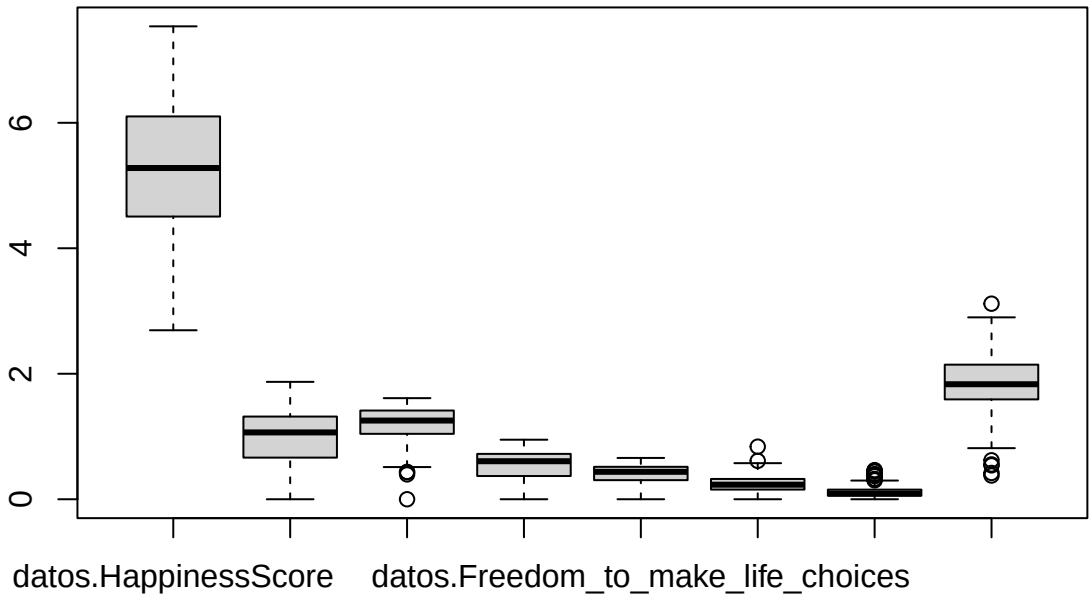
```
## [1] 8
```

```
# Analisis descriptivo de los datos
```

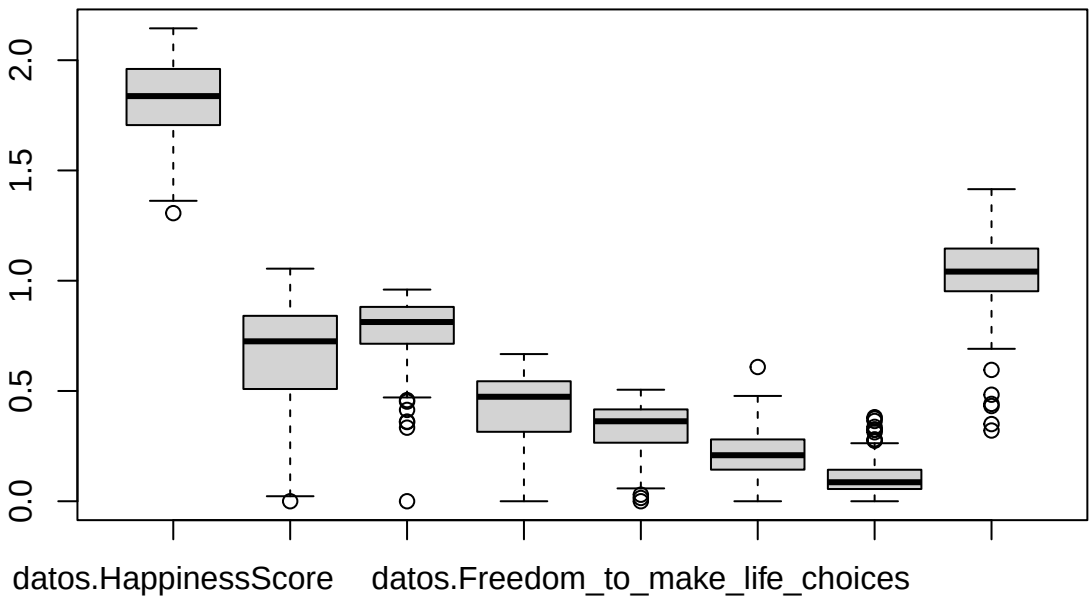
```
summary(datos)
```

```
##  datos.HappinessScore  datos.GDP_PC    datos.Social_support
##  Min.   :2.693        Min.   :0.0000   Min.   :0.000
##  1st Qu.:4.505        1st Qu.:0.6635   1st Qu.:1.042
##  Median :5.279        Median :1.0650   Median :1.254
##  Mean   :5.354        Mean   :0.9847   Mean   :1.189
##  3rd Qu.:6.101        3rd Qu.:1.3180   3rd Qu.:1.414
##  Max.   :7.537        Max.   :1.8710   Max.   :1.611
##  datos.Healthy_life_expectancy datos.Freedom_to_make_life_choices
##  Min.   :0.0000                Min.   :0.0000
##  1st Qu.:0.3700                1st Qu.:0.3040
##  Median :0.6060                Median :0.4370
##  Mean   :0.5513                Mean   :0.4088
##  3rd Qu.:0.7230                3rd Qu.:0.5165
##  Max.   :0.9490                Max.   :0.6580
##  datos.Generosity datos.Perceptions_of_corruption datos.Dystopia_residual
##  Min.   :0.0000   Min.   :0.0000                  Min.   :0.378
##  1st Qu.:0.1540   1st Qu.:0.0570                  1st Qu.:1.591
##  Median :0.2320   Median :0.0900                  Median :1.833
##  Mean   :0.2469   Mean   :0.1231                  Mean   :1.850
##  3rd Qu.:0.3235   3rd Qu.:0.1535                  3rd Qu.:2.145
##  Max.   :0.8380   Max.   :0.4640                  Max.   :3.117
```

```
boxplot(datos)
```

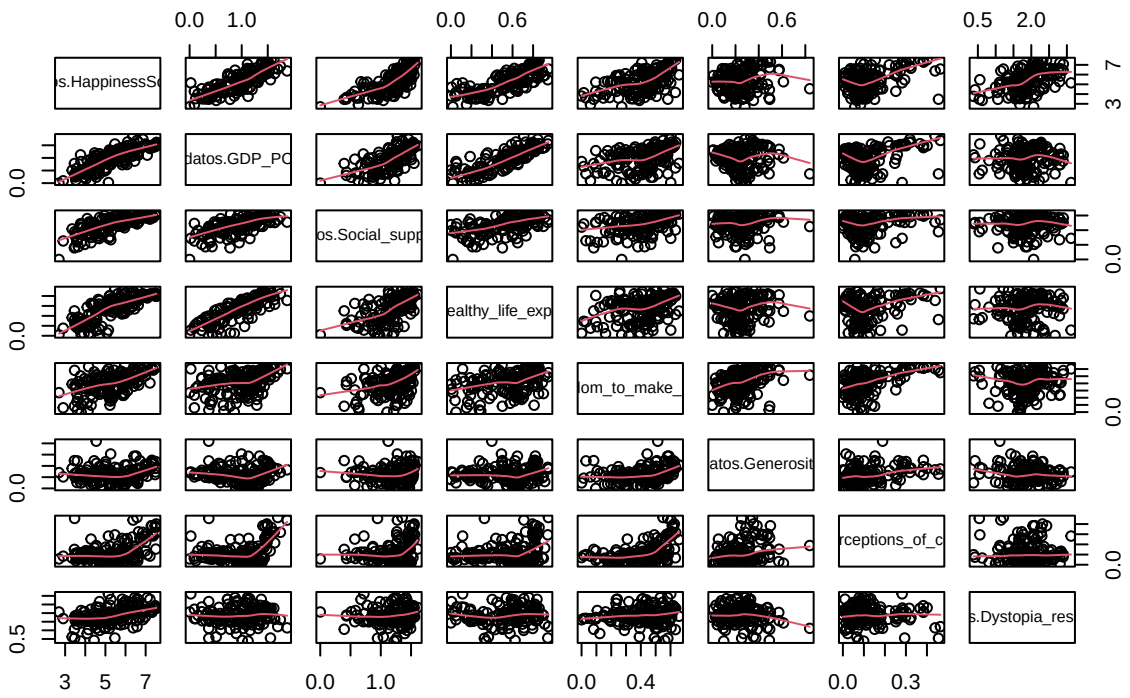



```
boxplot(log(datos+1))
```




```
require(graphics)
pairs(datos, panel = panel.smooth, main = "Felicidad")
```

