Principal Component Analysis (PCA)

Pablo E. Gutiérrez-Fonseca

8/26/2021

1. Primer paso: cargar las librerias que necesitas.

```
library(ggplot2)
library(dplyr)
library(missMDA) # Imputate
library(ggfortify) # autoplot()
library(cluster) #pam
library(factoextra) #get_pca_var()
library(data.table) # data.table()
library(devtools)

install_github("vqv/ggbiplot") #ggbiplot
library(ggbiplot)
```

2. Segundo paso: cargar los datos.

```
channel <- read.csv("data/channel_form.csv", header=TRUE)
head(channel)
```

```
##      Forma NAN_Am NADBO NAtemp  nit NASatO2 Elevacion Ancho Velocidad Rocas
## 1 Trapecio   0.03  2.38  27.33 0.35   92.04        23    16         5    20
## 2 Trapecio   0.03  2.95  27.81   NA  100.03        31    11         0    20
## 3 Trapecio   0.03  3.13  24.27   NA   96.82        35    14        10    30
## 4 Trapecio   1.15  4.73  27.06 7.54   64.35         9     5         2     0
## 5 Trapecio   0.50  8.16  26.60   NA  110.39        43    11         9    10
## 6 Trapecio   0.53  8.57  23.82   NA  106.09        23    11         5    20
##   Canto grava arena Limo
## 1    25    30    20    0
## 2    45    20    15    0
## 3    30    20    10    0
## 4     0     0    50   50
## 5    40    10    20   20
## 6    60    20     0    0
```

2.1 Vamos a examinar los datos

```
summary(channel)
```

```
##     Forma               NAN_Am         NADBO           NAtemp
##  Length:138         Min.   :0.0200   Min.   : 1.310   Min.   :14.67
##  Class :character   1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30
##  Mode  :character   Median :0.2150   Median : 3.000   Median :26.05
##                     Mean   :0.3201   Mean   : 6.164   Mean   :25.84
##                     3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70
##                     Max.   :1.5000   Max.   :34.900   Max.   :32.18
##                                      NA's   :35
##       nit            NASatO2         Elevacion           Ancho
##  Min.   :  0.00   Min.   : 23.43   Min.   :   3.00   Min.   : 1.000
##  1st Qu.:  0.40   1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000
##  Median :  0.92   Median : 94.59   Median :  53.00   Median : 3.000
##  Mean   : 12.00   Mean   : 91.05   Mean   : 230.89   Mean   : 3.822
##  3rd Qu.:  1.62   3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000
##  Max.   :324.11   Max.   :122.73   Max.   :2370.00   Max.   :16.000
##  NA's   :57                                          NA's   :3
##    Velocidad          Rocas           Canto           grava
##  Min.   : 0.000   Min.   : 0.00   Min.   : 0.00   Min.   : 0.0
##  1st Qu.: 3.000   1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5
##  Median :11.000   Median :10.00   Median :25.00   Median :20.0
##  Mean   : 9.133   Mean   :16.25   Mean   :25.65   Mean   :17.8
##  3rd Qu.:14.000   3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0
##  Max.   :16.000   Max.   :90.00   Max.   :80.00   Max.   :80.0
##  NA's   :3        NA's   :3       NA's   :4       NA's   :3
##      arena             Limo
##  Min.   :  0.00   Min.   :  0.00
##  1st Qu.: 10.00   1st Qu.:  0.00
##  Median : 15.00   Median : 10.00
##  Mean   : 19.79   Mean   : 20.62
##  3rd Qu.: 25.00   3rd Qu.: 25.00
##  Max.   :100.00   Max.   :100.00
##  NA's   :3        NA's   :3
```

2.1 Remover la(s) variable(s) que tiene(n) mucho(s) NAs y las Etiquetas (a la funcion lo le gusta), luego las agregamos.

```r
channel_1 <- select(channel, -Forma)
summary(channel_1)
```

```
##      NAN_Am           NADBO            NAtemp           nit
##  Min.   :0.0200   Min.   : 1.310   Min.   :14.67   Min.   :  0.00
##  1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30   1st Qu.:  0.40
##  Median :0.2150   Median : 3.000   Median :26.05   Median :  0.92
##  Mean   :0.3201   Mean   : 6.164   Mean   :25.84   Mean   : 12.00
##  3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70   3rd Qu.:  1.62
##  Max.   :1.5000   Max.   :34.900   Max.   :32.18   Max.   :324.11
##                   NA's   :35                       NA's   :57
##     NASatO2         Elevacion           Ancho           Velocidad
##  Min.   : 23.43   Min.   :   3.00   Min.   : 1.000   Min.   : 0.000
##  1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000   1st Qu.: 3.000
##  Median : 94.59   Median :  53.00   Median : 3.000   Median :11.000
##  Mean   : 91.05   Mean   : 230.89   Mean   : 3.822   Mean   : 9.133
##  3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000   3rd Qu.:14.000
```

```
##  Max.   :122.73   Max.   :2370.00   Max.   :16.000   Max.   :16.000
##                                     NA's   :3        NA's   :3
##      Rocas           Canto           grava          arena
##  Min.   : 0.00   Min.   : 0.00   Min.   : 0.0   Min.   :  0.00
##  1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5   1st Qu.: 10.00
##  Median :10.00   Median :25.00   Median :20.0   Median : 15.00
##  Mean   :16.25   Mean   :25.65   Mean   :17.8   Mean   : 19.79
##  3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0   3rd Qu.: 25.00
##  Max.   :90.00   Max.   :80.00   Max.   :80.0   Max.   :100.00
##  NA's   :3       NA's   :4       NA's   :3      NA's   :3
##       Limo
##  Min.   :  0.00
##  1st Qu.:  0.00
##  Median : 10.00
##  Mean   : 20.62
##  3rd Qu.: 25.00
##  Max.   :100.00
##  NA's   :3
```

2.2 Vamos a imputar datos. Esto es comun para set de datos de campo, los cuales tienden a tener ceros (por mal funcionamiento de los equipos, condiciones climticas adversas que no puedemos ir al campo). Se realiza como un paso preliminar para para realizar un PCA en un set de datos completos.

Mas informacion aca: https://www.rdocumentation.org/packages/missMDA/versions/1.18/topics/imputePCA

