Hierarchical ascendant clustering with FactoMineR (Decathlon example)

Magalie Houée-Bigot & François Husson

Import data (data are imported from internet)

```
decathlon <- read.table("http://www.agrocampus-ouest.fr/math/RforStat/decathlon.csv",
   header=TRUE, sep=";",dec=".", row.names=1, check.names=FALSE)
```

`header=TRUE` : indicates that the file contains the names of the variables

`sep=";"` : indicates the fields separator (usually ";" or "," for csv files)

`dec="."` : indicates the decimal points used in the file

`row.names=1` : indicates the column of the table which contains the row names

It is important to check that the import is well done

```
summary(decathlon)
```

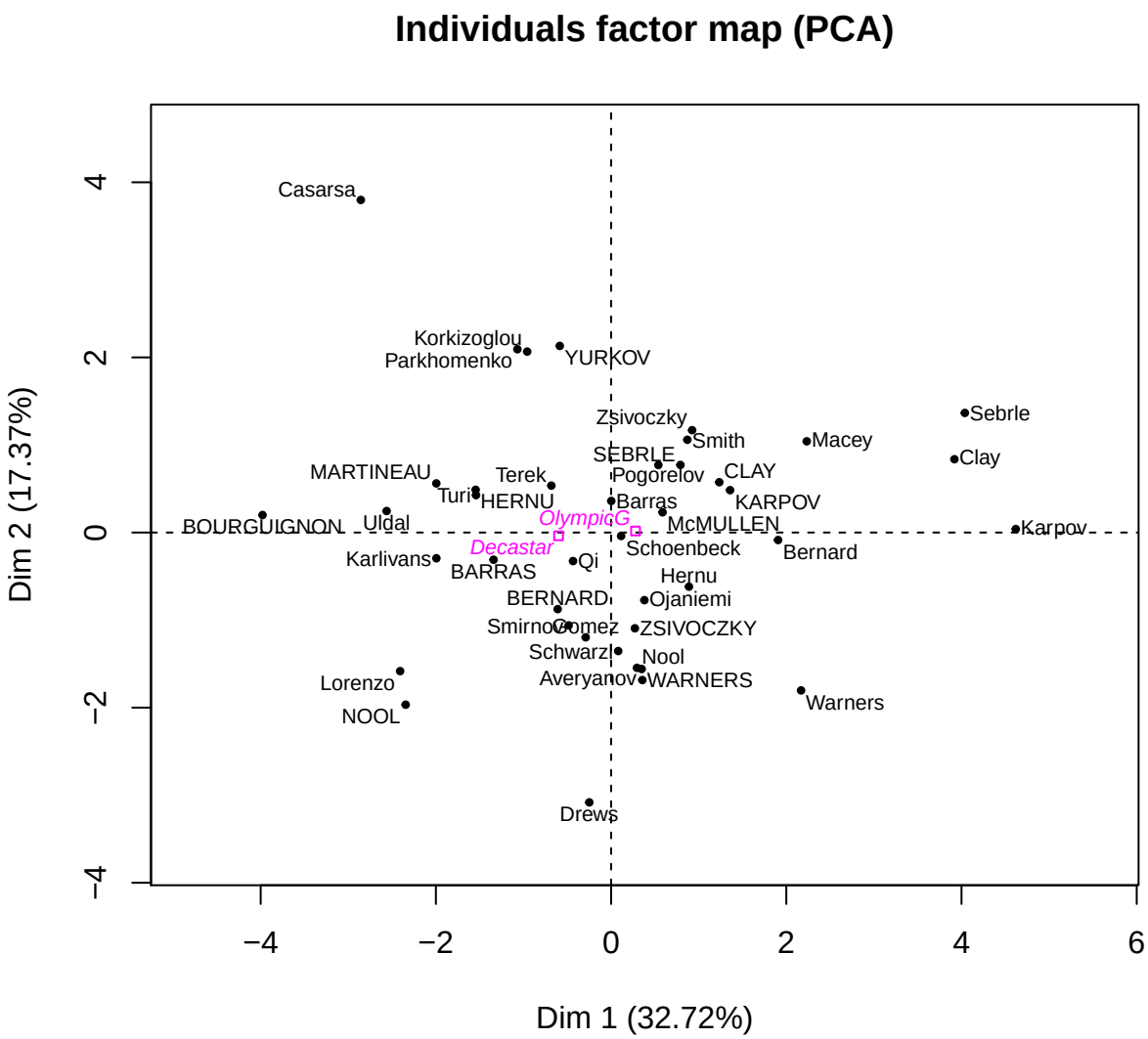
```
##       100m         Long jump       Shot put       High jump
##  Min.   :10.44   Min.   :6.61   Min.   :12.68   Min.   :1.850
##  1st Qu.:10.85   1st Qu.:7.03   1st Qu.:13.88   1st Qu.:1.920
##  Median :10.98   Median :7.30   Median :14.57   Median :1.950
##  Mean   :11.00   Mean   :7.26   Mean   :14.48   Mean   :1.977
##  3rd Qu.:11.14   3rd Qu.:7.48   3rd Qu.:14.97   3rd Qu.:2.040
##  Max.   :11.64   Max.   :7.96   Max.   :16.36   Max.   :2.150
##       400m           110m H          Discus        Pole vault
##  Min.   :46.81   Min.   :13.97   Min.   :37.92   Min.   :4.200
##  1st Qu.:48.93   1st Qu.:14.21   1st Qu.:41.90   1st Qu.:4.500
##  Median :49.40   Median :14.48   Median :44.41   Median :4.800
##  Mean   :49.62   Mean   :14.61   Mean   :44.33   Mean   :4.762
##  3rd Qu.:50.30   3rd Qu.:14.98   3rd Qu.:46.07   3rd Qu.:4.920
##  Max.   :53.20   Max.   :15.67   Max.   :51.65   Max.   :5.400
##     Javeline         1500m            Rank           Points
##  Min.   :50.31   Min.   :262.1   Min.   : 1.00   Min.   :7313
##  1st Qu.:55.27   1st Qu.:271.0   1st Qu.: 6.00   1st Qu.:7802
##  Median :58.36   Median :278.1   Median :11.00   Median :8021
##  Mean   :58.32   Mean   :279.0   Mean   :12.12   Mean   :8005
##  3rd Qu.:60.89   3rd Qu.:285.1   3rd Qu.:18.00   3rd Qu.:8122
##  Max.   :70.52   Max.   :317.0   Max.   :28.00   Max.   :8893
##    Competition
##  Decastar:13
##  OlympicG:28
##
##
##
##
```