Felicidad

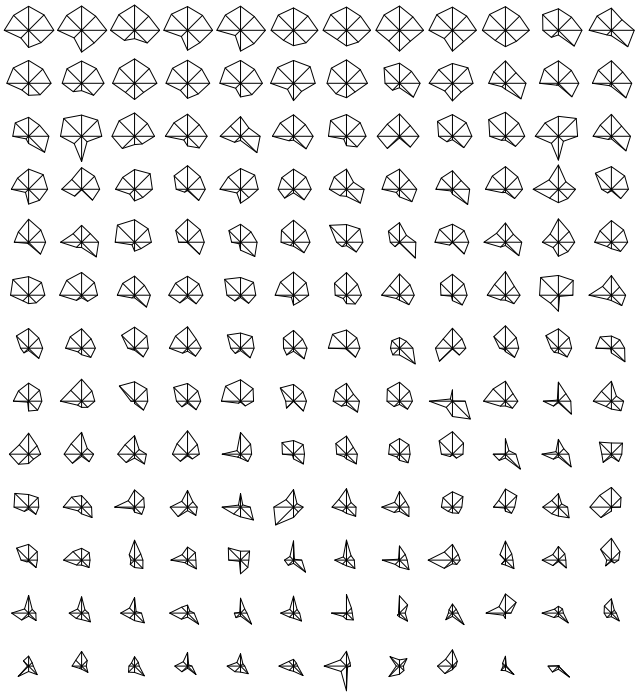



```
library(TeachingDemos)
```

```
##
## Attaching package: 'TeachingDemos'
```

```
## The following object is masked from 'package:corrr':
##
##     dice
```

```
stars(datos) # Datos de paises
```



```
# Matriz de Correlaciones y determinante
```

```
round(cor(datos), 3)
```

```
##                                   datos.HappinessScore datos.GDP_PC
## datos.HappinessScore                             1.000        0.812
## datos.GDP_PC                                     0.812        1.000
## datos.Social_support                             0.753        0.688
## datos.Healthy_life_expectancy                    0.782        0.843
## datos.Freedom_to_make_life_choices               0.570        0.370
## datos.Generosity                                 0.155       -0.019
## datos.Perceptions_of_corruption                  0.429        0.351
## datos.Dystopia_residual                          0.475        0.024
##                                   datos.Social_support
## datos.HappinessScore                             0.753
## datos.GDP_PC                                     0.688
## datos.Social_support                             1.000
## datos.Healthy_life_expectancy                    0.612
## datos.Freedom_to_make_life_choices               0.425
## datos.Generosity                                 0.052
## datos.Perceptions_of_corruption                  0.232
## datos.Dystopia_residual                          0.070
##                                   datos.Healthy_life_expectancy
## datos.HappinessScore                                      0.782
## datos.GDP_PC                                              0.843
## datos.Social_support                                      0.612
## datos.Healthy_life_expectancy                             1.000
```

```
## datos.Freedom_to_make_life_choices                        0.350
## datos.Generosity                                          0.063
## datos.Perceptions_of_corruption                           0.280
## datos.Dystopia_residual                                   0.055
##                                    datos.Freedom_to_make_life_choices
## datos.HappinessScore                                            0.570
## datos.GDP_PC                                                    0.370
## datos.Social_support                                            0.425
## datos.Healthy_life_expectancy                                   0.350
## datos.Freedom_to_make_life_choices                              1.000
## datos.Generosity                                                0.316
## datos.Perceptions_of_corruption                                 0.499
## datos.Dystopia_residual                                         0.082
##                                    datos.Generosity
## datos.HappinessScore                          0.155
## datos.GDP_PC                                 -0.019
## datos.Social_support                          0.052
## datos.Healthy_life_expectancy                 0.063
## datos.Freedom_to_make_life_choices            0.316
## datos.Generosity                              1.000
## datos.Perceptions_of_corruption               0.294
## datos.Dystopia_residual                      -0.117
##                                    datos.Perceptions_of_corruption
## datos.HappinessScore                                         0.429
## datos.GDP_PC                                                 0.351
## datos.Social_support                                         0.232
## datos.Healthy_life_expectancy                                0.280
## datos.Freedom_to_make_life_choices                           0.499
## datos.Generosity                                             0.294
## datos.Perceptions_of_corruption                              1.000
## datos.Dystopia_residual                                     -0.023
##                                    datos.Dystopia_residual
## datos.HappinessScore                                 0.475
## datos.GDP_PC                                         0.024
## datos.Social_support                                 0.070
## datos.Healthy_life_expectancy                        0.055
## datos.Freedom_to_make_life_choices                   0.082
## datos.Generosity                                    -0.117
## datos.Perceptions_of_corruption                     -0.023
## datos.Dystopia_residual                              1.000
```

```
cor(datos)
```

```
##                                    datos.HappinessScore datos.GDP_PC
## datos.HappinessScore                          1.0000000   0.81247008
## datos.GDP_PC                                  0.8124701   1.00000000
## datos.Social_support                          0.7527670   0.68837429
## datos.Healthy_life_expectancy                 0.7820005   0.84317681
## datos.Freedom_to_make_life_choices            0.5701711   0.36985405
## datos.Generosity                              0.1552751  -0.01909411
## datos.Perceptions_of_corruption               0.4291186   0.35109116
## datos.Dystopia_residual                       0.4753642   0.02421302
##                                    datos.Social_support
## datos.HappinessScore                         0.75276700
## datos.GDP_PC                                 0.68837429
```

```
## datos.Social_support                          1.00000000
## datos.Healthy_life_expectancy                 0.61210814
## datos.Freedom_to_make_life_choices            0.42509115
## datos.Generosity                              0.05156338
## datos.Perceptions_of_corruption               0.23179826
## datos.Dystopia_residual                       0.07048874
##                                    datos.Healthy_life_expectancy
## datos.HappinessScore                                  0.78200054
## datos.GDP_PC                                          0.84317681
## datos.Social_support                                  0.61210814
## datos.Healthy_life_expectancy                         1.00000000
## datos.Freedom_to_make_life_choices                    0.34989332
## datos.Generosity                                      0.06333123
## datos.Perceptions_of_corruption                       0.27991895
## datos.Dystopia_residual                               0.05496211
##                                    datos.Freedom_to_make_life_choices
## datos.HappinessScore                                       0.57017106
## datos.GDP_PC                                               0.36985405
## datos.Social_support                                       0.42509115
## datos.Healthy_life_expectancy                              0.34989332
## datos.Freedom_to_make_life_choices                         1.00000000
## datos.Generosity                                           0.31613484
## datos.Perceptions_of_corruption                            0.49944012
## datos.Dystopia_residual                                    0.08203725
##                                    datos.Generosity
## datos.HappinessScore                     0.15527511
## datos.GDP_PC                            -0.01909411
## datos.Social_support                     0.05156338
## datos.Healthy_life_expectancy            0.06333123
## datos.Freedom_to_make_life_choices       0.31613484
## datos.Generosity                         1.00000000
## datos.Perceptions_of_corruption          0.29394706
## datos.Dystopia_residual                 -0.11652408
##                                    datos.Perceptions_of_corruption
## datos.HappinessScore                                     0.4291186
## datos.GDP_PC                                             0.3510912
## datos.Social_support                                     0.2317983
## datos.Healthy_life_expectancy                            0.2799189
## datos.Freedom_to_make_life_choices                       0.4994401
## datos.Generosity                                         0.2939471
## datos.Perceptions_of_corruption                          1.0000000
## datos.Dystopia_residual                                 -0.0227789
##                                    datos.Dystopia_residual
## datos.HappinessScore                            0.47536423
## datos.GDP_PC                                    0.02421302
## datos.Social_support                            0.07048874
## datos.Healthy_life_expectancy                   0.05496211
## datos.Freedom_to_make_life_choices              0.08203725
## datos.Generosity                               -0.11652408
## datos.Perceptions_of_corruption                -0.02277890
## datos.Dystopia_residual                         1.00000000
```

```
det(cor(datos))
```

```
## [1] 2.811414e-08
```

```r
# Autovalores
```

```r
cor(datos)
```

```
##                                    datos.HappinessScore datos.GDP_PC
## datos.HappinessScore                          1.0000000   0.81247008
## datos.GDP_PC                                  0.8124701   1.00000000
## datos.Social_support                          0.7527670   0.68837429
## datos.Healthy_life_expectancy                 0.7820005   0.84317681
## datos.Freedom_to_make_life_choices            0.5701711   0.36985405
## datos.Generosity                              0.1552751  -0.01909411
## datos.Perceptions_of_corruption               0.4291186   0.35109116
## datos.Dystopia_residual                       0.4753642   0.02421302
##                                    datos.Social_support
## datos.HappinessScore                          0.75276700
## datos.GDP_PC                                  0.68837429
## datos.Social_support                          1.00000000
## datos.Healthy_life_expectancy                 0.61210814
## datos.Freedom_to_make_life_choices            0.42509115
## datos.Generosity                              0.05156338
## datos.Perceptions_of_corruption               0.23179826
## datos.Dystopia_residual                       0.07048874
##                                    datos.Healthy_life_expectancy
## datos.HappinessScore                                  0.78200054
## datos.GDP_PC                                          0.84317681
## datos.Social_support                                  0.61210814
## datos.Healthy_life_expectancy                         1.00000000
## datos.Freedom_to_make_life_choices                    0.34989332
## datos.Generosity                                      0.06333123
## datos.Perceptions_of_corruption                       0.27991895
## datos.Dystopia_residual                               0.05496211
##                                    datos.Freedom_to_make_life_choices
## datos.HappinessScore                                        0.57017106
## datos.GDP_PC                                                0.36985405
## datos.Social_support                                        0.42509115
## datos.Healthy_life_expectancy                               0.34989332
## datos.Freedom_to_make_life_choices                          1.00000000
## datos.Generosity                                            0.31613484
## datos.Perceptions_of_corruption                             0.49944012
## datos.Dystopia_residual                                     0.08203725
##                                    datos.Generosity
## datos.HappinessScore                      0.15527511
## datos.GDP_PC                             -0.01909411
## datos.Social_support                      0.05156338
## datos.Healthy_life_expectancy             0.06333123
## datos.Freedom_to_make_life_choices        0.31613484
## datos.Generosity                          1.00000000
## datos.Perceptions_of_corruption           0.29394706
## datos.Dystopia_residual                  -0.11652408
##                                    datos.Perceptions_of_corruption
## datos.HappinessScore                                     0.4291186
## datos.GDP_PC                                             0.3510912
## datos.Social_support                                     0.2317983
## datos.Healthy_life_expectancy                            0.2799189
```

```
## datos.Freedom_to_make_life_choices                       0.4994401
## datos.Generosity                                         0.2939471
## datos.Perceptions_of_corruption                          1.0000000
## datos.Dystopia_residual                                 -0.0227789
##                                    datos.Dystopia_residual
## datos.HappinessScore                            0.47536423
## datos.GDP_PC                                    0.02421302
## datos.Social_support                            0.07048874
## datos.Healthy_life_expectancy                   0.05496211
## datos.Freedom_to_make_life_choices              0.08203725
## datos.Generosity                               -0.11652408
## datos.Perceptions_of_corruption                -0.02277890
## datos.Dystopia_residual                         1.00000000
```

```
eigen(cor(datos))
```

```
## eigen() decomposition
## $values
## [1] 3.827940e+00 1.395173e+00 1.083488e+00 6.708165e-01 5.271082e-01
## [6] 3.595494e-01 1.359236e-01 2.811579e-07
##
## $vectors
##            [,1]       [,2]        [,3]        [,4]        [,5]        [,6]
## [1,] -0.4889175 -0.1315483  0.21897961  0.08768740 -0.06680894  0.02705583
## [2,] -0.4463288 -0.1818190 -0.29052086 -0.03413448 -0.19937840 -0.12517975
## [3,] -0.4092022 -0.1437586 -0.16784650  0.18894158  0.42952622  0.69428073
## [4,] -0.4298298 -0.1676090 -0.25562155  0.14358679 -0.30711133 -0.42700264
## [5,] -0.3347144  0.3650791  0.20949324 -0.18852915  0.67058401 -0.46190671
## [6,] -0.1024341  0.6522437  0.13941135  0.68427676 -0.23264188  0.06290369
## [7,] -0.2745812  0.4599692  0.09628723 -0.65420500 -0.39063420  0.31813146
## [8,] -0.1078374 -0.3613880  0.83757780  0.05538560 -0.14343790  0.02680868
##              [,7]        [,8]
## [1,]  0.089745493  0.82144009
## [2,]  0.730325019 -0.30556270
## [3,] -0.194841017 -0.20864843
## [4,] -0.628428441 -0.17211369
## [5,]  0.019222351 -0.10882372
## [6,]  0.093513836 -0.09793519
## [7,] -0.128562188 -0.07380461
## [8,] -0.006573674 -0.36308304
```

```
# Adecuacion del Modelo: Test de Bartlett y KMO
```

```
library(psych)
```

```
##
## Attaching package: 'psych'
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
correl<-cor(datos)
cortest.bartlett(correl, n = nrow(datos))
```

```
## $chisq
## [1] 2616.742
```

```
##
## $p.value
## [1] 0
##
## $df
## [1] 28
```

```
KMO(correl)
```

```
## Kaiser-Meyer-Olkin factor adequacy
## Call: KMO(r = correl)
## Overall MSA =  0.16
## MSA for each item =
##               datos.HappinessScore                         datos.GDP_PC
##                               0.27                                 0.23
##               datos.Social_support      datos.Healthy_life_expectancy
##                               0.19                                 0.21
## datos.Freedom_to_make_life_choices                   datos.Generosity
##                               0.14                                 0.03
##    datos.Perceptions_of_corruption            datos.Dystopia_residual
##                               0.10                                 0.04
```