Primero separar e imputar los datos de sustrato y los fisicoquimicos por aparte.

```
df1 <- select(channel_1, Elevacion, Ancho, Velocidad, Rocas, Canto, grava, arena, Limo)
df1
```

```
##     Elevacion Ancho Velocidad Rocas Canto grava arena  Limo
## 1          23    16         5  20.0  25.0  30.0  20.0   0.0
## 2          31    11         0  20.0  45.0  20.0  15.0   0.0
## 3          35    14        10  30.0  30.0  20.0  10.0   0.0
## 4           9     5         2   0.0   0.0   0.0  50.0  50.0
## 5          43    11         9  10.0  40.0  10.0  20.0  20.0
## 6          23    11         5  20.0  60.0  20.0   0.0   0.0
## 7          86    11        13   0.0  80.0  20.0  20.0   0.0
## 8          26     3        11   0.0  30.0  20.0  25.0  25.0
## 9          24     3        14   5.0  25.0  35.0  20.0  15.0
## 10         53    11         4   0.0  70.0   5.0  20.0   5.0
## 11         24    11         3   0.0  70.0  20.0  10.0   0.0
## 12        619     2        14  30.0  30.0  20.0  20.0   0.0
## 13        598     3        14  20.0  30.0  20.0  10.0  20.0
## 14        583     3        14  20.0  30.0  20.0  10.0  20.0
## 15        114     2        11   0.0  15.0  30.0  25.0  15.0
## 16         46     3        14   0.0   5.0  20.0  40.0  35.0
## 17         46     3        16   0.0   1.0  40.0  40.0  19.0
## 18        158    11         4  40.0  50.0   5.0   5.0   0.0
## 19         34    11         4   0.0  70.0  15.0  15.0   0.0
## 20       1818    NA        NA    NA    NA    NA    NA    NA
## 21        205    11         4   0.0  80.0  10.0  10.0   0.0
## 22         38     3        13   0.0  40.0  30.0  20.0  10.0
```

```
## 23           98      3           14  25.0  25.0  15.0  25.0  10.0
## 24           49      3           15  10.0  60.0  10.0  10.0  10.0
## 25           29      3           14   5.0  25.0  30.0  25.0  15.0
## 26           99      3           14  25.0  40.0   0.0  10.0  25.0
## 27           20      3           14  15.0  15.0   5.0  30.0  35.0
## 28           82      1           11  60.0   0.0  20.0  20.0   0.0
## 29           43      2           11   0.0  50.0  50.0   0.0   0.0
## 30           17      3            2   0.0  33.3  33.3  33.3   0.0
## 31          149      3            3  90.0  10.0   0.0   0.0   0.0
## 32           10      1           14  15.0  20.0  40.0  10.0  15.0
## 33           28      1           14  10.0  70.0  10.0   0.0  10.0
## 34           18      1           12  10.0  20.0  50.0  10.0  10.0
## 35           85      1           14  10.0  20.0  50.0  10.0  10.0
## 36          130      2            2   0.0  30.0   0.0  70.0   0.0
## 37           51      2           10  35.0  50.0   0.0  15.0   0.0
## 38          198      1            3  90.0   0.0   0.0  10.0   0.0
## 39           13      1            3  33.3  33.3   0.0   0.0  33.3
## 40           53      2            3   0.0   0.0  50.0  50.0   0.0
## 41          492      2           14  50.0  20.0  10.0  10.0  10.0
## 42          428      2           14  20.0  40.0  20.0  10.0  10.0
## 43           49      3           11   0.0  10.0  30.0  50.0  10.0
## 44           67      3           12  20.0  40.0  20.0  10.0  10.0
## 45           67      1           11  10.0  60.0  20.0   5.0   5.0
## 46          100      2            9  20.0  35.0  25.0  15.0   5.0
## 47           83      1           14  50.0  30.0  10.0   5.0   5.0
## 48           63      1           12  10.0  60.0  20.0   5.0   5.0
## 49           60      3           12  10.0   5.0   5.0  30.0  50.0
## 50           25      3           11   0.0  70.0  20.0   5.0   5.0
## 51           30      3           11   0.0  10.0  40.0  40.0  10.0
## 52           50      2            3   0.0   0.0   0.0  50.0  50.0
## 53           36      2            3   0.0   0.0  10.0  20.0  70.0
## 54           22      3           11   0.0  20.0  60.0  10.0  10.0
## 55           11      2           12   0.0   0.0  80.0  20.0   0.0
## 56           71      3           14   5.0  50.0  20.0  15.0  10.0
## 57           15      3           12   0.0  10.0  70.0  10.0  10.0
## 58           85      3            9   5.0  60.0  20.0  10.0   5.0
## 59           21      3           11   0.0  10.0  60.0  20.0  10.0
## 60          659      2           13  10.0  70.0  20.0   0.0   0.0
## 61          615      3           14  30.0  30.0  30.0  10.0   0.0
## 62          517      3           14  50.0  30.0  10.0  10.0   0.0
## 63          422      2           14  30.0  40.0  20.0  10.0   0.0
## 64          363      3           14  30.0  40.0  20.0   5.0   5.0
## 65          117      3           14  10.0  70.0  10.0  10.0   0.0
## 66          244      2            9  25.0  30.0  25.0  15.0   5.0
## 67           15      2           11   0.0   0.0  40.0  40.0  20.0
## 68           22      3           14  10.0  40.0  30.0  15.0   5.0
## 69         1114      1           10  75.0  15.0   0.0  10.0   0.0
## 70          353      1           14  40.0  20.0  20.0  20.0   0.0
## 71          314      1           14  50.0  10.0  20.0  20.0   0.0
## 72         1630      1           14  30.0  25.0  25.0   0.0  20.0
## 73          628      1           14  30.0  20.0  20.0  20.0  10.0
## 74          137      1           14  20.0  60.0  10.0  10.0   0.0
## 75           51      2           14  30.0  25.0  25.0   0.0  20.0
## 76           27      2            8  40.0  30.0  20.0  10.0   0.0
```

```
## 77          27    12          0   0.0   0.0  15.0  85.0   0.0
## 78          15    12          0   0.0   0.0  10.0  90.0   0.0
## 79          16    12          0   0.0   0.0  20.0  80.0   0.0
## 80          15     5          2   0.0   0.0   0.0  50.0  50.0
## 81           6    11          2   0.0   0.0   0.0  50.0  50.0
## 82           3    11          2   0.0   0.0   0.0  50.0  50.0
## 83          10    11          2   0.0   0.0   0.0  50.0  50.0
## 84           8    11          2   0.0   0.0   0.0   0.0 100.0
## 85          86    11          4   0.0  65.0  20.0  10.0   5.0
## 86          26    11          2   0.0   0.0   0.0  50.0  50.0
## 87           9     2         11   0.0   0.0   0.0   0.0 100.0
## 88          28     5          2   0.0    NA  80.0  10.0  10.0
## 89          27     5          1   0.0   0.0  60.0  20.0  20.0
## 90          21     3         11   0.0   0.0   0.0  40.0  60.0
## 91          13     3          2   0.0   0.0   0.0  20.0  80.0
## 92          23     3          2   0.0   0.0   0.0  50.0  50.0
## 93          23     3          2   0.0   0.0   0.0   0.0 100.0
## 94          11     3          2   0.0   0.0   0.0   0.0 100.0
## 95          27     2          3   0.0   0.0   0.0   0.0 100.0
## 96          19     2          2   0.0   0.0   0.0   0.0 100.0
## 97          43     1          2   0.0   0.0   0.0   0.0 100.0
## 98          46     2          3   0.0   0.0  10.0   0.0  90.0
## 99          44     3         12   0.0   0.0   0.0   0.0 100.0
## 100         53     2         14   0.0  15.0   5.0  15.0  65.0
## 101         42     3          2   0.0   0.0   0.0   0.0 100.0
## 102         50     3          2   0.0   0.0   0.0  15.0  85.0
## 103         42     2          2   0.0   0.0   0.0   5.0  95.0
## 104         58     3         12   0.0   0.0   0.0  50.0  50.0
## 105         43     2          3   0.0   0.0   0.0 100.0   0.0
## 106         51     2         11   0.0   0.0  50.0  50.0   0.0
## 107         15     3          2   0.0   0.0   0.0  50.0  50.0
## 108         22     2         11   0.0   0.0   0.0  50.0  50.0
## 109         13     2         11   0.0   5.0  35.0  30.0  30.0
## 110        115     5          9   0.0  80.0  10.0  10.0   0.0
## 111        491     2         14  35.0  20.0   0.0  35.0  10.0
## 112        524     3         14  40.0  30.0  20.0  10.0   0.0
## 113         98     2         14  25.0  30.0  25.0  15.0   5.0
## 114        275    NA         NA    NA    NA    NA    NA    NA
## 115       1488     2         14  20.0  40.0  20.0  10.0  10.0
## 116        196     2         15  35.0  40.0  10.0  10.0   5.0
## 117        291     2         11  30.0  30.0  20.0  15.0   5.0
## 118        223    11          5  40.0  50.0   5.0   5.0   0.0
## 119       1346    NA         NA    NA    NA    NA    NA    NA
## 120       2370     2         15  25.0  25.0  35.0  10.0   5.0
## 121         17    11          4  30.0  40.0  10.0  10.0  10.0
## 122       1412     2         15  35.0  40.0  15.0  10.0   0.0
## 123        490     2         15  20.0  30.0  35.0  15.0   0.0
## 124        252     3         15  25.0  30.0  30.0  15.0   0.0
## 125        162     2         14  15.0  20.0  15.0  25.0  25.0
## 126        494     2         15  45.0  25.0  10.0  15.0   5.0
## 127        428     2         15  55.0  30.0   5.0   5.0   5.0
## 128        358     1          4  30.0  60.0   0.0  10.0   0.0
## 129        363     1          3  10.0  40.0  25.0  25.0   0.0
## 130        371     2          6  25.0  25.0  20.0  20.0  10.0
```

```
## 131      1420     1         5  40.0  40.0  10.0  10.0   0.0
## 132       828     1         4  40.0  40.0  10.0  10.0   0.0
## 133       952     1        14  50.0  20.0  20.0  10.0   0.0
## 134       422     2        13  30.0  40.0  20.0  10.0   0.0
## 135       144     3        15  50.0  30.0  10.0   5.0   5.0
## 136       200     3        14  15.0  30.0  30.0  20.0   5.0
## 137       327     2        13  40.0  30.0  20.0   8.0   2.0
## 138        60     3        15  30.0  25.0  10.0  30.0   5.0
```

```
df1a <- imputePCA(df1,ncp=4, scale = TRUE, method = c("Regularized","EM"),
                      row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                      coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                      maxiter = 1000)


df2 <- select(channel_1, Elevacion, NAN_Am, NAtemp, NASatO2, nit, NADBO)
df2a <- imputePCA(df2, ncp=4, scale = TRUE, method = c("Regularized","EM"),
                   row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                   coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                   maxiter = 1000)
```