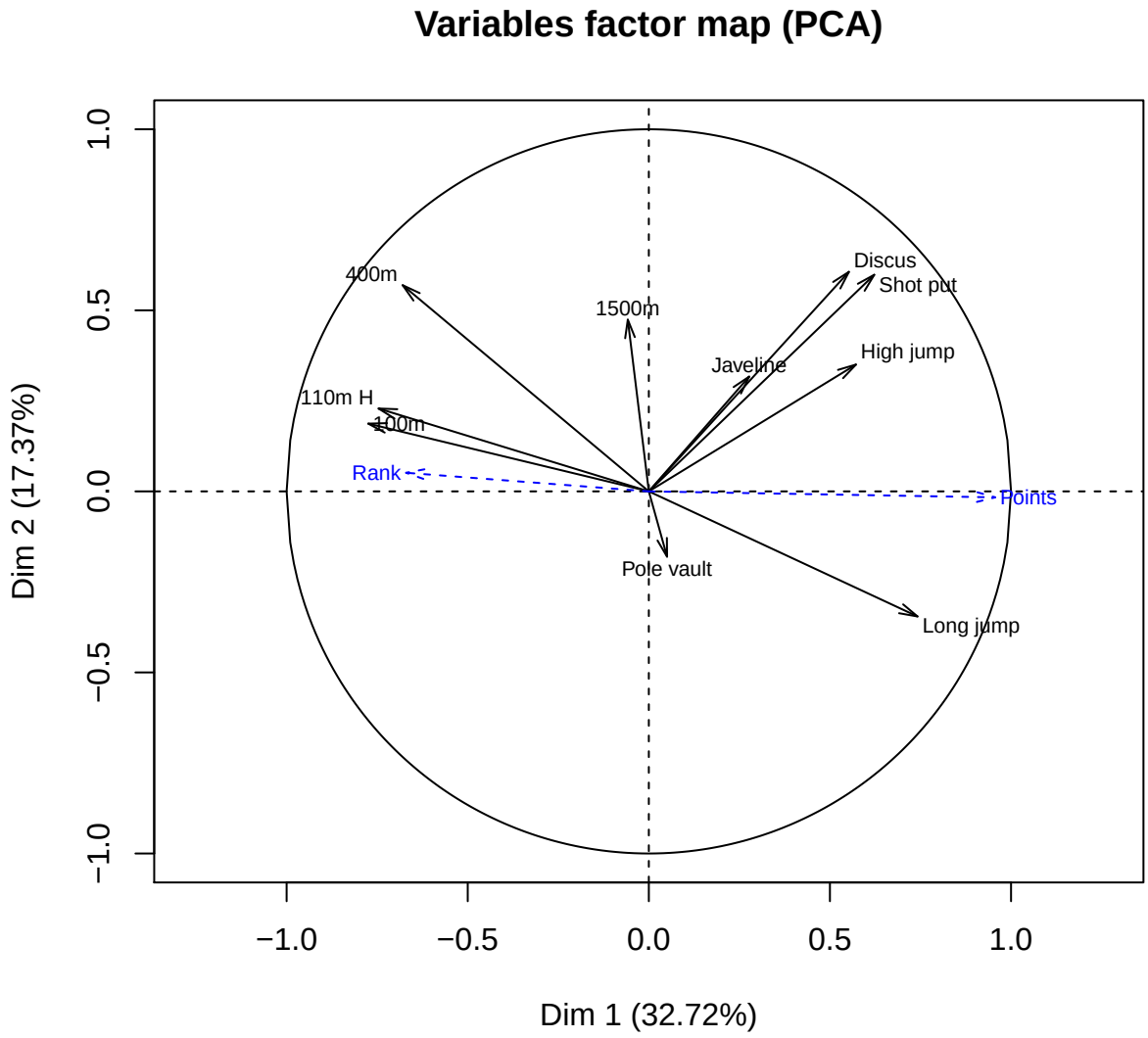
Loading FactoMineR

```
library(FactoMineR)
```

PCA

```
res <- PCA(decathlon, quanti.sup=11:12, quali.sup=13, ncp=Inf)
```






```
res$eig # table of eigenvalues
```

