Mise en œuvre de la classification (TP SAS)

Classification automatique sur un tableau présence absence

Il s'agit d'un tableau ayant comme individus des souches bactériennes, certaines étant étudiées au labo et inconnues, d'autres étant des souches de référence, issues de collection et parfaitement identifiées.

Les variables sont des critères biochimiques (croissance sur un substrat donné, à une température donnée, production de gaz, ...). Chaque souche peut répondre positivement (1) ou non (0) sur le test biochimique. L'objectif est de voir quelles sont les souches proches (dans le même groupe de la classification) des souches de collection (étiquetées T).

Les souches proches sont étudiées plus finement par une hybridation ADN/ADN pour valider leur appartenance à la même espèce bactérienne.

La classification est donc ici utilisée comme méthode de débroussaillage, l'hybridation étant lourde et coûteuse.

Acquisition et transformation des données

```
title1 "stat/jaccard6";

%include "stat/jaccard+"; /* inclusion du programme permettant */
                          /* de faire des beaux arbres         */

footnote;

data naza1a;
  infile "/nom du répertoire/deer301.prn" firstobs=2;
  input sou $ c4 c5 c6 c10 c12 c13 c18 c21-c28;

data naza1b;
  infile "/nom du répertoire/deer302.prn" firstobs=2;
  input c30-c37 c39 c40 e3 e4 e7 e8 e10 e11;

data naza1;
  merge naza1a naza1b;
run;

title2 "tableau d'origine";
proc print;
run;
```



```
stat/jaccard6                                  1
                              tableau d'origine
                                        11:45 Monday, October 20, 1997

      O  S  C C C C C C C C C C C C C C C C C C C C C C C C C C E E E E E E
      B  O  4 5 6 1 1 1 1 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 4 3 4 7 8 1 1
      S  U        0 2 3 8 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 9 0         0 1

      1 B2  0 0 0 1 1 1 0 1 0 0 0 1 0 0 1 1 1 0 0 1 1 1 1 0 1 1 1 1 0 0 0
      2 B4  0 0 0 1 1 0 1 1 0 0 0 1 0 0 1 1 1 1 0 1 1 1 1 0 1 1 1 1 0 0 0
      3 B5  0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 1 1 1 1 0 1 1 1 1 1 0 0
      4 B7  0 0 0 1 1 0 0 1 1 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 0 0 0
      5 B8  0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 1 1 0 0 0 1 1 1 0 1 1 1 1 1 0 0
      6 B10 0 0 0 1 1 0 0 1 0 0 1 1 0 0 1 1 1 1 0 0 0 1 1 1 1 0 1 0 0 1 1 0 0
      7 B11 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 1 0 0
      8 B12 0 0 0 1 1 0 0 1 0 0 1 1 1 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 1 0 0
      9 B14 0 0 0 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 0 0
     10 B15 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 0 0
     11 B16 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 0 0
     12 B17 1 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 0 1
     13 B18 0 0 0 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 0 0 0
     14 B21 0 0 0 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 0 0 0
     15 B25 1 0 0 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 1 0 0
     16 B26 0 1 0 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 1 0 0 0
     17 B27 0 0 1 1 1 0 0 1 0 0 0 1 1 0 1 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 0 0
     18 B29 1 1 1 1 0 0 0 0 0 0 0 0 1 0 0 1 1 0 0 0 0 1 1 1 1 0 0 1 1 1 1 0 0
     19 T32 1 1 1 1 1 1 0 0 1 0 0 0 1 0 0 1 1 1 1 0 0 0 1 0 0 0 0 0 1 1 1 1 0 0
     20 T33 0 1 0 0 1 1 1 0 0 0 1 1 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0
     21 T34 0 0 0 1 1 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0
     22 T35 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 0 0 1 1 0 0 0 0
     23 T39 0 1 0 1 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 0 1 1 1 1 0 0 0
     24 B9  0 0 0 1 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 0 1 1 1 1 1 0 0
     25 B19 1 0 0 1 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 1 0 0
     26 T37 1 1 1 1 1 0 1 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 0 1 1 0 0 1 1 1 1 0 0 0
     27 T42 1 1 1 1 1 1 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 1 1 1 0 0 1 1 1 1 0 0 0
     28 T43 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 1 1 0 1 0 0 0 0 0 0
     29 T44 1 1 1 1 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 1 0 0 0 1 1 1 1 0 1 1 1 1 1 0 0
     30 T45 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 0 0 1 1 1 1 0 0 1 0 0 0 1 1 1 1 1 1 0 0
      .   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Étape de classification (CAH, centres mobiles, mixte, Jaccard)

La classification automatique sera abordée de plusieurs façons :

- À partir des composantes des individus obtenues après l'AFC sur le tableau des indicatrices,
  - classification type nuées dynamiques,
  - classification hiérarchique (critère de Ward).
  - classification mixte : CAH puis nuées dynamiques.
- Enfin, classification sur les données brutes, non plus sur une matrice de distance euclidienne, mais avec l'indice de similarité de Jaccard comme matrice de distance.

ACM et récupération des coordonnées sur les axes factoriels