Unir las dos tablas y seleccionar las columnas para hacer el PCA.

```
df1b <- as.data.frame(df1a) # Sustrata
df2b <- as.data.frame(df2a) # Physicochemical


new_channel <- do.call("merge", c(lapply(list(df1b, df2b), data.frame, row.names=NULL),
by = 0, all = TRUE, sort = FALSE))[-1]

new_channel2 <- select(new_channel,
                      completeObs.Elevacion.x, completeObs.Ancho, completeObs.Velocidad,
                     completeObs.Rocas, completeObs.Canto, completeObs.grava, completeObs.arena,
                    completeObs.Limo, completeObs.NAtemp, completeObs.NASatO2,
                      )
```

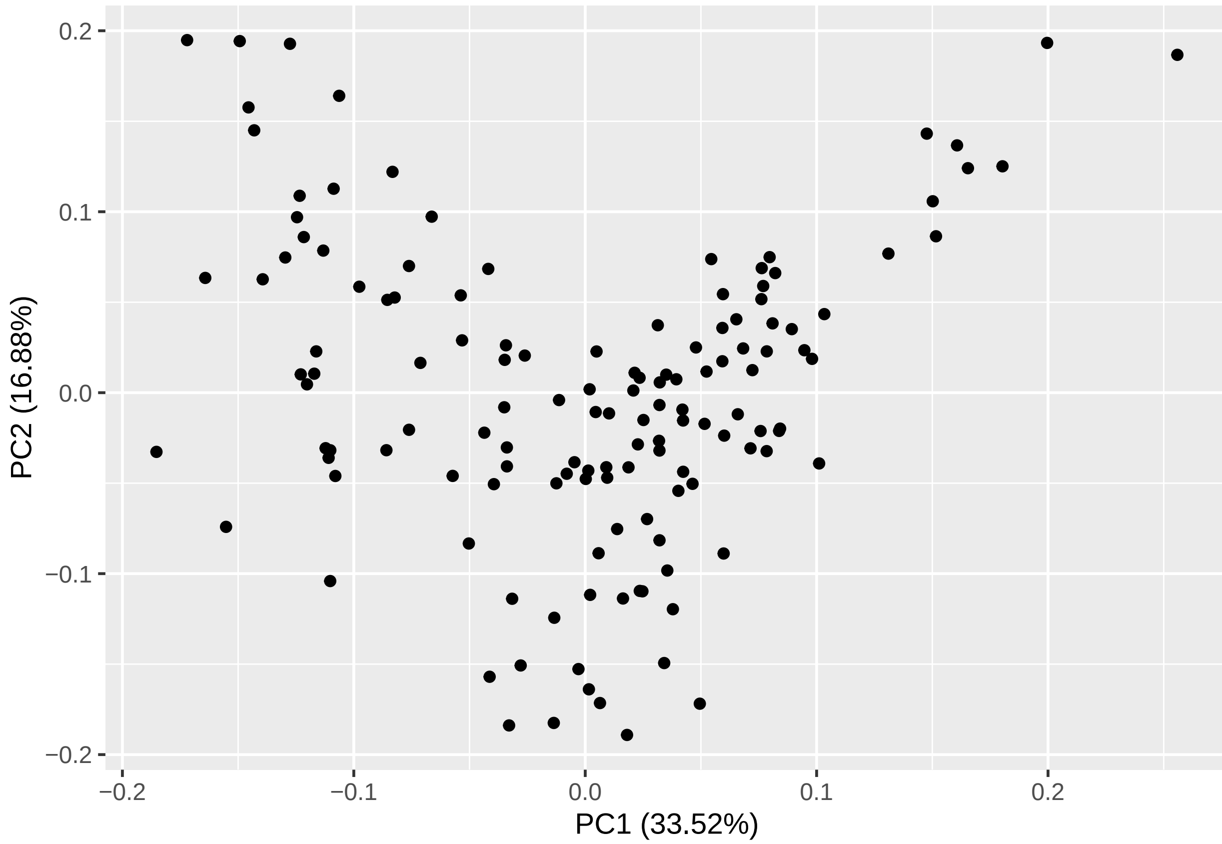
3. Vamos a correr el PCA

```
channel.pca <- prcomp(new_channel2, center = TRUE, scale = TRUE)
summary(channel.pca)
```