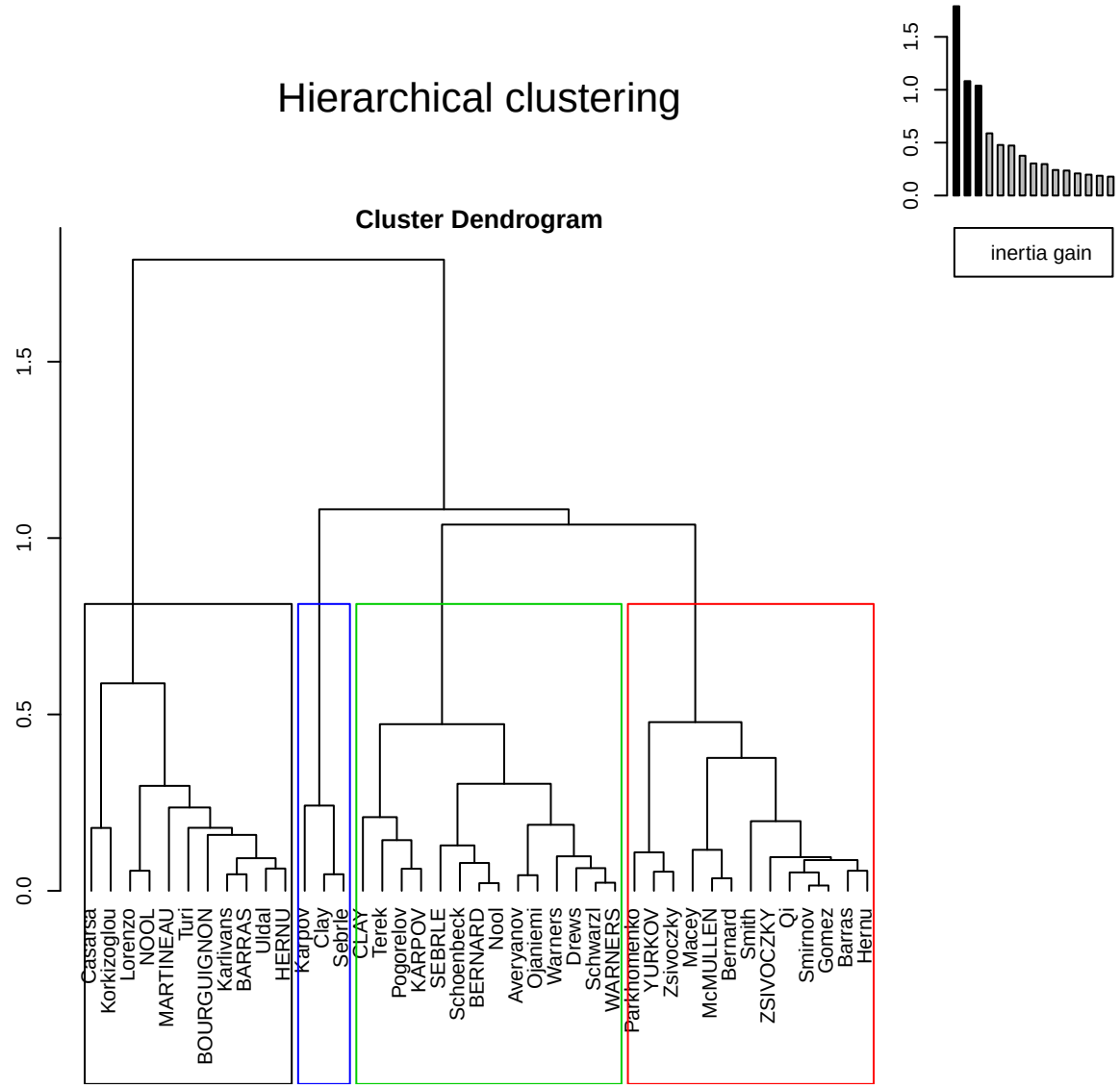
```
##         eigenvalue percentage of variance
## comp 1   3.2719055              32.719055
## comp 2   1.7371310              17.371310
## comp 3   1.4049167              14.049167
## comp 4   1.0568504              10.568504
## comp 5   0.6847735               6.847735
## comp 6   0.5992687               5.992687
## comp 7   0.4512353               4.512353
## comp 8   0.3968766               3.968766
## comp 9   0.2148149               2.148149
## comp 10  0.1822275               1.822275
##         cumulative percentage of variance
## comp 1                           32.71906
## comp 2                           50.09037
```

```
## comp 3                          64.13953
## comp 4                          74.70804
## comp 5                          81.55577
## comp 6                          87.54846
## comp 7                          92.06081
## comp 8                          96.02958
## comp 9                          98.17773
## comp 10                        100.00000
```

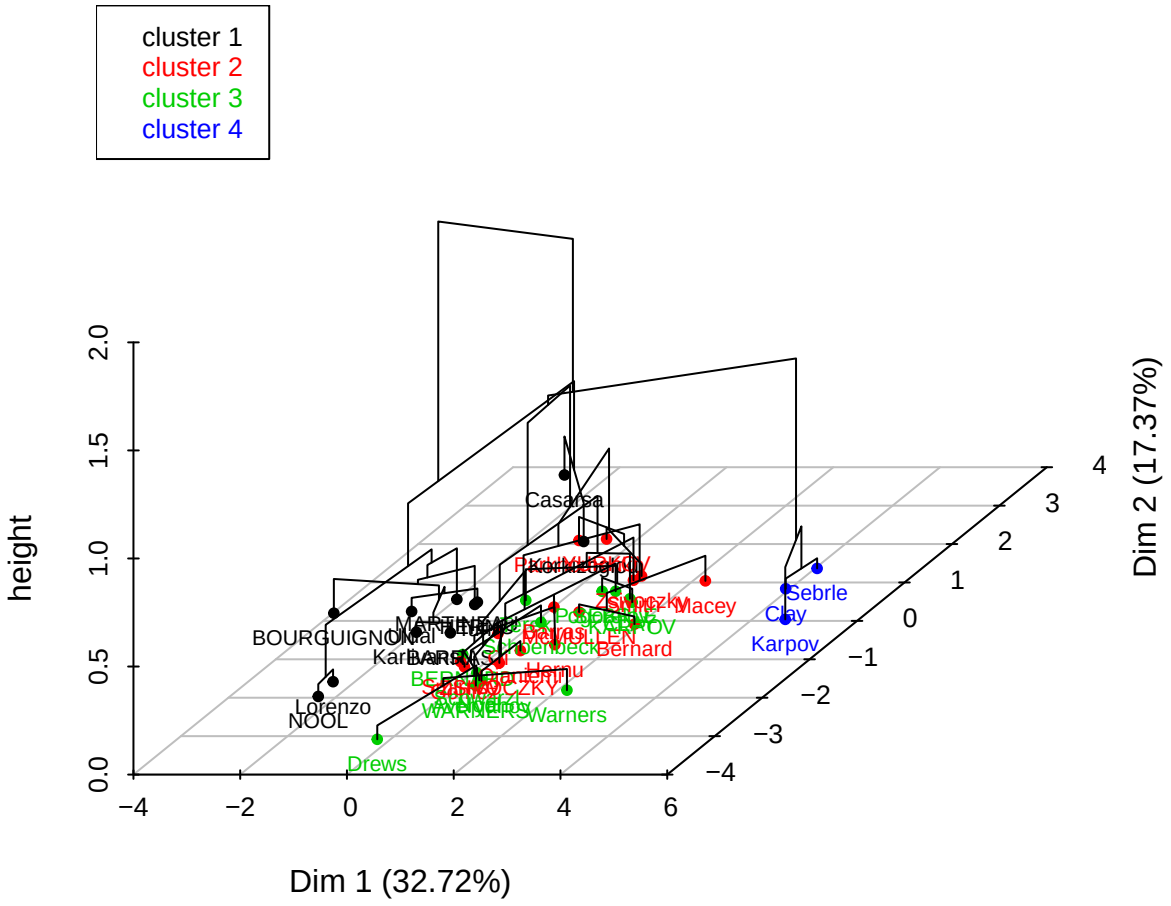
```
# PCA with 8 dimensions kept in the results
res <- PCA(decathlon, quanti.sup=11:12, quali.sup=13, ncp=8, graph=FALSE)
```