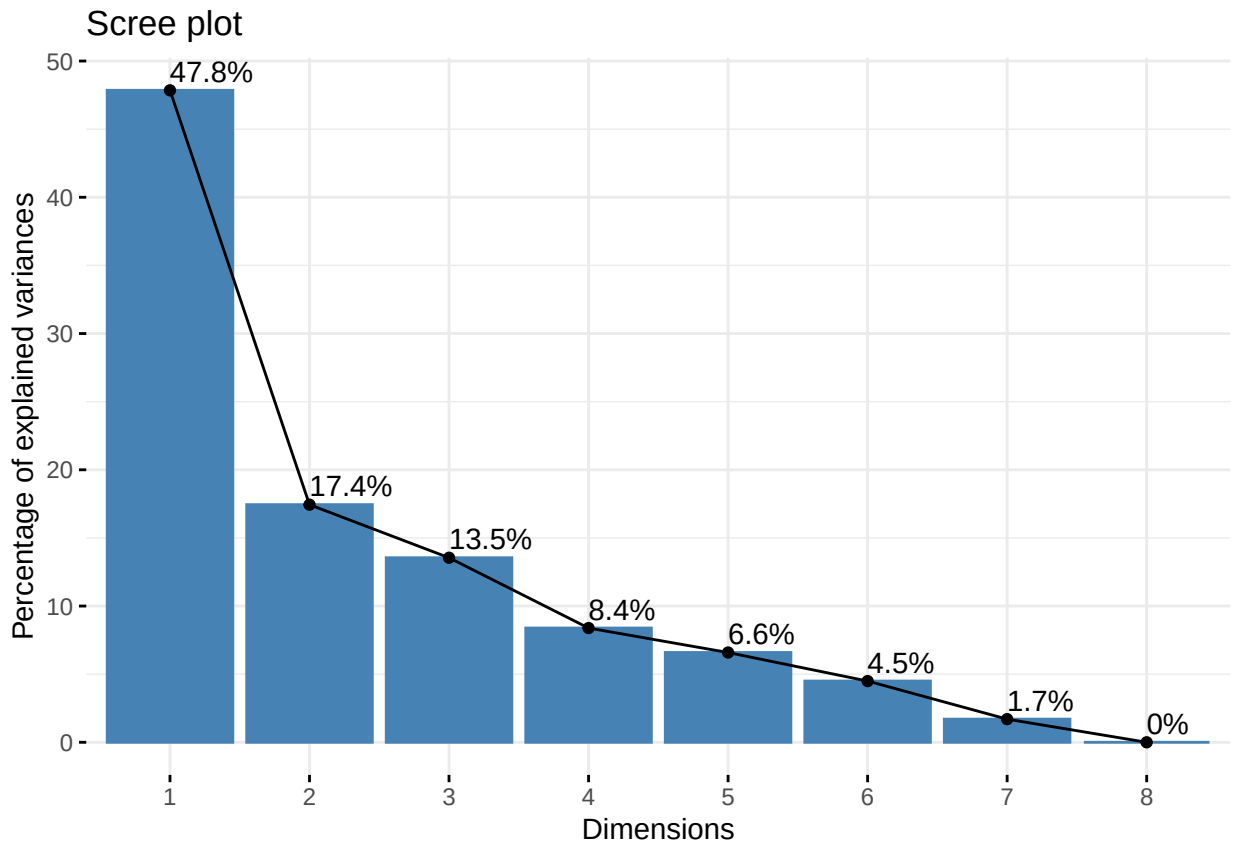
```
# PCA
```

```
acp <- princomp(datos, cor=TRUE)
summary(acp)
```

```
## Importance of components:
##                           Comp.1    Comp.2    Comp.3     Comp.4     Comp.5
## Standard deviation     1.9565123 1.1811745 1.0409075 0.81903390 0.72602217
## Proportion of Variance 0.4784925 0.1743966 0.1354361 0.08385207 0.06588852
## Cumulative Proportion  0.4784925 0.6528892 0.7883252 0.87217731 0.93806584
##                            Comp.6     Comp.7       Comp.8
## Standard deviation     0.59962442 0.36867816 5.302432e-04
## Proportion of Variance 0.04494368 0.01699045 3.514474e-08
## Cumulative Proportion  0.98300952 0.99999996 1.000000e+00
```

```
# Grafico de codo-Sedimentacion scree-plot
```

```
fviz_eig(acp, addlabels = TRUE)
```




```
# FACTORES: Cargas Factoriales
# Los Comp. tienen que inerpretarse
```

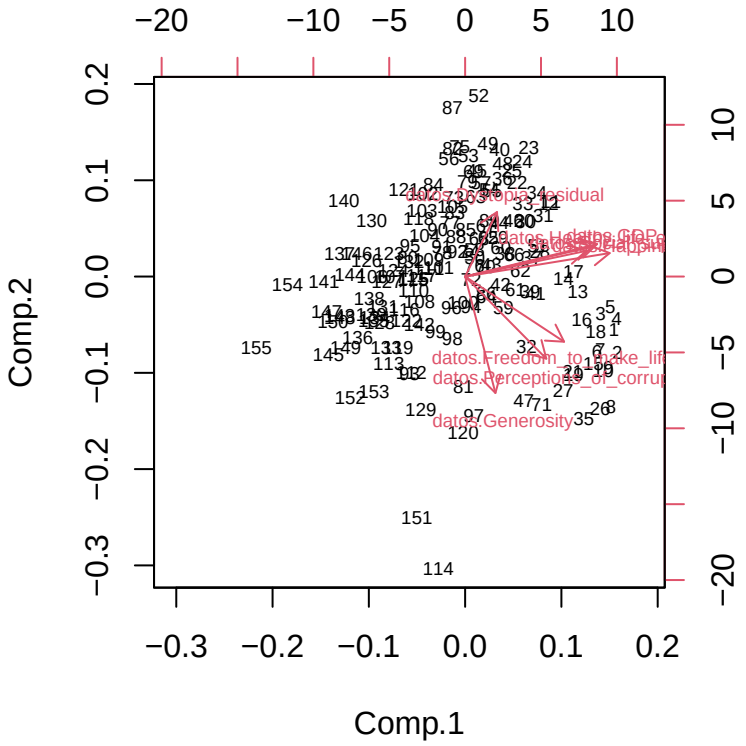
```
loadings(acp)
```

```
##
## Loadings:
##                                  Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6
## datos.HappinessScore              0.489  0.132  0.219
## datos.GDP_PC                      0.446  0.182 -0.291         0.199 -0.125
## datos.Social_support              0.409  0.144 -0.168  0.189 -0.430  0.694
## datos.Healthy_life_expectancy     0.430  0.168 -0.256  0.144  0.307 -0.427
## datos.Freedom_to_make_life_choices  0.335 -0.365  0.209 -0.189 -0.671 -0.462
## datos.Generosity                  0.102 -0.652  0.139  0.684  0.233
## datos.Perceptions_of_corruption   0.275 -0.460        -0.654  0.391  0.318
## datos.Dystopia_residual           0.108  0.361  0.838         0.143
##                                  Comp.7 Comp.8
## datos.HappinessScore                     0.821
## datos.GDP_PC                      0.730 -0.306
## datos.Social_support             -0.195 -0.209
## datos.Healthy_life_expectancy    -0.628 -0.172
## datos.Freedom_to_make_life_choices       -0.109
## datos.Generosity
## datos.Perceptions_of_corruption  -0.129
## datos.Dystopia_residual                  -0.363
##
##                Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
```

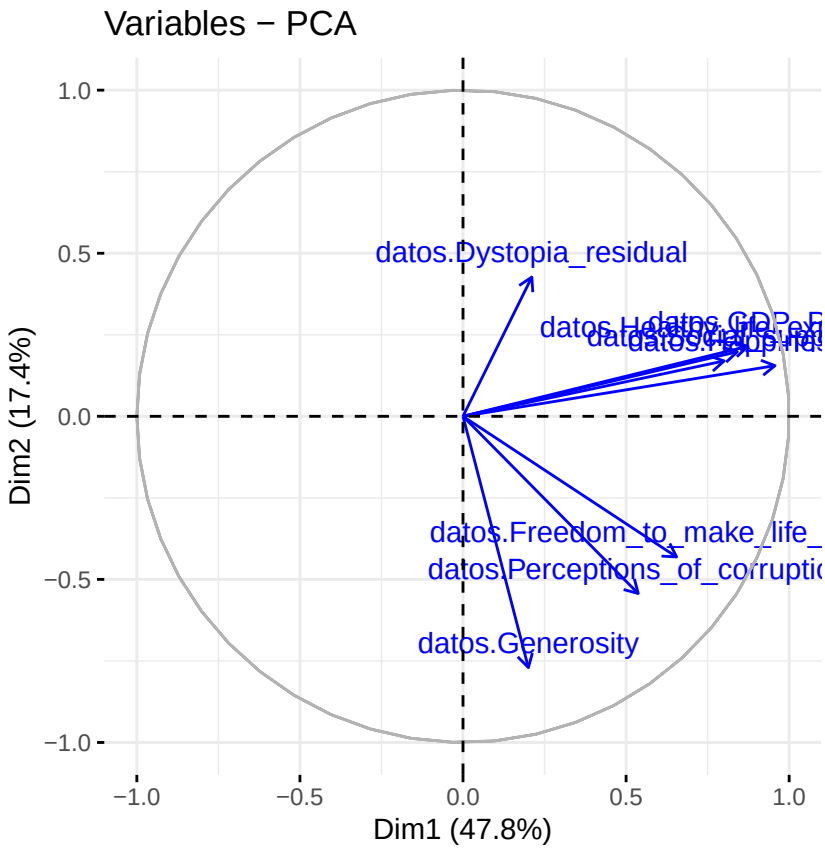
```
## SS loadings     1.000  1.000  1.000  1.000  1.000  1.000  1.000  1.000
## Proportion Var  0.125  0.125  0.125  0.125  0.125  0.125  0.125  0.125
## Cumulative Var  0.125  0.250  0.375  0.500  0.625  0.750  0.875  1.000
```

```
## Puntuaciones y Biplot
```