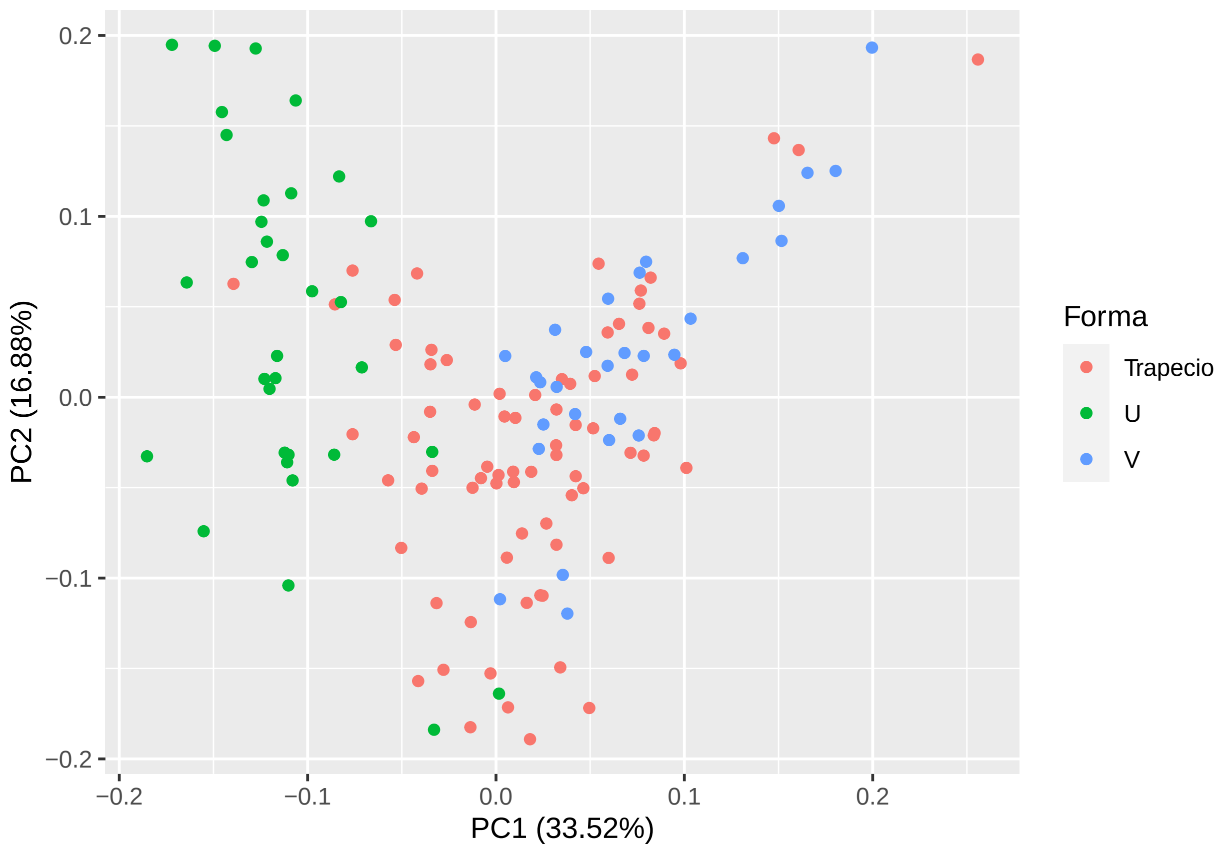
```
## Importance of components:
##                           PC1    PC2    PC3    PC4     PC5     PC6     PC7
## Standard deviation     1.8308 1.2991 1.1906 1.0728 0.90108 0.75065 0.70276
## Proportion of Variance 0.3352 0.1688 0.1417 0.1151 0.08119 0.05635 0.04939
## Cumulative Proportion  0.3352 0.5040 0.6457 0.7608 0.84198 0.89833 0.94772
##                            PC8    PC9    PC10
## Standard deviation     0.61343 0.3756 0.07403
## Proportion of Variance 0.03763 0.0141 0.00055
## Cumulative Proportion  0.98535 0.9994 1.00000
```

3.1 Vamos a ver el grafico.

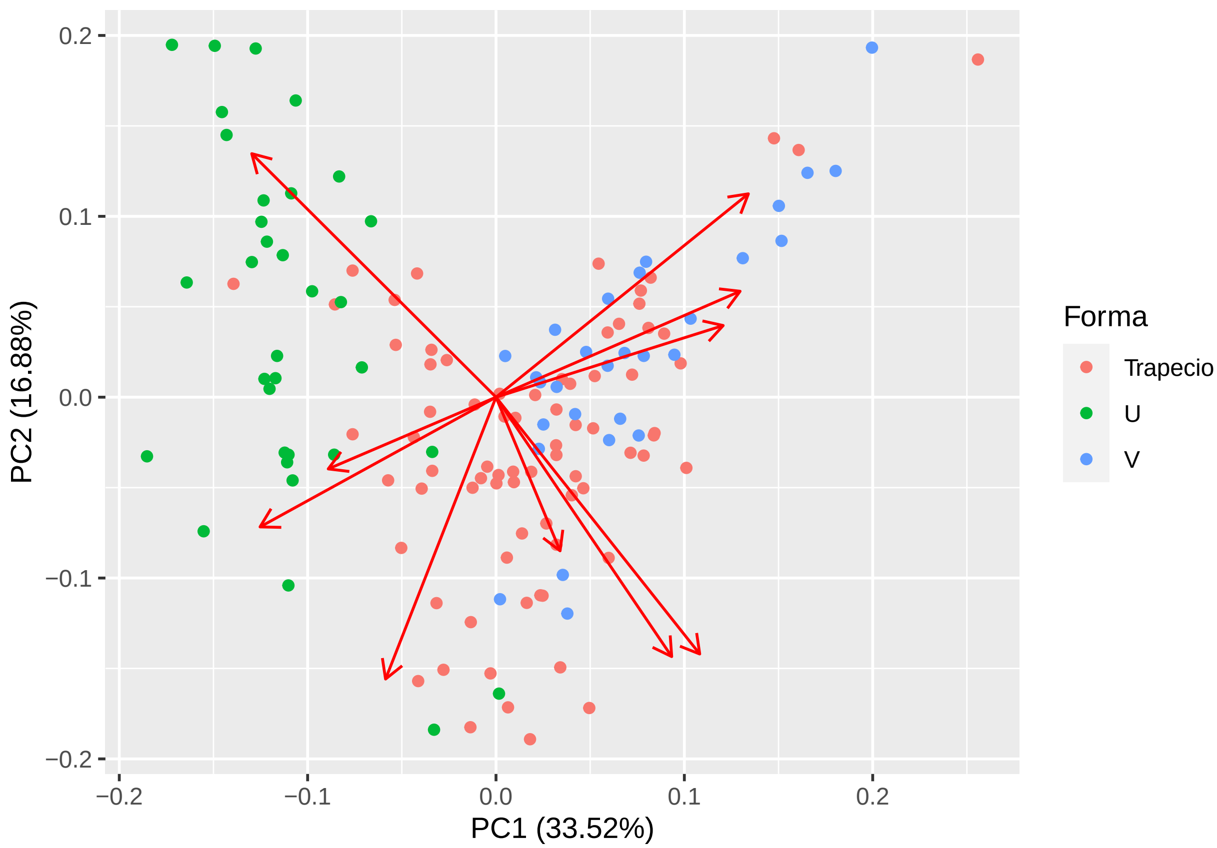
```r
autoplot(channel.pca)
```



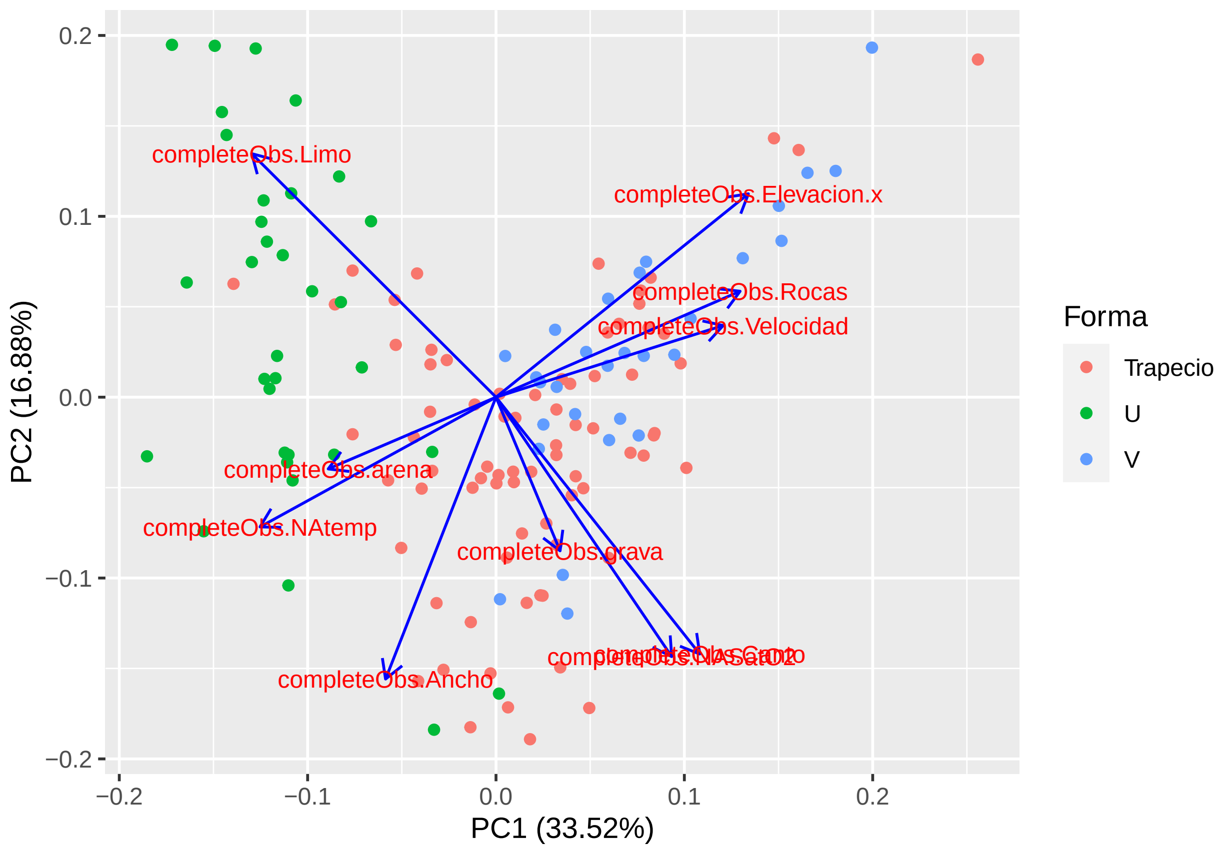

```r
autoplot(channel.pca, data = channel, colour = 'Forma')
```




```r
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE)
```