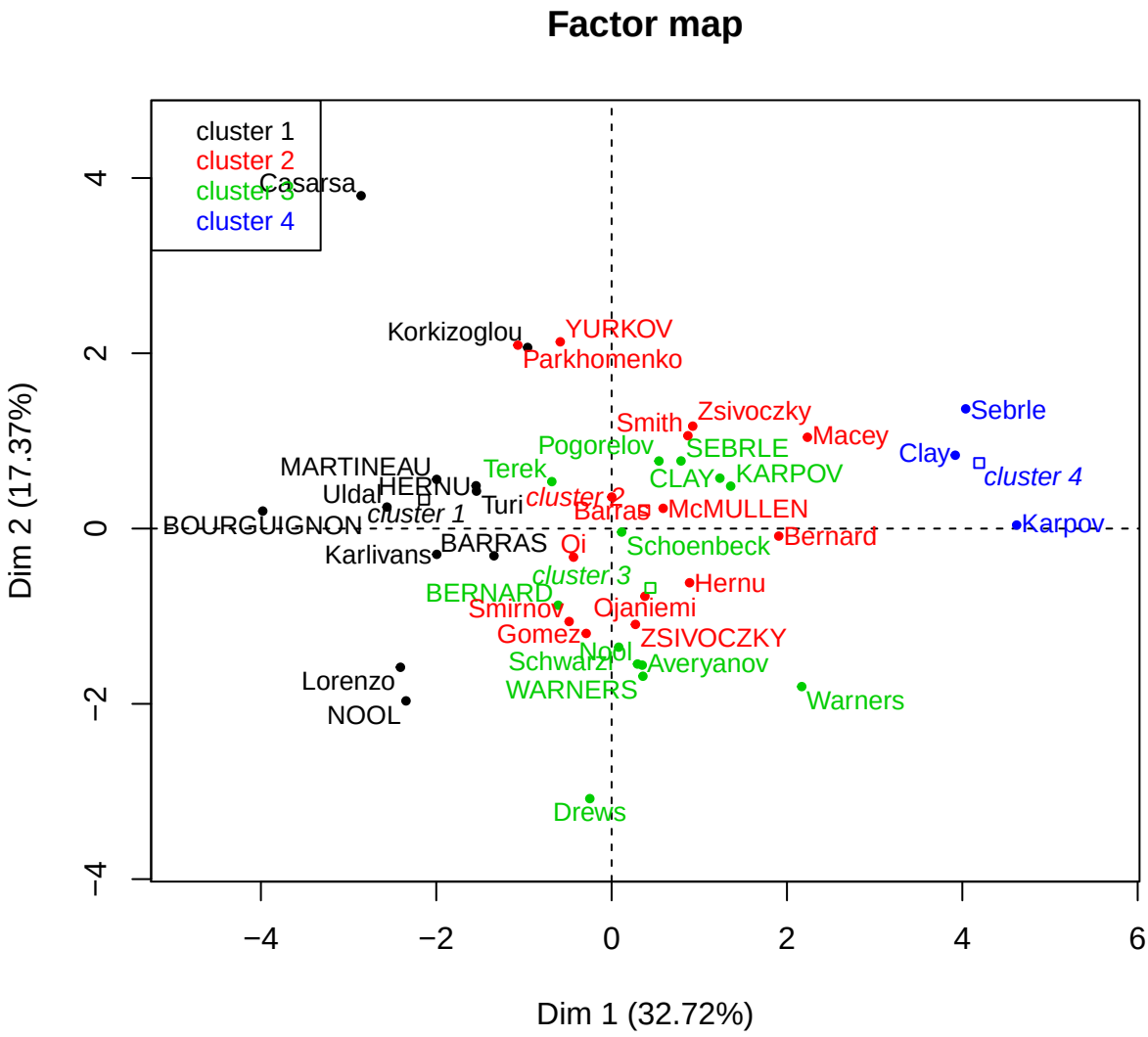
Hierarchical ascendant clustering

```
# Hierarchical ascendant clustering with consolidation
res.hcpc <- HCPC(res, kk=Inf, min=3, max=10, consol=TRUE)
```