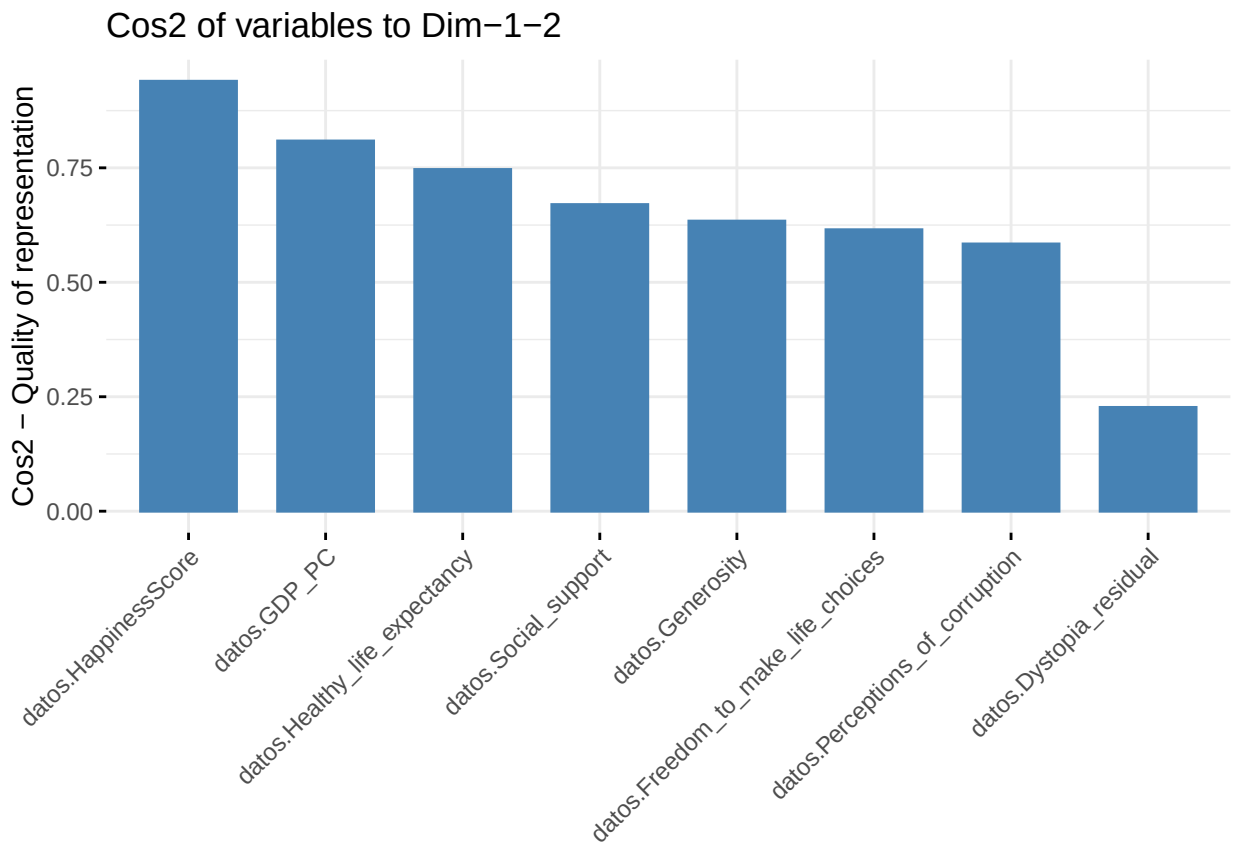
```
# acp$scores

biplot(acp, cex=0.60)
```




```
# Biplot circular
fviz_pca_var(acp, col.var = "blue")
```




```
# Calidad de cada variable
fviz_cos2(acp, choice = "var", axes = 1:2)
```




```
# Puntuaciones sobre los factores: Se utiliza para construir
# indices
```

```
acp$scores[,1:3]
```

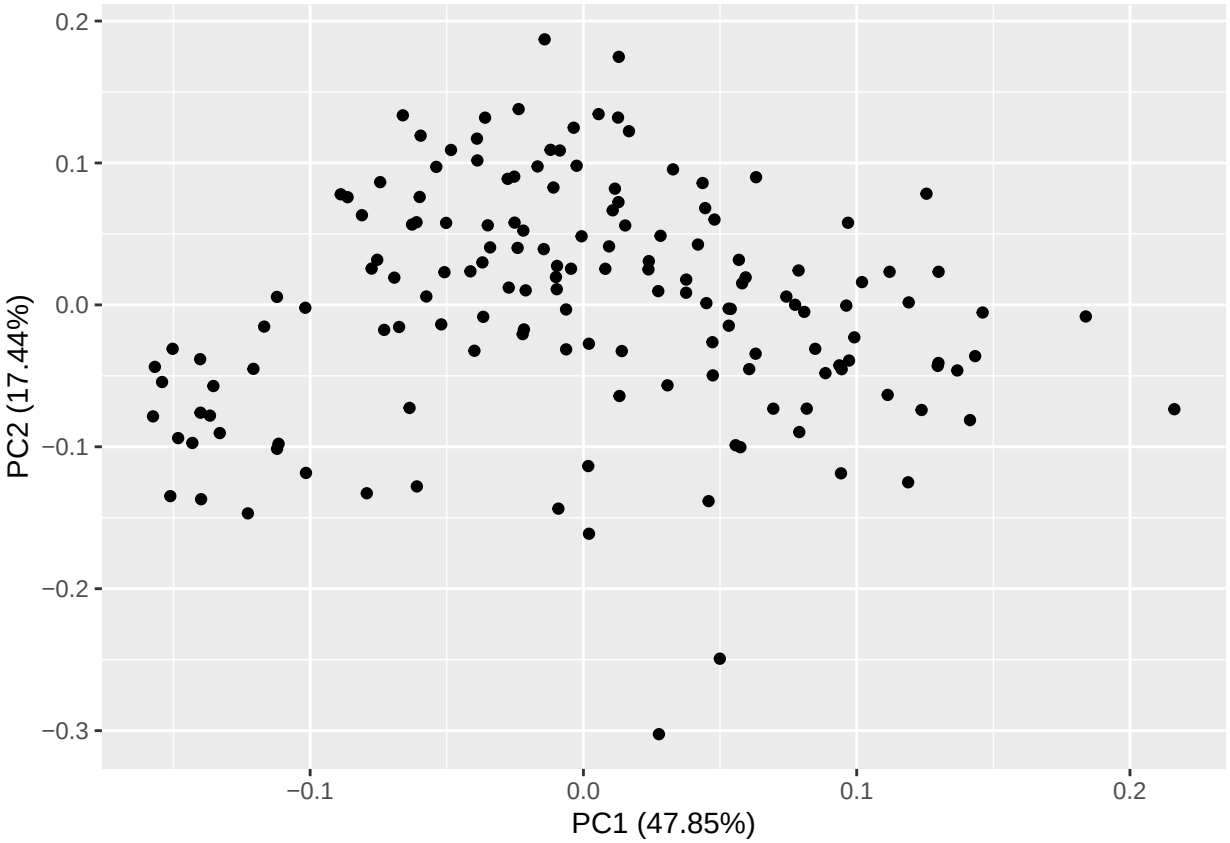
```
##             Comp.1       Comp.2      Comp.3
##   [1,]  3.76787981 -0.801755331  0.85555080
##   [2,]  3.84872707 -1.159069053  1.06290626
##   [3,]  3.42711087 -0.564075683  0.88785130
##   [4,]  3.83218125 -0.644469446  0.78029293
##   [5,]  3.67324388 -0.456611629  1.12055687
##   [6,]  3.33957007 -1.150988296  0.98932665
##   [7,]  3.42426228 -1.120729583  0.76182360
##   [8,]  3.69393768 -1.987833776  0.71711009
##   [9,]  3.62405454 -1.384615725  0.64384408
##  [10,]  3.49694857 -1.435256087  0.56467182
##  [11,]  2.17012323  1.149743552  1.31638694
##  [12,]  2.10881372  1.119531642  1.83659527
##  [13,]  2.85494307 -0.225829812  0.40189267
##  [14,]  2.48692309 -0.030061785  0.47128000
##  [15,]  3.25178851 -1.332412944 -0.10666701
##  [16,]  2.95086394 -0.664957969  0.26049378
##  [17,]  2.74027898  0.082907950  0.26800293
##  [18,]  3.30911455 -0.843609918 -0.60635211
##  [19,]  2.73946451 -1.496212299 -0.22351388
##  [20,]  1.49249107  0.859024882  0.82915964
##  [21,]  2.72589775 -1.443865809 -0.03321080
```

```
##  [22,]  1.31555165  1.434737815  1.43502398
##  [23,]  1.61488038  1.970531487  0.50548081
##  [24,]  1.45537235  1.759023409  1.00168930
##  [25,]  1.18391438  1.610555518  1.47945964
##  [26,]  3.41873218 -2.020005684 -1.22132886
##  [27,]  2.48098243 -1.746717323 -0.35987230
##  [28,]  1.89383793  0.377662803  0.49672219
##  [29,]  0.83437455  0.597444908  2.18350557
##  [30,]  1.53230512  0.835363755  0.64404103
##  [31,]  1.98060613  0.932134980 -0.25741215
##  [32,]  1.55464980 -1.071059858  0.67560782
##  [33,]  1.46416185  1.121650681 -0.12773044
##  [34,]  1.81717940  1.275749587 -0.61677961
##  [35,]  3.00021578 -2.167266117 -1.16209944
##  [36,]  0.94829311  1.501633843  1.17140025
##  [37,]  1.69085493  0.283328495  0.17315228
##  [38,]  1.01042093  0.348573220  0.28714157
##  [39,]  1.64838083 -0.229505199 -0.59536446
##  [40,]  0.87938946  1.946013983 -0.40122659
##  [41,]  1.78169189 -0.260189033 -0.49088744
##  [42,]  0.89595279 -0.124245599  0.17124688
##  [43,]  0.66736691  0.179707208  1.37840085
##  [44,]  0.85531055  0.827111772  0.63246115
##  [45,]  0.29398976  1.611821371  1.41257106
##  [46,]  1.22771515  0.852259891 -0.48811473
##  [47,]  1.48926136 -1.887285362  0.69069153
##  [48,]  0.95179407  1.728051397 -1.08583109
##  [49,]  0.57923482  2.035342331  0.01418117
##  [50,]  0.24571554  0.289670350  1.81977854
##  [51,]  1.84372268  0.468669310 -1.49981522
##  [52,]  0.34663387  2.760218519 -0.33489519
##  [53,]  0.08705904  1.841696198  0.77642305
##  [54,]  0.61859655  1.333285650 -0.33497771
##  [55,]  0.67681967  1.310305846 -0.79623644
##  [56,] -0.40729364  1.805501133  1.42095217
##  [57,]  0.40987498  1.439207497  0.19448147
##  [58,]  0.23583012  0.404977757  1.38119012
##  [59,]  0.97474646 -0.476943851  0.05034357
##  [60,]  0.90324618  0.441389033 -0.41167139
##  [61,]  1.27112803 -0.202833571 -0.83532450
##  [62,]  1.40457163  0.087142056 -1.33329365
##  [63,]  0.26804598  1.220248623  0.39313792
##  [64,]  0.54280102 -0.304107449 -0.29346180
##  [65,]  0.58827896  0.592159649 -1.00259330
##  [66,]  1.24279564  0.339756276 -1.33250826
##  [67,]  0.53720097  0.771966516 -0.75868474
##  [68,]  0.35457655  0.579888632 -0.18566492
##  [69,]  0.21105065  1.604903784 -0.63248383
##  [70,]  0.51607634  0.150886126 -0.39405848
##  [71,]  1.93728963 -1.958147888 -2.60408486
##  [72,]  0.15504722 -0.047683799  0.53001729
##  [73,] -0.28172245  1.207926978 -0.42193378
##  [74,]  0.11053080  0.375902599 -0.26246850
##  [75,] -0.13574725  1.983127940 -1.26140735
```