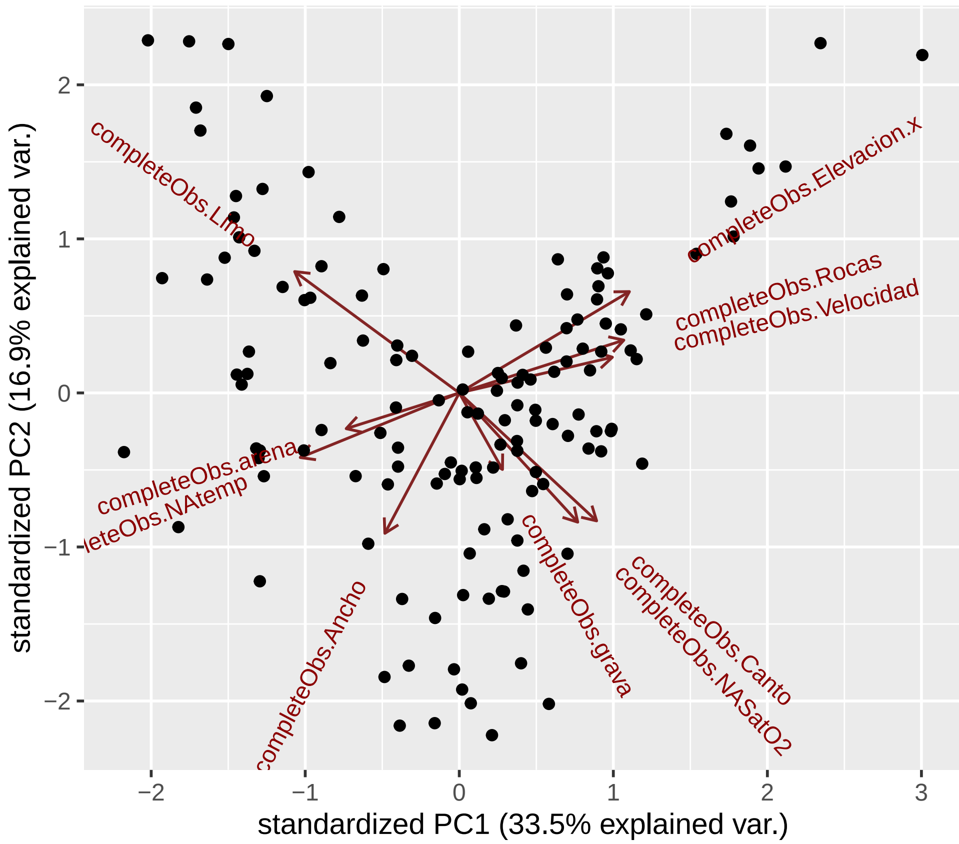



```
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE,
         loadings.colour = 'blue',
         loadings.label = TRUE, loadings.label.size = 3)
```



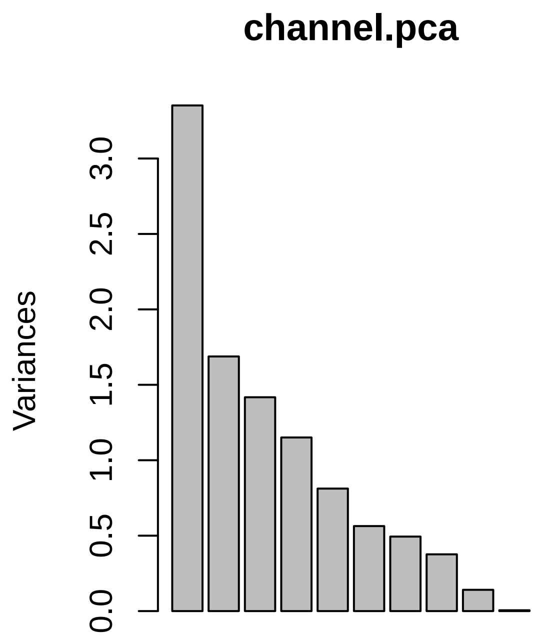
Otra manera de ver el grafico

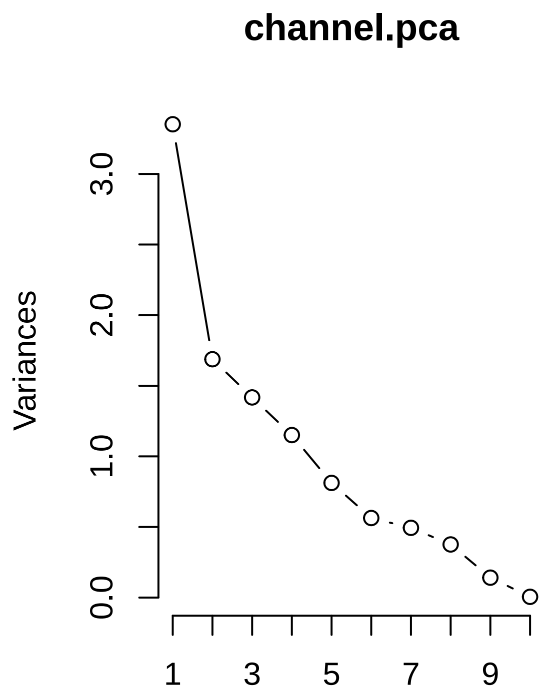
```
ggbiplot(channel.pca, labels=rownames(channel$Forma))
```



3.2 Ver graficamente lo que explica cada axis.

```
layout(matrix(1:2, ncol=2))
screeplot(channel.pca)
screeplot(channel.pca, type="lines")
```