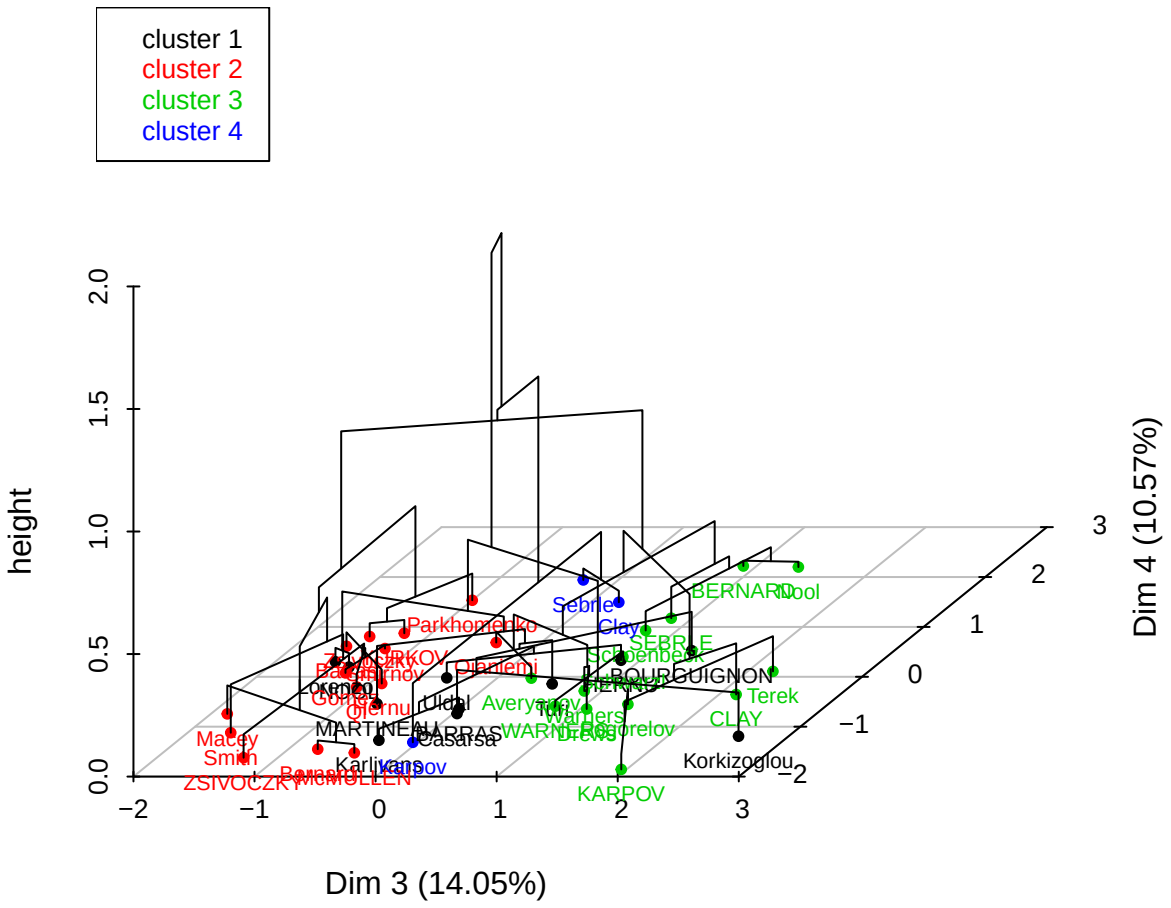
Hierarchical clustering on the factor map





Hierarchical tree on the PCA dimensions 3 and 4

```
plot(res.hcpc, axes=3:4)
```



Outputs

```
names(res.hcpc)
```

```
## [1] "data.clust" "desc.var"   "desc.axes"  "call"       "desc.ind"
```

```
res.hcpc$call$t
```

```
## $res
## **Results for the Principal Component Analysis (PCA)**
## The analysis was performed on 41 individuals, described by 13 variables
## *The results are available in the following objects:
##
```

```
##    name
## 1  "$eig"
## 2  "$var"
## 3  "$var$coord"
## 4  "$var$cor"
## 5  "$var$cos2"
## 6  "$var$contrib"
## 7  "$ind"
## 8  "$ind$coord"
## 9  "$ind$cos2"
## 10 "$ind$contrib"
## 11 "$quanti.sup"
## 12 "$quanti.sup$coord"
## 13 "$quanti.sup$cor"
## 14 "$quali.sup"
## 15 "$quali.sup$coord"
## 16 "$quali.sup$v.test"
## 17 "$call"
## 18 "$call$centre"
## 19 "$call$ecart.type"
## 20 "$call$row.w"
## 21 "$call$col.w"
##    description
## 1  "eigenvalues"
## 2  "results for the variables"
## 3  "coord. for the variables"
## 4  "correlations variables - dimensions"
## 5  "cos2 for the variables"
## 6  "contributions of the variables"
## 7  "results for the individuals"
## 8  "coord. for the individuals"
## 9  "cos2 for the individuals"
## 10 "contributions of the individuals"
## 11 "results for the supplementary quantitative variables"
## 12 "coord. for the supplementary quantitative variables"
## 13 "correlations suppl. quantitative variables - dimensions"
## 14 "results for the supplementary categorical variables"
## 15 "coord. for the supplementary categories"
## 16 "v-test of the supplementary categories"
## 17 "summary statistics"
## 18 "mean of the variables"
## 19 "standard error of the variables"
## 20 "weights for the individuals"
## 21 "weights for the variables"
##
## $tree
##
## Call:
## flashClust::hclust(d = dissi, method = method, members = weight)
##
## Cluster method   : ward
## Distance         : euclidean
## Number of objects: 41
##
```

```
##
## $nb.clust
## [1] 4
##
## $within
##  [1] 9.60295766 7.81359025 6.73201549 5.69384289 5.10568403 4.62753793
##  [7] 4.15518969 3.77848179 3.47508130 3.17757353 2.93601063 2.69982282
## [13] 2.49103892 2.29370340 2.10659252 1.92797387 1.74973452 1.59132327
## [19] 1.44775789 1.31915516 1.20305119 1.09413928 0.99635559 0.90095691
## [25] 0.80853956 0.72143332 0.64254463 0.57837735 0.51529830 0.45271459
## [31] 0.39587815 0.33905840 0.28492784 0.23292321 0.18607536 0.13926531
## [37] 0.09510137 0.05959903 0.03662152 0.01495934
##
## $inert.gain
##  [1] 1.78936741 1.08157476 1.03817260 0.58815886 0.47814610 0.47234824
##  [7] 0.37670790 0.30340049 0.29750778 0.24156290 0.23618781 0.20878390
## [13] 0.19733552 0.18711087 0.17861865 0.17823935 0.15841125 0.14356538
## [19] 0.12860273 0.11610397 0.10891190 0.09778369 0.09539868 0.09241735
## [25] 0.08710624 0.07888869 0.06416729 0.06307905 0.06258371 0.05683644
## [31] 0.05681976 0.05413056 0.05200463 0.04684785 0.04681006 0.04416394
## [37] 0.03550234 0.02297751 0.02166218 0.01495934
##
## $quot
## [1] 1.041806 1.765123 1.230082 1.012275 1.253885 1.241619 1.019807 1.231595
```