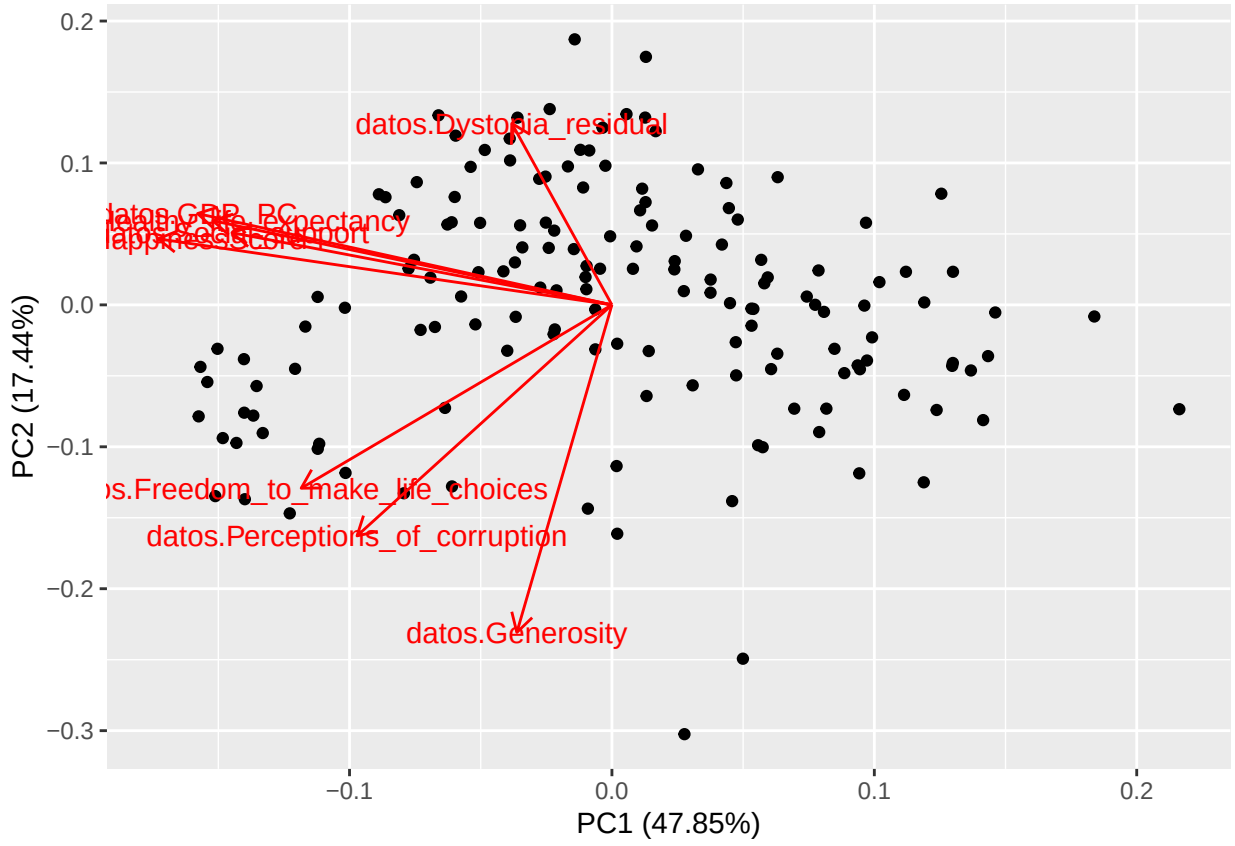
```
##  [76,]  0.23809695  0.162808689 -0.55665998
##  [77,] -0.37372296  0.825467136 -0.49196865
##  [78,] -0.58158641  0.368803462  0.12458147
##  [79,]  0.06049124  1.446267135 -0.64563616
##  [80,] -1.45092752  0.285796321  2.03661245
##  [81,] -0.04334484 -1.675552962 -0.39515793
##  [82,] -0.30953740  1.946970638 -1.03709661
##  [83,] -0.26225366  0.982843496 -0.85830921
##  [84,] -0.80135621  1.408592153  1.00354652
##  [85,]  0.01646543  0.712834456 -0.42546038
##  [86,]  0.53186243 -0.255171193 -1.00122854
##  [87,] -0.31645022  2.578057247 -1.48520587
##  [88,] -0.22918880  0.608024773 -0.74351559
##  [89,]  0.61529975  0.855094425 -2.01028806
##  [90,] -0.68966951  0.718213362 -0.37598271
##  [91,] -0.58495587  0.454884997  0.35275279
##  [92,] -0.19579970  0.374921057 -0.76334379
##  [93,] -1.40391020 -1.479609436  3.97141749
##  [94,]  0.15441794 -0.462412154 -0.55009304
##  [95,] -1.39027693  0.468083826  1.34056631
##  [96,] -0.34316595 -0.479958399  0.34419097
##  [97,]  0.22394245 -2.118171885 -0.80599032
##  [98,] -0.32258449 -0.947246736 -0.27330354
##  [99,] -0.75216149 -0.836353058  0.54778010
## [100,] -0.04897848 -0.403861709 -1.54620912
## [101,] -0.66955546  0.142902974 -0.50255496
## [102,] -1.06593811  1.266610806 -0.33876355
## [103,] -1.08901695  1.005994847 -0.26024543
## [104,] -1.02438046  0.627053316 -0.53508655
## [105,] -0.31340981  1.067893203 -2.40822514
## [106,] -2.35090049 -0.007495057  2.25875831
## [107,] -1.89310720  0.001131137  1.52129422
## [108,] -1.15346572 -0.387989757 -0.80225373
## [109,] -0.91936404  0.262913383 -0.88522492
## [110,] -1.30048227 -0.216645485  0.65310812
## [111,] -0.91814764  0.126419439 -0.52184787
## [112,] -1.36136327 -1.458990040  0.34981243
## [113,] -1.93017646 -1.322138298  2.11311028
## [114,] -0.67543546 -4.462404995  0.06317326
## [115,] -1.31741707 -0.041892386  0.13217240
## [116,] -1.54030013 -0.507757389  0.50069303
## [117,] -1.09966972  0.018140149 -1.19523709
## [118,] -1.17204992  0.886994034 -1.36757849
## [119,] -1.69806360 -1.079075713  1.06541819
## [120,] -0.04957957 -2.379058447 -2.30147747
## [121,] -1.54387406  1.327508091 -1.22895215
## [122,] -1.48256695 -0.667666426 -0.22488386
## [123,] -1.92409342  0.357642589 -0.53824057
## [124,] -1.81472346  0.086364844  0.06034456
## [125,] -1.29927210 -0.038863787 -0.73443232
## [126,] -2.49118426  0.236621321  1.10291128
## [127,] -1.97491562 -0.072670050 -0.04629313
## [128,] -2.16436884 -0.709541210  0.75147698
## [129,] -1.11954969 -2.040007774 -0.67703314
```

```
## [130,] -2.36604401  0.853772610 -0.66885816
## [131,] -2.07288879 -0.456725565 -0.07895835
## [132,] -1.41908618  0.224110767 -2.54246306
## [133,] -1.99729609 -1.078792953  0.08851721
## [134,] -2.28882676 -0.628776940  0.30673144
## [135,] -2.30956851 -0.668821887  0.70643526
## [136,] -2.72059727 -0.935715096  1.36889072
## [137,] -3.17619398  0.343874829  0.72066593
## [138,] -2.42270439 -0.337596959 -0.03269971
## [139,] -2.37549057 -0.578343247 -0.21135877
## [140,] -3.06777855  1.155500835 -0.79741997
## [141,] -3.57000556 -0.079201090  0.94753988
## [142,] -1.15708865 -0.732803684 -2.71176630
## [143,] -3.17505919 -0.604112362  0.85012518
## [144,] -2.90903447  0.025600661 -0.35567721
## [145,] -3.45705756 -1.197927317  0.14606633
## [146,] -2.73816204  0.343825305 -0.94222468
## [147,] -3.50274757 -0.532519792  0.54754193
## [148,] -3.16881281 -0.634046358  0.31639507
## [149,] -3.02399273 -1.092686039  0.19596250
## [150,] -3.34344700 -0.681625211  0.74272745
## [151,] -1.22004215 -3.678063743 -1.19014230
## [152,] -2.90418292 -1.844333463 -1.20373409
## [153,] -2.30340588 -1.751254759 -1.80853517
## [154,] -4.49264690 -0.120550786  0.05109630
## [155,] -5.28408734 -1.084497793  1.58030928
```

```r
library(ggfortify)

pcagrafico1<-prcomp(datos, scale. = TRUE)

autoplot(pcagrafico1)
```