```
title2 "AFC sur tableau d'origine";
proc corresp data=naza1 observed outc=coor dim=31;
  tables sou , c4 c5 c6 c10 c12 c13 c18 c21-c28 c30-c37 c39 c40
               e3 e4 e7 e8 e10 e11;
run;
```

```
stat/jaccard6                              3
                          AFC sur tableau d'origine
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                    The Correspondence Analysis Procedure
stat/jaccard6                              4
                          AFC sur tableau d'origine
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                              Contingency Table

              0         1         0         1         0         1         .

  B10         1         0         1         0         1         0         .
  B11         1         0         1         0         1         0         .
  B12         1         0         1         0         1         0         .
  B13         1         0         1         0         1         0         .
  B14         1         0         1         0         1         0         .
  B15         1         0         1         0         1         0         .
  B16         1         0         1         0         1         0         .
  B17         0         1         1         0         1         0         .
  B18         1         0         1         0         1         0         .
  B19         0         1         1         0         1         0         .
  B2          1         0         1         0         1         0         .
  B20         0         1         0         1         0         1         .
  B21         1         0         1         0         1         0         .
  B25         0         1         1         0         1         0         .
  B26         1         0         0         1         1         0         .
  B27         1         0         1         0         0         1         .
  B29         0         1         0         1         0         1         .
  B30         1         0         1         0         1         0         .
  B4          1         0         1         0         1         0         .
  B5          1         0         1         0         1         0         .
  .           .         .         .         .         .         .         .
```

```
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                        AFC sur tableau d'origine
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                    The Correspondence Analysis Procedure

                     Inertia and Chi-Square Decomposition

       Singular  Principal Chi-
       Values    Inertias  Squares Percents    3    6    9   12   15
                                               ----+----+----+----+----+---
       0.39665   0.15733   351.157  15.73% *************************
       0.34628   0.11991   267.634  11.99% ********************
       0.27675   0.07659   170.948   7.66% *************
       0.25987   0.06753   150.728   6.75% ***********
       0.24759   0.06130   136.818   6.13% **********
       0.24245   0.05878   131.196   5.88% **********
       0.22407   0.05021   112.058   5.02% ********
       0.20666   0.04271    95.327   4.27% *******
       0.19962   0.03985    88.943   3.98% *******
       0.18462   0.03408    76.073   3.41% ******
       0.17979   0.03232    72.146   3.23% *****
       0.17043   0.02904    64.828   2.90% *****
       0.16354   0.02674    59.694   2.67% ****
       0.15840   0.02509    56.004   2.51% ****
       0.15131   0.02289    51.099   2.29% ****
       0.14122   0.01994    44.515   1.99% ***
       0.13692   0.01875    41.842   1.87% ***
       0.12881   0.01659    37.031   1.66% ***
       0.12192   0.01486    33.177   1.49% **
       0.11937   0.01425    31.806   1.42% **
       0.11591   0.01344    29.987   1.34% **
       0.11122   0.01237    27.612   1.24% **
       0.10446   0.01091    24.353   1.09% **
       0.09356   0.00875    19.537   0.88% *
       0.07736   0.00598    13.358   0.60% *
       0.07397   0.00547    12.211   0.55% *
       0.06919   0.00479    10.684   0.48% *
       0.05863   0.00344     7.671   0.34% *
       0.05568   0.00310     6.920   0.31% *
       0.04625   0.00214     4.774   0.21%
       0.02891   0.00084     1.866   0.08%
                 -------   -------
                 1.00000      2232 (Degrees of Freedom = 4331)
```



```
title2 "Table issue de AFC sur tableau d'origine";
proc print data=coor(obs=10 drop=dim3-dim31
                            contr3-contr31
                            sqcos3-sqcos31
                            best3-best31);
run;

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                Table issue de AFC sur tableau d'origine
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 OBS   _TYPE_    _NAME_   QUALITY     MASS     INERTIA     DIM1      DIM2