The original data with a column called clust containing the partition

```
res.hcpc$data.clust
```

```
##              100m Long jump Shot put High jump  400m 110m H Discus
## Sebrle      10.85      7.84    16.36      2.12 48.36  14.05  48.72
## Clay        10.44      7.96    15.23      2.06 49.19  14.13  50.11
## Karpov      10.50      7.81    15.93      2.09 46.81  13.97  51.65
## Macey       10.89      7.47    15.73      2.15 48.97  14.56  48.34
## Warners     10.62      7.74    14.48      1.97 47.97  14.01  43.73
## Zsivoczky   10.91      7.14    15.31      2.12 49.40  14.95  45.62
## Hernu       10.97      7.19    14.65      2.03 48.73  14.25  44.72
## Nool        10.80      7.53    14.26      1.88 48.81  14.80  42.05
## Bernard     10.69      7.48    14.80      2.12 49.13  14.17  44.75
## Schwarzl    10.98      7.49    14.01      1.94 49.76  14.25  42.43
## Pogorelov   10.95      7.31    15.10      2.06 50.79  14.21  44.60
## Schoenbeck  10.90      7.30    14.77      1.88 50.30  14.34  44.41
## Barras      11.14      6.99    14.91      1.94 49.41  14.37  44.83
## Smith       10.85      6.81    15.24      1.91 49.27  14.01  49.02
## Averyanov   10.55      7.34    14.44      1.94 49.72  14.39  39.88
## Ojaniemi    10.68      7.50    14.97      1.94 49.12  15.01  40.35
## Smirnov     10.89      7.07    13.88      1.94 49.11  14.77  42.47
## Qi          11.06      7.34    13.55      1.97 49.65  14.78  45.13
## Drews       10.87      7.38    13.07      1.88 48.51  14.01  40.11
## Parkhomenko 11.14      6.61    15.69      2.03 51.04  14.88  41.90
## Terek       10.92      6.94    15.15      1.94 49.56  15.12  45.62
## Gomez       11.08      7.26    14.57      1.85 48.61  14.41  40.95
```

```
## Turi        11.08      6.91    13.62      2.03 51.67  14.26  39.83
## Lorenzo     11.10      7.03    13.22      1.85 49.34  15.38  40.22
## Karlivans   11.33      7.26    13.30      1.97 50.54  14.98  43.34
## Korkizoglou 10.86      7.07    14.81      1.94 51.16  14.96  46.07
## Uldal       11.23      6.99    13.53      1.85 50.95  15.09  43.01
## Casarsa     11.36      6.68    14.92      1.94 53.20  15.39  48.66
## SEBRLE      11.04      7.58    14.83      2.07 49.81  14.69  43.75
## CLAY        10.76      7.40    14.26      1.86 49.37  14.05  50.72
## KARPOV      11.02      7.30    14.77      2.04 48.37  14.09  48.95
## BERNARD     11.02      7.23    14.25      1.92 48.93  14.99  40.87
## YURKOV      11.34      7.09    15.19      2.10 50.42  15.31  46.26
## WARNERS     11.11      7.60    14.31      1.98 48.68  14.23  41.10
## ZSIVOCZKY   11.13      7.30    13.48      2.01 48.62  14.17  45.67
## McMULLEN    10.83      7.31    13.76      2.13 49.91  14.38  44.41
## MARTINEAU   11.64      6.81    14.57      1.95 50.14  14.93  47.60
## HERNU       11.37      7.56    14.41      1.86 51.10  15.06  44.99
## BARRAS      11.33      6.97    14.09      1.95 49.48  14.48  42.10
## NOOL        11.33      7.27    12.68      1.98 49.20  15.29  37.92
## BOURGUIGNON 11.36      6.80    13.46      1.86 51.16  15.67  40.49
##             Pole vault Javeline  1500m Rank Points Competition clust
## Sebrle            5.00    70.52 280.01    1   8893    OlympicG     4
## Clay              4.90    69.71 282.00    2   8820    OlympicG     4
## Karpov            4.60    55.54 278.11    3   8725    OlympicG     4
## Macey             4.40    58.46 265.42    4   8414    OlympicG     2
## Warners           4.90    55.39 278.05    5   8343    OlympicG     3
## Zsivoczky         4.70    63.45 269.54    6   8287    OlympicG     2
## Hernu             4.80    57.76 264.35    7   8237    OlympicG     2
## Nool              5.40    61.33 276.33    8   8235    OlympicG     3
## Bernard           4.40    55.27 276.31    9   8225    OlympicG     2
## Schwarzl          5.10    56.32 273.56   10   8102    OlympicG     3
## Pogorelov         5.00    53.45 287.63   11   8084    OlympicG     3
## Schoenbeck        5.00    60.89 278.82   12   8077    OlympicG     3
## Barras            4.60    64.55 267.09   13   8067    OlympicG     2
## Smith             4.20    61.52 272.74   14   8023    OlympicG     2
## Averyanov         4.80    54.51 271.02   15   8021    OlympicG     3
## Ojaniemi          4.60    59.26 275.71   16   8006    OlympicG     2
## Smirnov           4.70    60.88 263.31   17   7993    OlympicG     2
## Qi                4.50    60.79 272.63   18   7934    OlympicG     2
## Drews             5.00    51.53 274.21   19   7926    OlympicG     3
## Parkhomenko       4.80    65.82 277.94   20   7918    OlympicG     2
## Terek             5.30    50.62 290.36   21   7893    OlympicG     3
## Gomez             4.40    60.71 269.70   22   7865    OlympicG     2
## Turi              4.80    59.34 290.01   23   7708    OlympicG     1
## Lorenzo           4.50    58.36 263.08   24   7592    OlympicG     1
## Karlivans         4.50    52.92 278.67   25   7583    OlympicG     1
## Korkizoglou       4.70    53.05 317.00   26   7573    OlympicG     1
## Uldal             4.50    60.00 281.70   27   7495    OlympicG     1
## Casarsa           4.40    58.62 296.12   28   7404    OlympicG     1
## SEBRLE            5.02    63.19 291.70    1   8217    Decastar     3
## CLAY              4.92    60.15 301.50    2   8122    Decastar     3
## KARPOV            4.92    50.31 300.20    3   8099    Decastar     3
## BERNARD           5.32    62.77 280.10    4   8067    Decastar     3
## YURKOV            4.72    63.44 276.40    5   8036    Decastar     2
## WARNERS           4.92    51.77 278.10    6   8030    Decastar     3
```

```
## ZSIVOCZKY         4.42    55.37 268.00    7   8004    Decastar     2
## McMULLEN          4.42    56.37 285.10    8   7995    Decastar     2
## MARTINEAU         4.92    52.33 262.10    9   7802    Decastar     1
## HERNU             4.82    57.19 285.10   10   7733    Decastar     1
## BARRAS            4.72    55.40 282.00   11   7708    Decastar     1
## NOOL              4.62    57.44 266.60   12   7651    Decastar     1
## BOURGUIGNON       5.02    54.68 291.70   13   7313    Decastar     1
```