3.3 Vamos a ver la contribucion de cada una de las variables. Usamos otra libreria. factoextra

```
get_eigenvalue(channel.pca)
```

```
##         eigenvalue variance.percent cumulative.variance.percent
## Dim.1  3.351771382      33.51771382                    33.51771
## Dim.2  1.687784849      16.87784849                    50.39556
## Dim.3  1.417515556      14.17515556                    64.57072
## Dim.4  1.150813813      11.50813813                    76.07886
## Dim.5  0.811945749       8.11945749                    84.19831
## Dim.6  0.563472075       5.63472075                    89.83303
## Dim.7  0.493870965       4.93870965                    94.77174
## Dim.8  0.376301294       3.76301294                    98.53476
## Dim.9  0.141043913       1.41043913                    99.94520
## Dim.10 0.005480404       0.05480404                   100.00000
```

```
res.var <- get_pca_var(channel.pca)
res.var$contrib        # Contributions to the PCs
```

```
##                              Dim.1     Dim.2      Dim.3        Dim.4      Dim.5
## completeObs.Elevacion.x 15.650521 11.018055  3.9883933  6.866845991  7.2507524
## completeObs.Ancho        2.995659 21.169083 20.1763877  0.782394827  8.0384714
## completeObs.Velocidad   12.680938  1.367885 17.3554922  0.002286462  0.4693952
## completeObs.Rocas       14.638439  2.988940  3.5160945  0.940300927 26.0511863
## completeObs.Canto       10.197470 17.575280  0.6099534 10.995731297 10.0075213
```

```
## completeObs.grava        1.009169  6.292470 37.4296016 10.540099765  8.2524292
## completeObs.arena        6.914027  1.371730  1.3904347 47.896684587 11.1026042
## completeObs.Limo        14.654110 15.802001  0.5460166 10.536099998  2.8891108
## completeObs.NAtemp      13.675744  4.484761 13.2035607  9.649933383 10.3019337
## completeObs.NASatO2      7.583922 17.929795  1.7840653  1.789622764 15.6365957
##                              Dim.6      Dim.7       Dim.8       Dim.9
## completeObs.Elevacion.x  0.2751258  3.3889418  1.73466654 49.78539218
## completeObs.Ancho        4.9212309  4.4997068 33.70847849  3.70838167
## completeObs.Velocidad   23.0968905  3.8943631 40.23566828  0.87670991
## completeObs.Rocas       22.9334757 10.9313657  0.62010149  0.16656921
## completeObs.Canto       12.0919438  5.2834450 13.20379077  0.08616884
## completeObs.grava       21.4105742  3.8293843  0.09253419  0.43170684
## completeObs.arena       13.5222844  0.3321596  1.22547811  0.52436381
## completeObs.Limo         0.4546208 12.4242895  6.25704917  0.15589274
## completeObs.NAtemp       0.7691982  2.7038635  1.13447080 44.03352238
## completeObs.NASatO2      0.5246557 52.7124806  1.78776216  0.23129244
##                               Dim.10
## completeObs.Elevacion.x 4.130553e-02
## completeObs.Ancho       2.061036e-04
## completeObs.Velocidad   2.037205e-02
## completeObs.Rocas       1.721353e+01
## completeObs.Canto       1.994869e+01
## completeObs.grava       1.071203e+01
## completeObs.arena       1.572023e+01
## completeObs.Limo        3.628081e+01
## completeObs.NAtemp      4.301250e-02
## completeObs.NASatO2     1.980823e-02
```

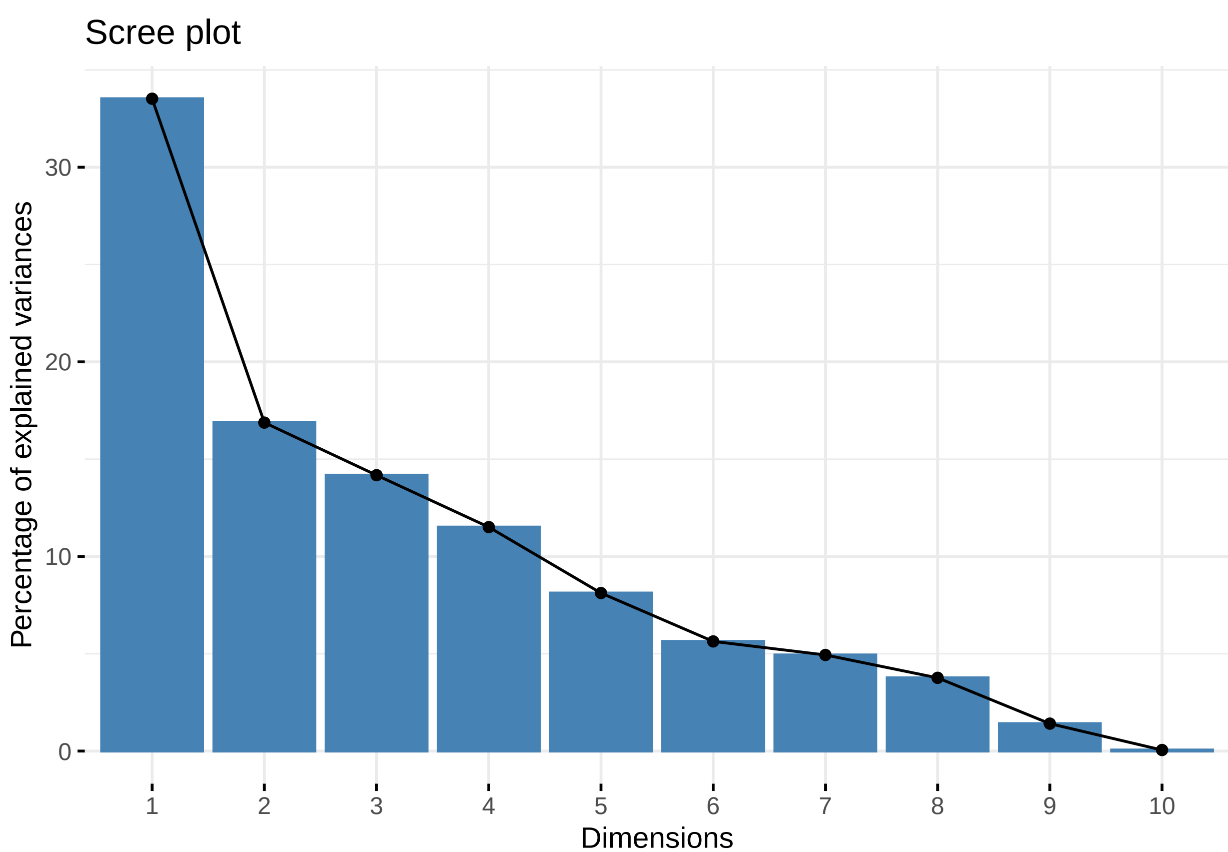
```
res.var$coord          # Coordinates
```

```
##                              Dim.1      Dim.2       Dim.3        Dim.4
## completeObs.Elevacion.x  0.7242718  0.4312320 -0.23777320  0.281113166
## completeObs.Ancho       -0.3168717 -0.5977362 -0.53479289  0.094888923
## completeObs.Velocidad    0.6519479  0.1519439  0.49600081  0.005129612
## completeObs.Rocas        0.7004620  0.2246038 -0.22325140 -0.104024579
## completeObs.Canto        0.5846331 -0.5446402 -0.09298486 -0.355725167
## completeObs.grava        0.1839159 -0.3258886  0.72840265  0.348277079
## completeObs.arena       -0.4813963 -0.1521573 -0.14039098  0.742429567
## completeObs.Limo        -0.7008368  0.5164337 -0.08797653 -0.348210991
## completeObs.NAtemp      -0.6770374 -0.2751238  0.43262285 -0.333245805
## completeObs.NASatO2      0.5041783 -0.5501058 -0.15902642 -0.143510369
##                               Dim.5       Dim.6       Dim.7       Dim.8
## completeObs.Elevacion.x -0.24263589 -0.03937331 -0.12937156  0.08079339
## completeObs.Ancho       -0.25547608 -0.16652256  0.14907295 -0.35615368
## completeObs.Velocidad    0.06173519  0.36075550  0.13868356 -0.38911096
## completeObs.Rocas        0.45991467 -0.35947702  0.23235069 -0.04830580
## completeObs.Canto       -0.28505376  0.26102629  0.16153452  0.22290365
## completeObs.grava       -0.25885372 -0.34733645 -0.13752170 -0.01866032
## completeObs.arena        0.30024510  0.27603314  0.04050235  0.06790795
## completeObs.Limo        -0.15316009  0.05061286 -0.24770942 -0.15344496
## completeObs.NAtemp       0.28921638 -0.06583477  0.11555776  0.06533780
## completeObs.NASatO2      0.35631541  0.05437176 -0.51022704 -0.08202056
##                               Dim.9        Dim.10
## completeObs.Elevacion.x -0.26498918  0.0015045632
```

```
## completeObs.Ancho        -0.07232183 -0.0001062794
## completeObs.Velocidad    -0.03516456 -0.0010566317
## completeObs.Rocas         0.01532761 -0.0307143439
## completeObs.Canto        -0.01102433 -0.0330646208
## completeObs.grava         0.02467582 -0.0242293741
## completeObs.arena        -0.02719528 -0.0293518712
## completeObs.Limo         -0.01482826 -0.0445907510
## completeObs.NAtemp       -0.24921196  0.0015353367
## completeObs.NASatO2      -0.01806167  0.0010419073
```