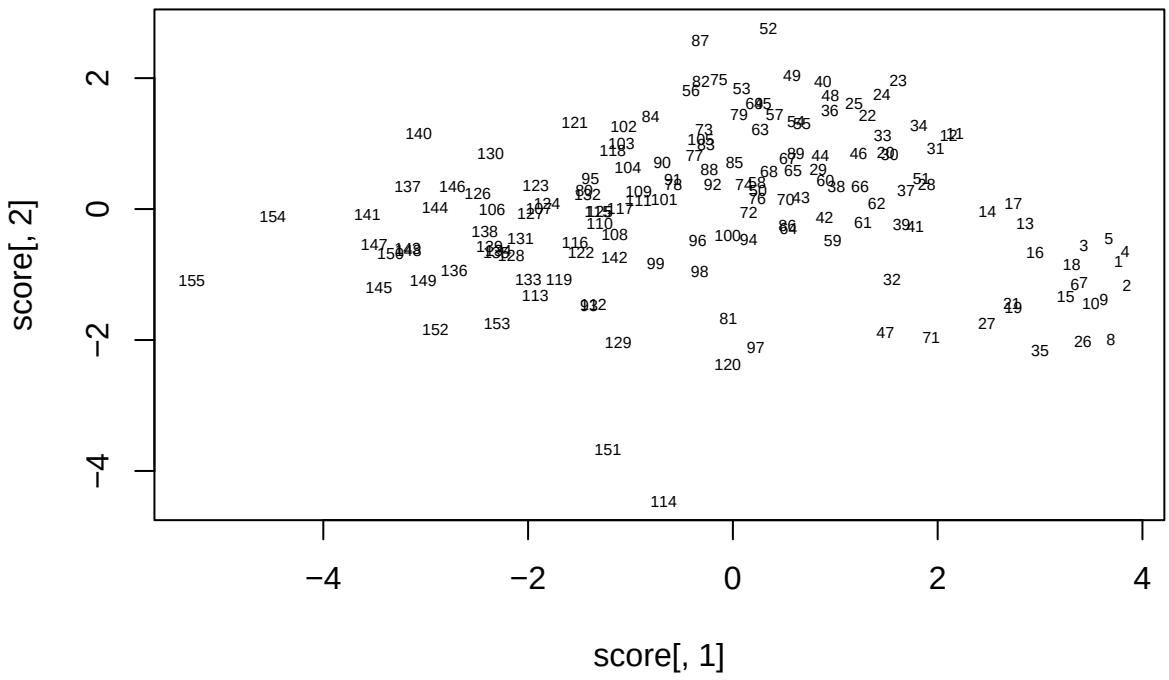



```
autoplot(pcagrafico1, data=datos, loadings=TRUE,
         loadings.label=TRUE)
```

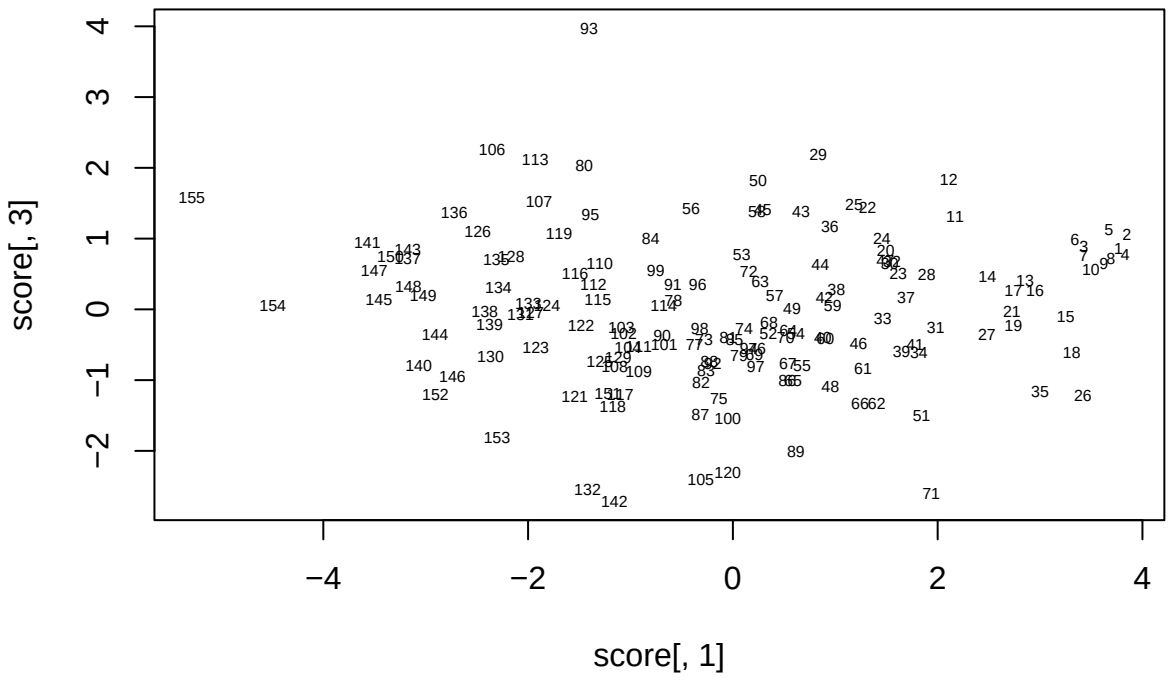



```
# Graficos Puntuaciones
```

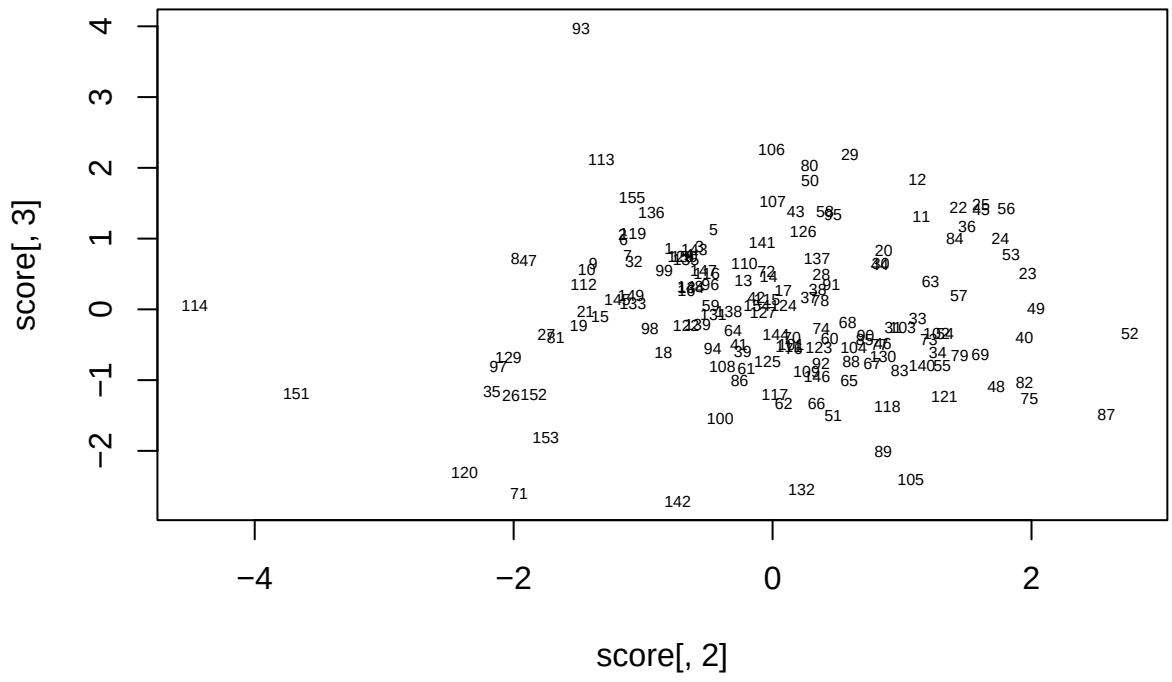
```
score<-acp$scores[,1:3]

plot(score[,1], score[,2], type='n')
text(score[,1], score[,2], labels=rownames(datos), lwd=1,cex=0.50)
```




```
plot(score[,1], score[,3], type='n')
text(score[,1], score[,3], labels=rownames(datos), lwd=1,cex=0.50)
```




```
plot(score[,2], score[,3], type='n')
text(score[,2], score[,3], labels=rownames(datos), lwd=1,cex=0.50)
```




```
# Rotacion varimax
# Muchas veces ayudan a la interpretacion de los factores
```

```
library(psych)

acp.varimax <- principal(datos, nfactors=3, rotate="varimax", scores=TRUE)
summary(acp.varimax)
```

```
##
## Factor analysis with Call: principal(r = datos, nfactors = 3, rotate = "varimax", scores = TRUE)
##
## Test of the hypothesis that 3 factors are sufficient.
## The degrees of freedom for the model is 7  and the objective function was  11.6
## The number of observations was  155  with Chi Square =  1723.1  with prob <  0
##
## The root mean square of the residuals (RMSA) is  0.08
```

```
# FACTORES: Interpretacion mas facil
loadings(acp.varimax)
```

```
##
## Loadings:
##                                 RC1    RC2    RC3
## datos.HappinessScore             0.827  0.322  0.452
## datos.GDP_PC                     0.944
## datos.Social_support             0.823  0.137
## datos.Healthy_life_expectancy    0.898  0.105
```

```
## datos.Freedom_to_make_life_choices  0.372  0.705  0.166
## datos.Generosity                   -0.118  0.792 -0.115
## datos.Perceptions_of_corruption     0.269  0.722
## datos.Dystopia_residual                           0.991
##
##                  RC1   RC2   RC3
## SS loadings    3.285 1.790 1.231
## Proportion Var 0.411 0.224 0.154
## Cumulative Var 0.411 0.634 0.788
```

```
acp.varimax2 <- principal(datos, nfactors=4, rotate="varimax", scores=TRUE)
summary(acp.varimax2)
```

```
##
## Factor analysis with Call: principal(r = datos, nfactors = 4, rotate = "varimax", scores = TRUE)
##
## Test of the hypothesis that 4 factors are sufficient.
## The degrees of freedom for the model is 2  and the objective function was  11.51
## The number of observations was  155  with Chi Square =  1702.28  with prob <  0
##
## The root mean square of the residuals (RMSA) is  0.06
```

```
loadings(acp.varimax2)
```

```
##
## Loadings:
##                                   RC1    RC4    RC3    RC2
## datos.HappinessScore               0.822  0.335  0.441  0.117
## datos.GDP_PC                       0.918  0.219
## datos.Social_support               0.837  0.119
## datos.Healthy_life_expectancy      0.903  0.126
## datos.Freedom_to_make_life_choices 0.330  0.684  0.142  0.299
## datos.Generosity                          0.191         0.963
## datos.Perceptions_of_corruption    0.151  0.922
## datos.Dystopia_residual                           0.991
##
##                  RC1   RC4   RC3   RC2
## SS loadings    3.168 1.544 1.210 1.055
## Proportion Var 0.396 0.193 0.151 0.132
## Cumulative Var 0.396 0.589 0.740 0.872
```

```
# Puntuaciones y Biplot Varimax
```

```
acp.varimax$scores
```