Description of the clusters by the variables

```
res.hcpc$desc.var
```

```
## $quanti.var
##                 Eta2      P-value
## Points     0.8437383 5.573335e-15
## Pole.vault 0.5764242 4.800164e-07
## 100m       0.5333868 2.775598e-06
## Long.jump  0.5021046 8.970185e-06
## 400m       0.4212961 1.339694e-04
## 110m.H     0.4063919 2.110412e-04
## Shot.put   0.3774738 4.924878e-04
## Rank       0.3754467 5.217813e-04
## Javeline   0.3150077 2.670122e-03
## High.jump  0.3129253 2.816321e-03
## Discus     0.2724198 7.661623e-03
## 1500m      0.2122280 3.007475e-02
##
## $quanti
## $quanti$`1`
##              v.test Mean in category Overall mean sd in category
## 100m       4.035700        11.271818    10.998049     0.19272298
## 400m       3.716021        50.721818    49.616341     1.11838210
## 110m.H     3.605283        15.044545    14.605854     0.38662558
## Rank       3.323127        18.909091    12.121951     7.39108241
## High.jump -2.239384         1.925455     1.976829     0.05836619
## Long.jump -2.796211         7.031818     7.260000     0.24052285
## Shot.put  -2.837963        13.873636    14.477073     0.69580918
## Points    -4.629619      7596.545455  8005.365854   140.51293285
##             Overall sd      p.value
## 100m        0.25979560 5.443985e-05
## 400m        1.13929751 2.023847e-04
## 110m.H      0.46599998 3.118133e-04
## Rank        7.82178048 8.901453e-04
## High.jump   0.08785906 2.513092e-02
## Long.jump   0.31251927 5.170562e-03
## Shot.put    0.81431175 4.540237e-03
## Points    338.18394159 3.663385e-06
##
## $quanti$`2`
##               v.test Mean in category Overall mean sd in category
## High.jump   2.089667         2.017143     1.976829     0.09191833
## 1500m      -2.880815       271.731429   279.024878     5.89983760
```

```
## Pole.vault -3.570803         4.547143     4.762439     0.17527238
##             Overall sd      p.value
## High.jump   0.08785906 0.0366477460
## 1500m      11.53001177 0.0039664846
## Pole.vault  0.27458865 0.0003558891
##
## $quanti$`3`
##              v.test Mean in category Overall mean sd in category
## Pole.vault 4.452686         5.046154     4.762439      0.1763536
##            Overall sd      p.value
## Pole.vault  0.2745887 8.480264e-06
##
## $quanti$`4`
##              v.test Mean in category Overall mean sd in category
## Points     4.242103       8812.66667  8005.365854    68.78145745
## Long.jump  3.468581          7.87000     7.260000     0.06480741
## Discus     3.107539         50.16000    44.325610     1.19668988
## Shot.put   2.974272         15.84000    14.477073     0.46568945
## Javeline   2.586808         65.25667    58.316585     6.87867397
## High.jump  2.289003          2.09000     1.976829     0.02449490
## 110m.H    -2.119695         14.05000    14.605854     0.06531973
## Rank      -2.299627          2.00000    12.121951     0.81649658
## 400m      -2.333955         48.12000    49.616341     0.98634004
## 100m      -2.745523         10.59667    10.998049     0.18080069
##             Overall sd      p.value
## Points    338.18394159 2.214348e-05
## Long.jump   0.31251927 5.232144e-04
## Discus      3.33639725 1.886523e-03
## Shot.put    0.81431175 2.936847e-03
## Javeline    4.76759315 9.686955e-03
## High.jump   0.08785906 2.207917e-02
## 110m.H      0.46599998 3.403177e-02
## Rank        7.82178048 2.146935e-02
## 400m        1.13929751 1.959810e-02
## 100m        0.25979560 6.041458e-03
##
##
## attr(,"class")
## [1] "catdes" "list "
```