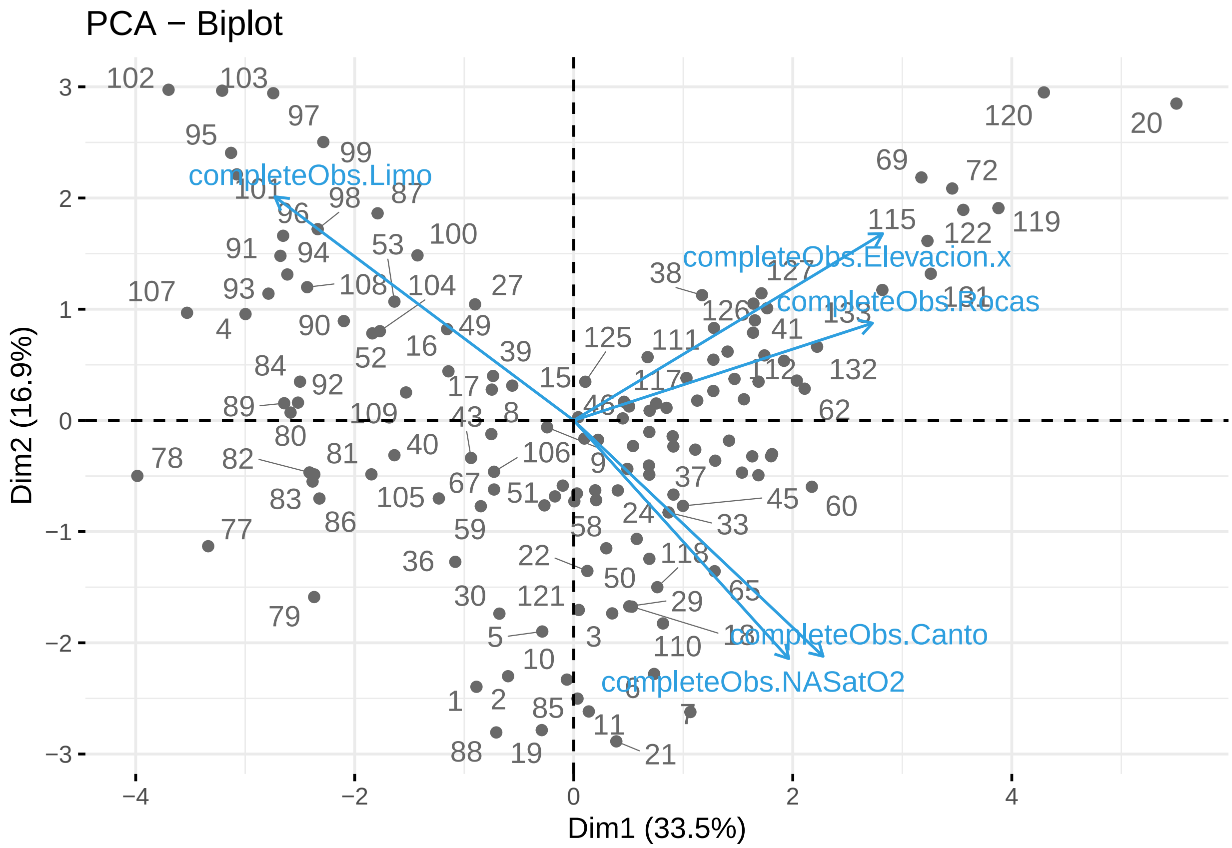
4 Otras formas de visualizar los datos.

```
fviz_eig(channel.pca)
```