   1   INERTIA                .        .       1.00000      .         .
   2   OBS        B10         1      0.013889   0.01360   -0.31919   0.03527
   3   OBS        B11         1      0.013889   0.00332   -0.32436   0.07125
   4   OBS        B12         1      0.013889   0.00940   -0.14547  -0.37360
   5   OBS        B13         1      0.013889   0.00639   -0.33562   0.17287
   6   OBS        B14         1      0.013889   0.00357   -0.34549  -0.05197
   7   OBS        B15         1      0.013889   0.00463   -0.39893   0.06801
   8   OBS        B16         1      0.013889   0.00463   -0.39893   0.06801
   9   OBS        B17         1      0.013889   0.02436   -0.31645   0.13499
  10   OBS        B18         1      0.013889   0.01960   -0.46900  -0.31600

 OBS    CONTR1     CONTR2     SQCOS1     SQCOS2    BEST1    BEST2   BEST

   1   0.15733    0.11991      .          .          .        .       .
   2   0.00899    0.00014    0.10402    0.00127       0        0      21
   3   0.00929    0.00059    0.44073    0.02127       0        0      24
   4   0.00187    0.01617    0.03126    0.20620       0        0      28
   5   0.00994    0.00346    0.24492    0.06498       0        0       8
   6   0.01054    0.00031    0.46447    0.01051       1        0       1
   7   0.01405    0.00054    0.47776    0.01389      17        0      17
   8   0.01405    0.00054    0.47776    0.01389      17        0      17
   9   0.00884    0.00211    0.05709    0.01039       0        0      18
  10   0.01942    0.01157    0.15589    0.07077      10        0      10
```

Classification type nuées dynamiques sur l'ensemble des axes de l'AFC

```
title2 "nuées dynamiques issues des 31 axes factoriels de l'AFC";
run;
proc fastclus data=coor out=fast maxc=10 maxiter=7;
  where _type_ ='OBS';
  var dim1-dim31;
*  id sou;
  id _name_;
run;
```

```
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          nuées dynamiques issues des 31 axes factoriels de l'AFC
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   FASTCLUS Procedure:  Replace=FULL  Radius=0  Maxclusters=10 Maxiter=7
   Converge=0.02

                              Initial Seeds

Cluster    DIM1      DIM2      DIM3      DIM4      DIM5      DIM6      DIM7
--------------------------------------------------------------------------------
  1    0.337804  -.863009  0.097716  0.309637  -.092377  -.156062 0.029758
  2    -.319708  0.250199  0.104562  -.099779  -.354578  0.346817 -.311919
  3    0.624581  0.163032  -.289353  -.202054  -.051459  0.464818 0.125827
  4    0.526985  0.592662  0.159685  -.498219  0.165119  -.362227 -.276851
  5    -.106312  -.153132  0.387630  0.058134  -.283583  -.483853 0.983428
  6    -.518847  0.085990  0.003241  0.291296  0.513071  0.318467 -.057283
  7    0.977188  0.143284  0.333528  -.279175  -.503057  0.563297 -.190134
  8    0.029478  -.540695  -.421014  -.136465  0.644237  -.297051 -.046736
  9    0.489193  0.402006  0.216780  0.677414  0.222006  -.356101 -.106308
 10    0.467048  -.614003  0.151712  -.524233  0.569173  0.350179 0.308028
```



```
            Minimum Distance Between Initial Seeds = 1.508092

                        Relative Change in Cluster Seeds
 Iteration   Criterion        1         2         3         4         5
                              6         7         8         9        10

--------------------------------------------------------------------------------
        1       0.1974    0.4848    0.6049    0.5312    0.4887    0.4572
                          0.4821    0.4356    0.3281    0.5437         0

        2       0.1347    0.1018    0.0486    0.1551         0    0.2838
                          0.1247         0         0         0         0

        3       0.1322         0    0.0122         0         0         0
                          0.0456         0         0         0         0

        4       0.1320         0    0.0255         0         0         0
                          0.1328         0         0         0         0

        5       0.1311         0    0.0274    0.0626         0         0
                          0.1268         0         0         0         0

        6       0.1305         0         0         0         0         0
                               0         0         0         0         0

                Convergence criterion is satisfied.