Description of the clusters by the axes

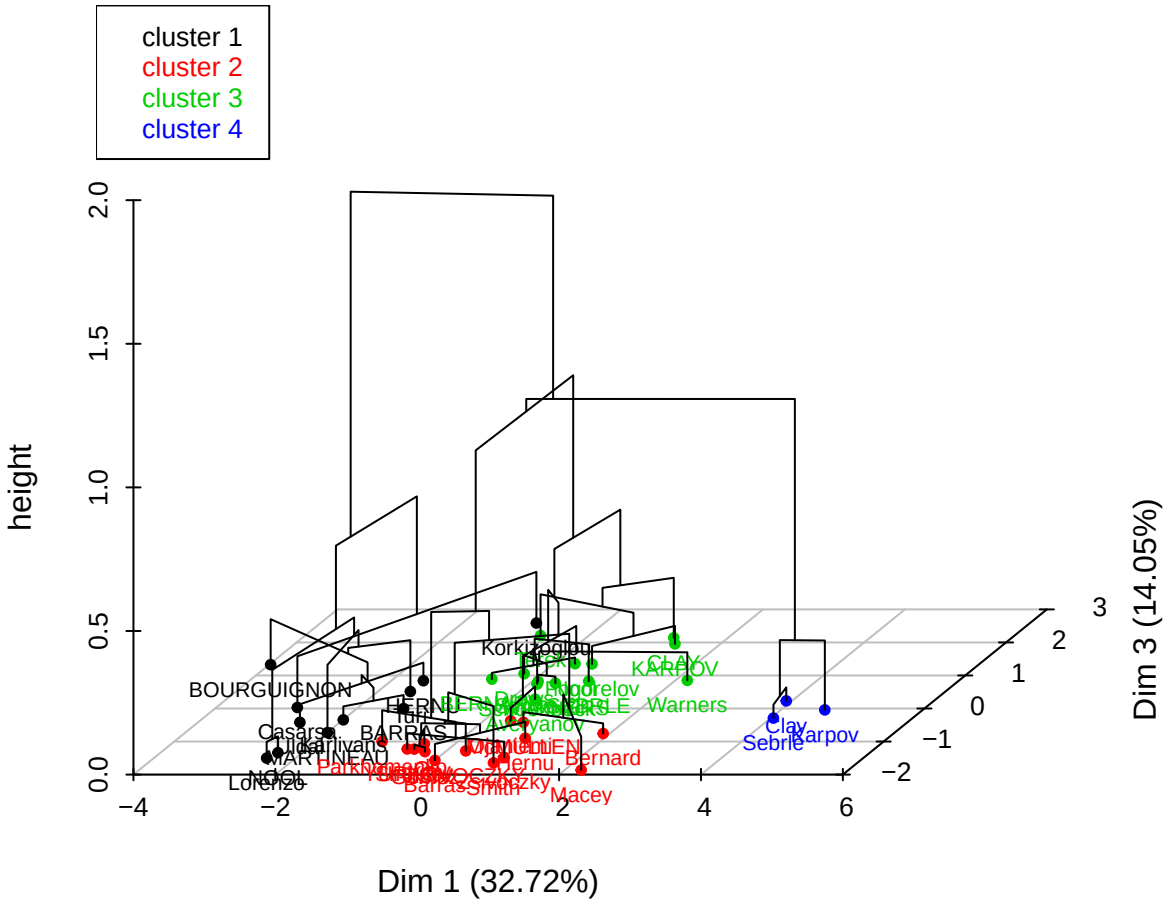
```
res.hcpc$desc.axes
```

```
## $quanti.var
##            Eta2      P-value
## Dim.1 0.8016334 4.493387e-13
## Dim.3 0.6337463 3.403421e-08
##
## $quanti
## $quanti$`1`
##          v.test Mean in category Overall mean sd in category Overall sd
```

```
## Dim.1 -4.528722        -2.138998 5.507535e-16      0.7963714   1.808841
##            p.value
## Dim.1 5.934161e-06
##
## $quanti$`2`
##          v.test Mean in category  Overall mean sd in category Overall sd
## Dim.3 -4.421665        -1.150798 -3.467755e-15      0.4209538   1.185292
##            p.value
## Dim.3 9.794314e-06
##
## $quanti$`3`
##          v.test Mean in category  Overall mean sd in category Overall sd
## Dim.3  4.263406        1.1726255 -3.467755e-15      0.5733819   1.185292
## Dim.2 -2.214701       -0.6773432 -8.316349e-15      1.2114992   1.318003
##            p.value
## Dim.3 0.0000201334
## Dim.2 0.0267805884
##
## $quanti$`4`
##         v.test Mean in category Overall mean sd in category Overall sd
## Dim.1 4.118906           4.1926 5.507535e-16      0.3060936   1.808841
##            p.value
## Dim.1 3.806749e-05
##
##
## attr(,"class")
## [1] "catdes" "list "
```

Hierarchical tree on the PCA dimensions 1 and 3

```
plot(res.hcpc,axes=c(1,3))
```



Description of the clusters by the individuals

```
res.hcpc$desc.ind
```

```
## $para
## Cluster: 1
##       Uldal      BARRAS   Karlivans       HERNU BOURGUIGNON
##    1.435595    1.538945    1.548147    1.757527    2.451654
## ------------------------------------------------------------
## Cluster: 2
##     Hernu        Qi    Barras   Smirnov Zsivoczky
##  1.503952  1.656106  1.663715  1.745507  1.819434
## ------------------------------------------------------------
## Cluster: 3
```

```
##   Schwarzl Schoenbeck    WARNERS  Pogorelov  Averyanov
##   1.088834   1.562252   1.651209   2.072228   2.143060
## ------------------------------------------------------------
## Cluster: 4
##     Clay   Sebrle   Karpov
## 1.535603 1.692349 2.569576
##
## $dist
## Cluster: 1
##     Casarsa BOURGUIGNON Korkizoglou   MARTINEAU        NOOL
##    5.083775    4.582906    4.041168    3.897578    3.884405
## ------------------------------------------------------------
## Cluster: 2
##       Smith Parkhomenko   Zsivoczky       Macey     Bernard
##    4.400988    3.607607    3.489667    3.365448    3.291086
## ------------------------------------------------------------
## Cluster: 3
##     CLAY    Drews   KARPOV     Nool    Terek
## 4.165973 4.111160 3.918168 3.894664 3.545632
## ------------------------------------------------------------
## Cluster: 4
##   Karpov   Sebrle     Clay
## 4.780916 4.610899 4.508333
```