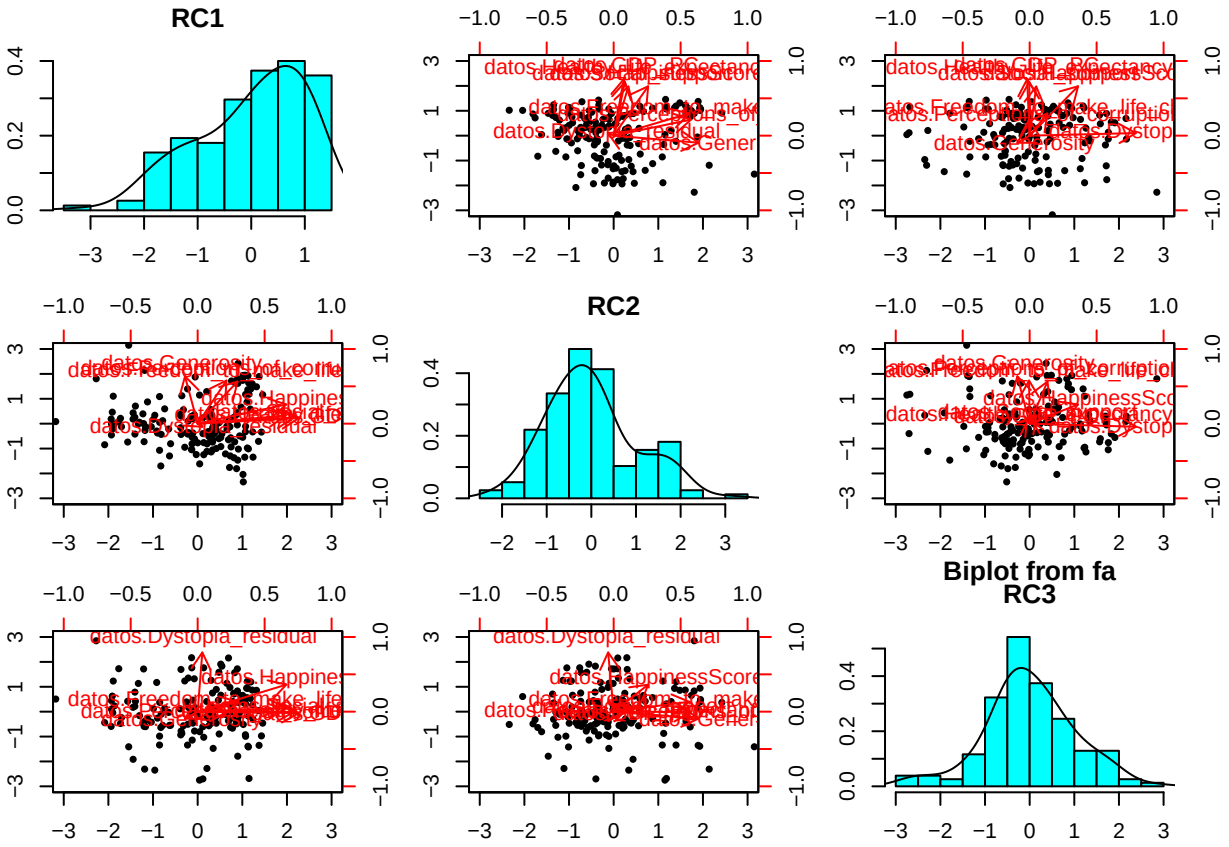
```
##                  RC1          RC2          RC3
##   [1,]  1.2217281173  1.602483300  0.867891540
##   [2,]  1.0963524334  1.934898778  0.944211583
##   [3,]  1.1223370581  1.364275732  0.936483486
##   [4,]  1.3171824220  1.481329926  0.858173415
##   [5,]  1.1909570177  1.396741128  1.196948744
##   [6,]  0.8908178242  1.802715555  0.832048446
##   [7,]  1.0080357644  1.740262432  0.652230375
##   [8,]  0.9070787567  2.422511106  0.368532320
##   [9,]  1.0630098320  1.946078556  0.486906978
##  [10,]  1.0161780695  1.936219306  0.389556956
```

```
##  [11,]  0.8884651946 -0.050092001  1.720716945
##  [12,]  0.6910207526  0.092021770  2.157292136
##  [13,]  1.1064566155  0.871012558  0.563069365
##  [14,]  0.9717631532  0.667303769  0.648047346
##  [15,]  1.1415806585  1.637489144 -0.186160129
##  [16,]  1.0737701115  1.177613694  0.312126209
##  [17,]  1.1804467574  0.585895670  0.532012354
##  [18,]  1.4561732360  1.163011828 -0.461593189
##  [19,]  0.9010677648  1.619806130 -0.390104832
##  [20,]  0.6533391810 -0.104059341  1.138601916
##  [21,]  0.8501766033  1.627107960 -0.209647237
##  [22,]  0.5425342785 -0.409430131  1.827971966
##  [23,]  1.1129483011 -0.977131394  1.217759156
##  [24,]  0.8289379784 -0.728737783  1.566878315
##  [25,]  0.5171790482 -0.554973521  1.908568574
##  [26,]  1.3751682606  1.892956376 -1.353818361
##  [27,]  0.7578690801  1.714384237 -0.612880519
##  [28,]  0.8067059109  0.249222028  0.738816888
##  [29,] -0.1364380193  0.295052297  2.168212221
##  [30,]  0.7223467546 -0.125562580  0.974254934
##  [31,]  1.2315343718 -0.332254656  0.265734630
##  [32,]  0.2016962255  1.287190910  0.406535591
##  [33,]  1.0092076755 -0.547296739  0.386368099
##  [34,]  1.3629400885 -0.710863944  0.044767139
##  [35,]  1.1270188129  1.927897714 -1.390190714
##  [36,]  0.4763038335 -0.603396243  1.583198479
##  [37,]  0.7894104943  0.193013777  0.407789096
##  [38,]  0.4637295308  0.030612061  0.459499519
##  [39,]  0.8685078127  0.364359621 -0.425117364
##  [40,]  1.0545334805 -1.345933365  0.348691218
##  [41,]  0.8880736544  0.441711678 -0.330637851
##  [42,]  0.3186461237  0.324065876  0.199199917
##  [43,] -0.0763958819  0.360937328  1.320892198
##  [44,]  0.4171036044 -0.265338130  0.894136109
##  [45,]  0.1352727352 -0.760803179  1.762139011
##  [46,]  0.9403435274 -0.491418119 -0.034847215
##  [47,] -0.0556483192  1.876635627  0.157362902
##  [48,]  1.2401961869 -1.345448111 -0.307433500
##  [49,]  0.8141138707 -1.368778342  0.707831734
##  [50,] -0.3742557799  0.303930741  1.696962950
##  [51,]  1.4284186563 -0.338122667 -0.973001128
##  [52,]  1.0151886901 -2.039336233  0.608384628
##  [53,]  0.3017821282 -1.135762278  1.260624518
##  [54,]  0.7484321556 -0.934097445  0.188282773
##  [55,]  0.9116506066 -1.022745069 -0.214030241
##  [56,] -0.1319813030 -1.048894399  1.760225085
##  [57,]  0.5185622827 -0.920701119  0.660865640
##  [58,] -0.2111253051  0.105148549  1.350899517
##  [59,]  0.2954625062  0.568817683 -0.008552794
##  [60,]  0.6574048698 -0.238650363 -0.129488112
##  [61,]  0.7794161625  0.203866853 -0.662923404
##  [62,]  1.0736124447 -0.108099628 -0.991582388
##  [63,]  0.3328541949 -0.739103017  0.750787082
##  [64,]  0.2537696858  0.262923381 -0.296268045
```

```
##  [65,]  0.7393382389 -0.566769119 -0.627247459
##  [66,]  1.0691400649 -0.327547709 -0.927864675
##  [67,]  0.6896572354 -0.647292551 -0.363995543
##  [68,]  0.3766532118 -0.398427618  0.055670881
##  [69,]  0.7304162554 -1.295556955 -0.025805161
##  [70,]  0.3972204802 -0.102533157 -0.243793994
##  [71,]  1.1502692899  1.181706022 -2.683930227
##  [72,] -0.1072842534  0.203110962  0.461187754
##  [73,]  0.3334426832 -1.054260011 -0.016302996
##  [74,]  0.2342242555 -0.319752851 -0.099325658
##  [75,]  0.8718839397 -1.807129186 -0.488493537
##  [76,]  0.3250500800 -0.211485408 -0.409090150
##  [77,]  0.2089959675 -0.810706147 -0.206189057
##  [78,] -0.2012495988 -0.361752109  0.165888847
##  [79,]  0.6229645812 -1.214197089 -0.101950573
##  [80,] -1.2109352840  0.004085814  1.715131184
##  [81,] -0.3548923758  1.120360682 -0.872820403
##  [82,]  0.7136960837 -1.759963669 -0.322177827
##  [83,]  0.4161600621 -0.996317056 -0.464180012
##  [84,] -0.2893760141 -0.947201518  1.233782311
##  [85,]  0.3342779237 -0.628659677 -0.144789991
##  [86,]  0.4818135140  0.043907215 -0.897197137
##  [87,]  1.0220756265 -2.339310797 -0.514599414
##  [88,]  0.2930846795 -0.684772496 -0.478559566
##  [89,]  1.1361217935 -1.011528031 -1.418026538
##  [90,]  0.0006167755 -0.769000238 -0.170471907
##  [91,] -0.2500547187 -0.367399406  0.390847795
##  [92,]  0.2506570155 -0.511611305 -0.565509957
##  [93,] -2.2724631099  1.804598532  2.848306476
##  [94,]  0.1142617580  0.231660288 -0.607636354
##  [95,] -0.9176675082 -0.294754094  1.173309792
##  [96,] -0.3933692414  0.367941696  0.114566603
##  [97,] -0.2273214979  1.396875339 -1.341964232
##  [98,] -0.3201336380  0.557721912 -0.566519308
##  [99,] -0.7391535769  0.595340404  0.139084167
## [100,]  0.3472537160 -0.108681298 -1.475358918
## [101,] -0.1082150685 -0.374606101 -0.458755979
## [102,] -0.0314660461 -1.241618102 -0.003778313
## [103,] -0.1375014242 -1.035052055 -0.019497061
## [104,] -0.1264999199 -0.813333845 -0.370682988
## [105,]  0.8971841426 -1.465435015 -1.789776045
## [106,] -1.7675758040  0.086265093  1.726621432
## [107,] -1.3290640552 -0.011810056  1.133961872
## [108,] -0.3794372249 -0.163421197 -0.933829102
## [109,] -0.0698020168 -0.613194816 -0.778653088
## [110,] -0.8507988277  0.051440851  0.370175101
## [111,] -0.2193094577 -0.419893756 -0.505464319
## [112,] -1.1237538421  0.873438201 -0.288801460
## [113,] -1.8911091703  1.103261015  1.230009221
## [114,] -1.5449332134  3.150537237 -1.410711337
## [115,] -0.6490629206 -0.213515228 -0.029537611
## [116,] -0.9916595752  0.175676451  0.122579120
## [117,] -0.1221458031 -0.550680011 -1.142777309
## [118,]  0.1359892789 -1.248013211 -1.027527639
```