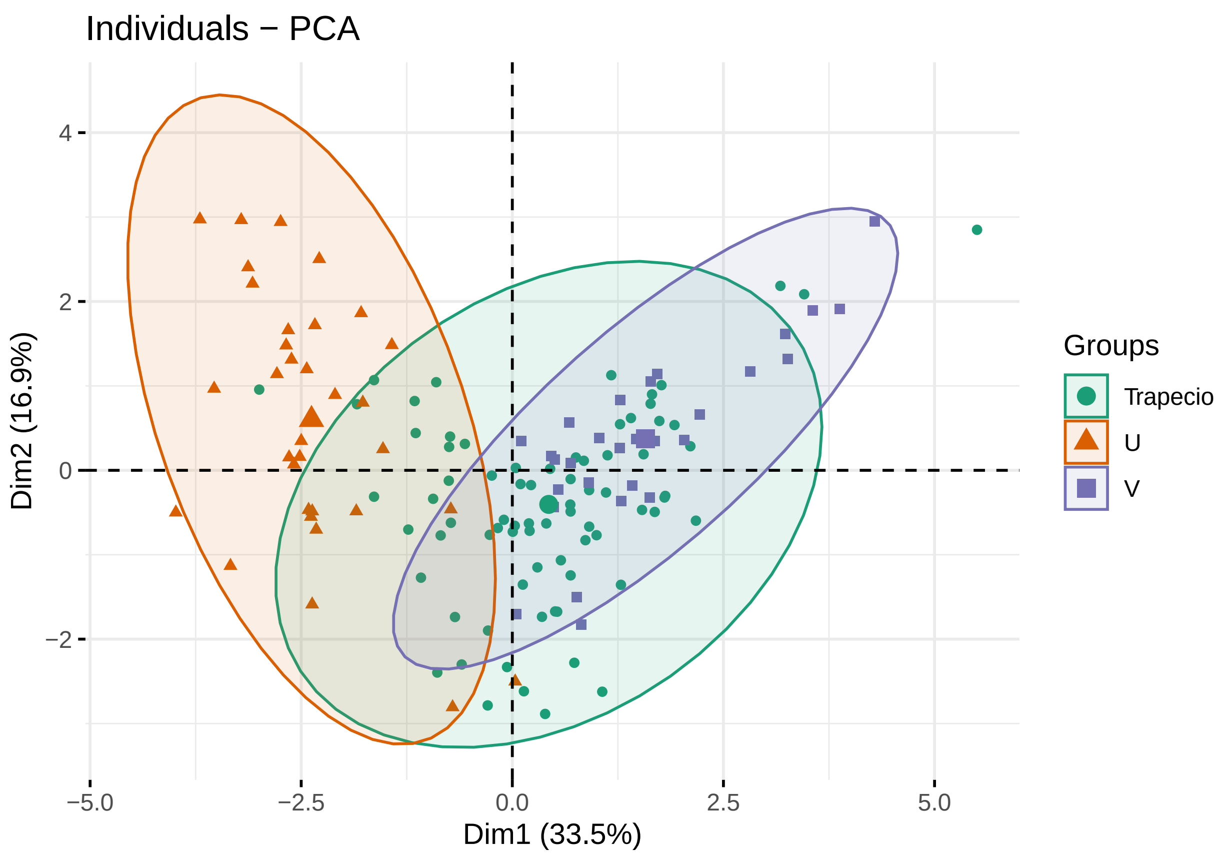

```
fviz_pca_biplot(channel.pca, repel = TRUE,
                col.var = "#2E9FDF", # Variables color
                col.ind = "#696969",  # Individuals color
                select.var = list(contrib = 5))
```

```
## Warning: ggrepel: 43 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



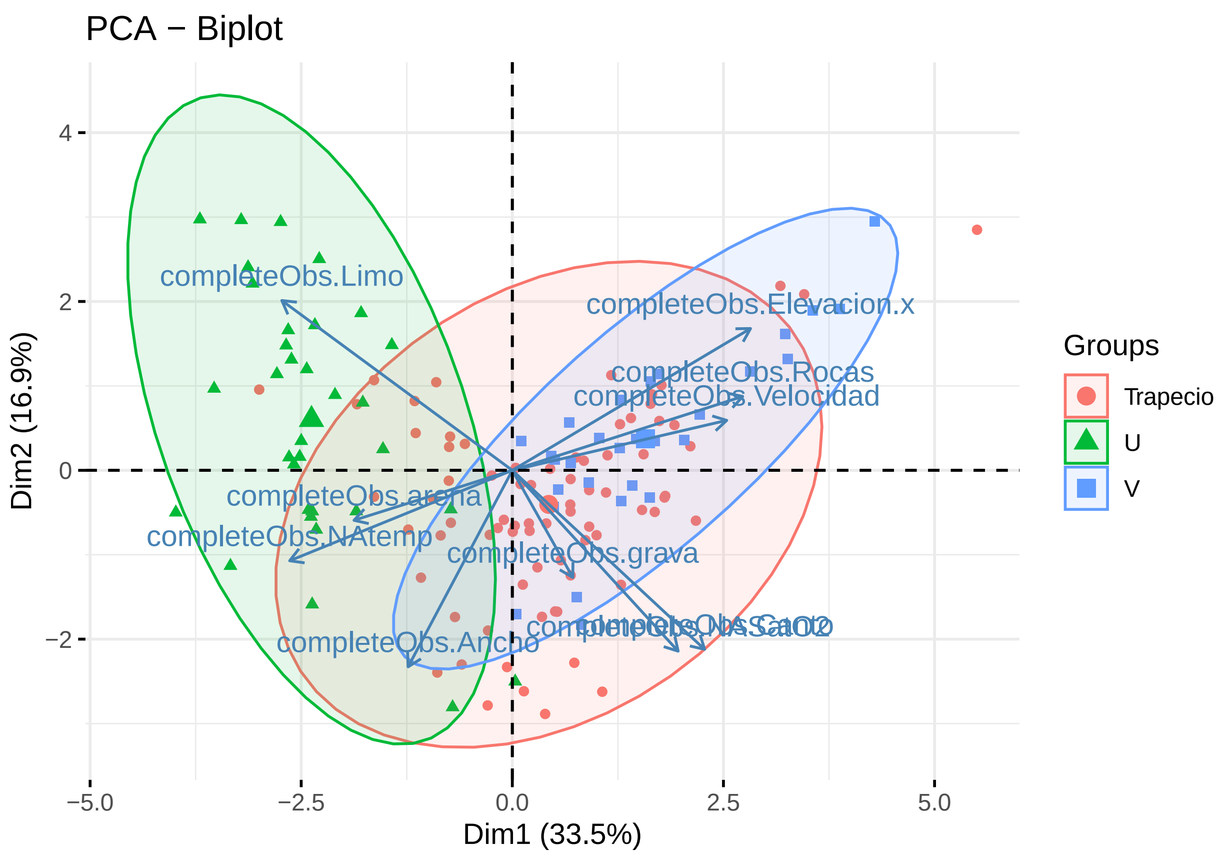
4.1 Con las elipses.

```
fviz_pca_ind(channel.pca, label="none", habillage=channel$Forma,
      addEllipses=TRUE, ellipse.level=0.95, palette = "Dark2")
```



4.1

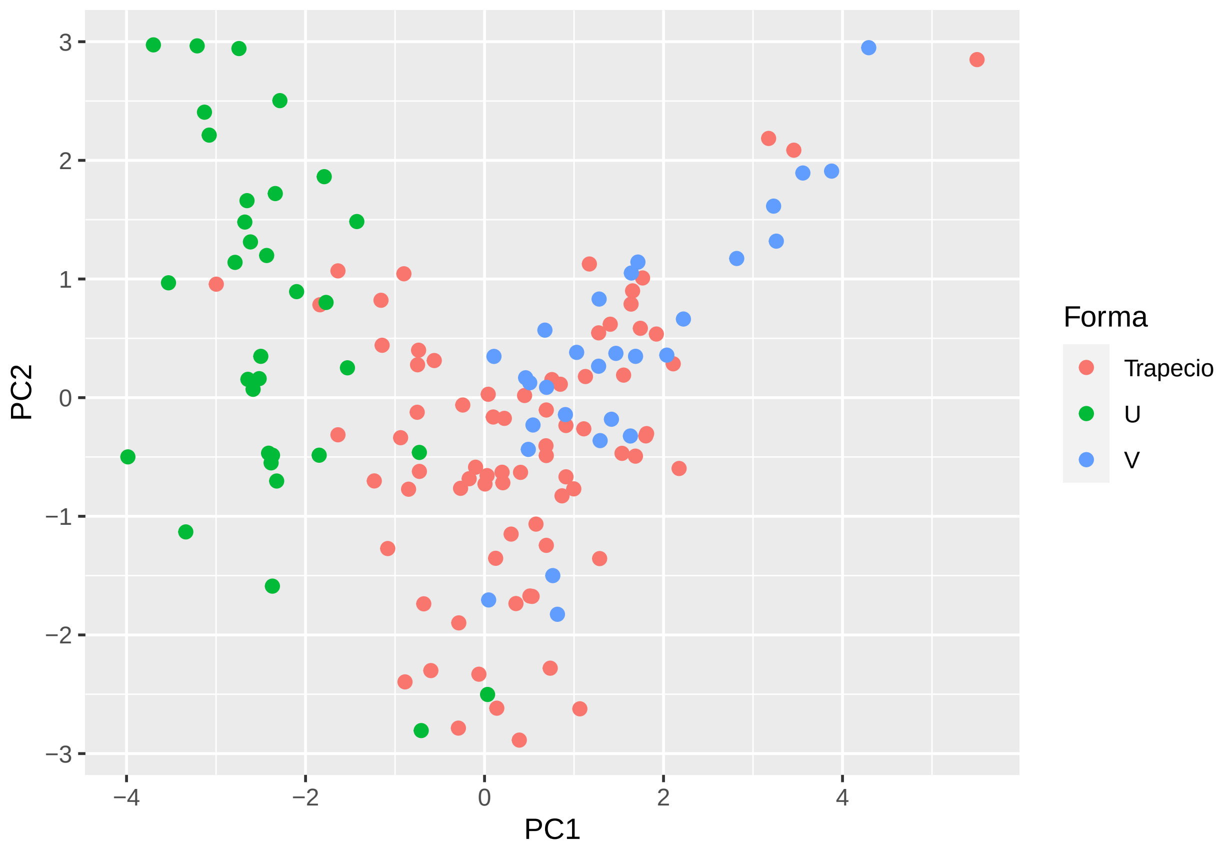
```
fviz_pca_biplot(channel.pca, label = "var", habillage=channel$Forma,
                addEllipses=TRUE, ellipse.level=0.95,
                ggtheme = theme_minimal())
```



5. Convertirlo en una data.frame para trabajarlo en ggplot2

```
data <- data.table(PC1=channel.pca$x[,1], PC2=channel.pca$x[,2], Forma=  channel[,1])
data <- data[order(channel$Forma),]

ggplot(data, aes(x=PC1,y=PC2)) +
  geom_point(size = 2, aes(color=Forma))
```


3
2
1
0
−1
−2
−3
−4
−2
0
2
4
PC1
PC2
Forma
Trapecio
U
V