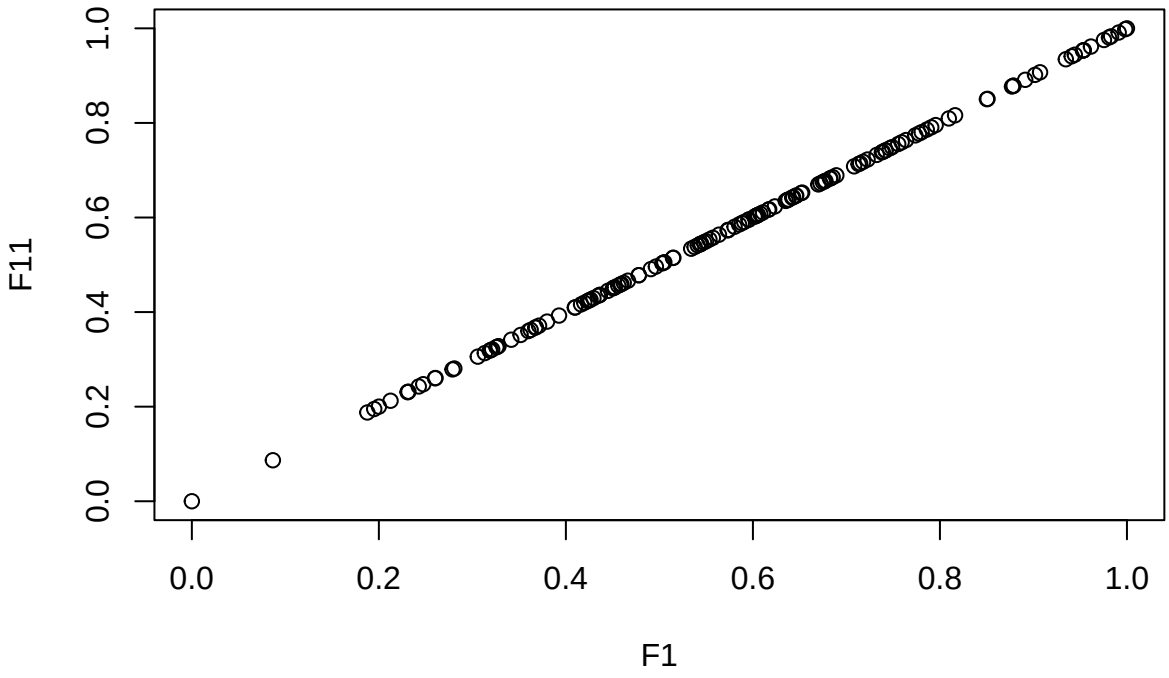
```
## [119,] -1.3944674401  0.706163499  0.418677566
## [120,]  0.0415781053  1.148766456 -2.750812818
## [121,]  0.0449702534 -1.614568800 -0.806056077
## [122,] -0.7840624652  0.119969130 -0.552428667
## [123,] -0.6065847799 -0.806180437 -0.547508816
## [124,] -0.8169335020 -0.431001147 -0.101339506
## [125,] -0.3711053119 -0.433250250 -0.780011607
## [126,] -1.4057271932 -0.417823463  0.784502009
## [127,] -0.8998471645 -0.375258991 -0.259824849
## [128,] -1.4072350791  0.256200769  0.215131175
## [129,] -0.8543867822  1.088872791 -1.339274984
## [130,] -0.6306145963 -1.297145267 -0.549618662
## [131,] -1.0390307323 -0.122249237 -0.418325361
## [132,]  0.2075432847 -1.113442100 -2.281043702
## [133,] -1.2267610243  0.393292400 -0.460152907
## [134,] -1.3035186227  0.057032415 -0.158526155
## [135,] -1.4478854826  0.184150562  0.174271204
## [136,] -1.9125213579  0.462594634  0.625466897
## [137,] -1.5680156894 -0.738783682  0.417605148
## [138,] -1.1792467309 -0.271743490 -0.375651224
## [139,] -1.1682160725 -0.130619494 -0.601670529
## [140,] -0.8260519529 -1.699653424 -0.636747639
## [141,] -1.9323714828 -0.453266103  0.442979746
## [142,]  0.1172275659 -0.398683577 -2.701939518
## [143,] -1.8667331193 -0.009327939  0.233186540
## [144,] -1.2000104343 -0.723586907 -0.591033054
## [145,] -1.9382376153  0.187398552 -0.592941006
## [146,] -0.8536581530 -1.071022587 -0.984100119
## [147,] -1.9016711382 -0.208342467 -0.040034428
## [148,] -1.7064647361 -0.122348307 -0.239475827
## [149,] -1.7288448691  0.214256111 -0.473436358
## [150,] -1.9308446113 -0.015374987  0.098768988
## [151,] -1.1883109061  2.139510806 -2.308561112
## [152,] -1.4456584814  0.434013178 -1.913608709
## [153,] -0.9604831815  0.337980540 -2.350247935
## [154,] -2.0833233051 -0.846583474 -0.441092635
## [155,] -3.1796774021  0.084834177  0.507132240
```

```
biplot(acp.varimax)
```

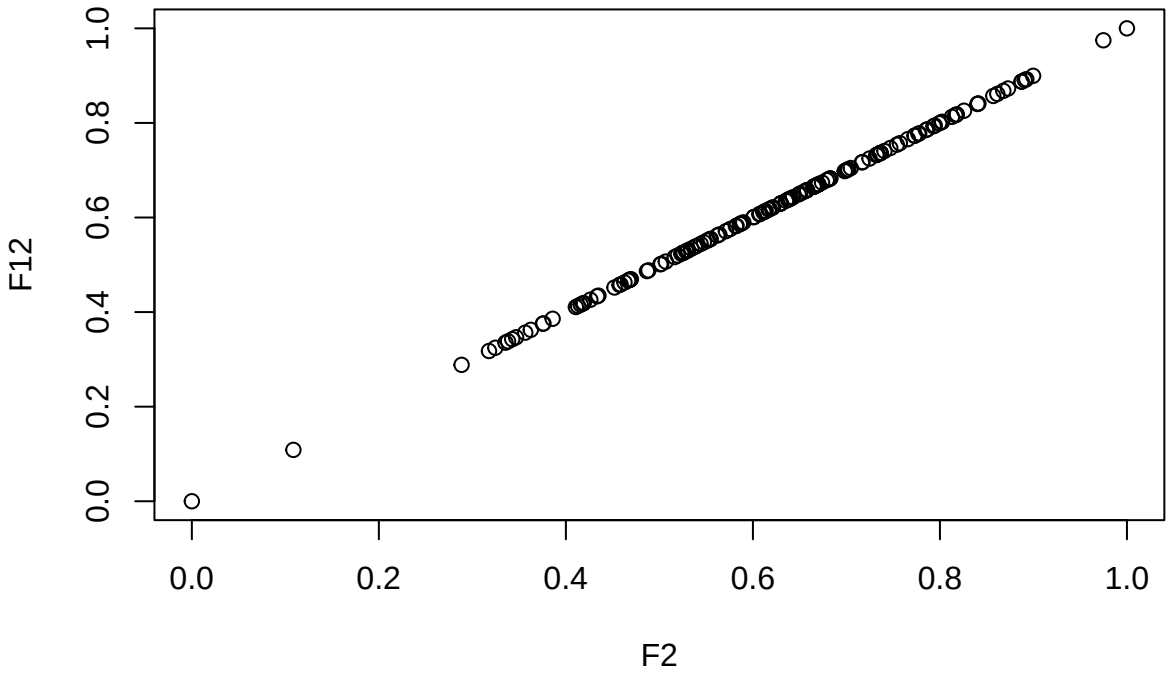



```
# Construir dos Indices I_1 e I_2 segun la metodologia estudiada
# -Correlacion
# -Grafica
# -Spearman
```

```
# Normalizar los factores
F1<-(acp$score[,1]-min(acp$score[,1]))/(max(acp$score[,1])-min(acp$score[,1]))
F2<-(acp$score[,2]-min(acp$score[,2]))/(max(acp$score[,2])-min(acp$score[,2]))

# Otra forma de hacerlo con scale()
F11<-scale(acp$score[,1], center=min(acp$score[,1]), scale=max(acp$score[,1])-min(acp$score[,1]))
F12<-scale(acp$score[,2], center=min(acp$score[,2]), scale=max(acp$score[,2])-min(acp$score[,2]))

# Se comprueba que es lo mismo
plot(F1,F11)
```




```
plot(F2,F12)
```




```
# Estos son los pesos de los factores
w1<-acp$sdev[1]^2
w2<-acp$sdev[2]^2
w1
```

```
##  Comp.1
## 3.82794
```

```
w2
```

```
##   Comp.2
## 1.395173
```

```
# Estos son los valores de los indices para cada pais
IB_1<-(w1/(w1+w2))*F1+(w2/(w1+w2))*F2
IB_2<-F1^(w1/(w1+w2))*F2^(w2/(w1+w2))
```