               Criterion Based on Final Seeds = 0.13048
```

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FASTCLUS Procedure: Replace=FULL Radius=0 Maxclusters=10 Maxiter=7
Converge=0.02

Cluster Summary

Cluster	Frequency	RMS Std Deviation	Maximum Distance from Seed to Observation	Nearest Cluster	Distance Between Cluster Centroids
1	8	0.1664	1.0767	2	0.9979
2	35	0.1212	1.0240	3	0.8161
3	8	0.1524	0.8945	2	0.8161
4	5	0.1619	0.9208	9	0.9978
5	2	0.1712	0.6742	2	1.2405
6	6	0.1628	1.0732	2	0.8197
7	2	0.1669	0.6569	4	1.2289
8	2	0.1257	0.4948	2	1.1689
9	3	0.1725	0.8199	4	0.9978
10	1	.	0	1	1.4407

Statistics for Variables

Variable	Total STD	Within STD	R-Squared	RSQ/(1-RSQ)
DIM1	0.399430	0.167213	0.846964	5.534406
DIM2	0.348707	0.195521	0.725464	2.642513
DIM3	0.278691	0.222673	0.442528	0.793811
DIM4	0.261690	0.184018	0.568204	1.315907
DIM5	0.249323	0.177657	0.556623	1.255417
DIM6	0.244147	0.164908	0.601605	1.510071
DIM7	0.225637	0.171138	0.497655	0.990663
DIM8	0.208113	0.152104	0.533535	1.143785
DIM9	0.201023	0.187609	0.239408	0.314765
DIM10	0.185912	0.154743	0.395021	0.652950
DIM11	0.181049	0.172987	0.202793	0.254379
DIM12	0.171622	0.165192	0.190967	0.236043
DIM13	0.164686	0.155145	0.225007	0.290335
DIM14	0.159514	0.159323	0.128854	0.147913
DIM15	0.152369	0.153053	0.118905	0.134951
DIM16	0.142215	0.146562	0.072562	0.078239
DIM17	0.137878	0.132513	0.193397	0.239768
DIM18	0.129710	0.124005	0.201895	0.252968
DIM19	0.122774	0.122490	0.130802	0.150486
DIM20	0.120211	0.122458	0.093816	0.103528
DIM21	0.116723	0.122401	0.039740	0.041385
DIM22	0.112005	0.115694	0.068297	0.073303
DIM23	0.105189	0.107718	0.084268	0.092022
DIM24	0.0942156	0.0991519	0.032860	0.033976
DIM25	0.0779056	0.0819636	0.033419	0.034574
DIM26	0.0744859	0.0781559	0.038589	0.040137
DIM27	0.0696720	0.0728353	0.045664	0.047849
DIM28	0.0590368	0.0618250	0.042331	0.044202
DIM29	0.0560713	0.0583931	0.052942	0.055902
DIM30	0.0465732	0.0478222	0.079296	0.086126
DIM31	0.0291172	0.0307008	0.029191	0.030069
OVER-ALL	0.180866	0.140605	0.472259	0.894870

```
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   FASTCLUS Procedure:  Replace=FULL  Radius=0  Maxclusters=10 Maxiter=7
   Converge=0.02

                          Statistics for Variables

                                  Pseudo F Statistic =     6.16
             Approximate Expected Over-All R-Squared =  0.46655
                          Cubic Clustering Criterion =    0.455
     WARNING: The two above values are invalid for correlated variables.

                                Cluster Means

Cluster    DIM1      DIM2      DIM3      DIM4      DIM5      DIM6      DIM7
-------------------------------------------------------------------------------
  1    0.477809  -.585246  0.109903  0.189902  -.053914  -.036889 -.054324
  2    -.267119  -.013165  0.028424  -.056893  -.081255  -.010711 -.054383
  3    0.231743  0.051420  -.477447  -.001335  0.032041  0.234669 0.181257
  4    0.561251  0.565100  0.178846  -.247038  0.137272  -.174213 -.137852
  5    -.211382  -.009071  0.031916  -.094835  -.238779  -.561331 0.707652
  6    -.325346  0.262394  0.194529  0.372981  0.261226  0.248331 0.092542
  7    0.862391  0.209921  0.066677  -.338026  -.490274  0.319847 -.253780
  8    -.219759  -.428349  -.183979  -.231613  0.590340  -.232107 -.133327
  9    0.496345  0.466836  -.032280  0.444396  0.157813  -.409753 0.024276
 10    0.467048  -.614003  0.151712  -.524233  0.569173  0.350179 0.308028

                        Cluster Standard Deviations

Cluster    DIM1      DIM2      DIM3      DIM4      DIM5      DIM6      DIM7
-------------------------------------------------------------------------------
  1    0.240207  0.293729  0.178111  0.307051  0.180260  0.117650 0.151047
  2    0.135415  0.158182  0.202739  0.124794  0.139174  0.132442 0.160521
  3    0.193530  0.130137  0.170800  0.241935  0.254970  0.279967 0.153972
  4    0.198506  0.180857  0.164886  0.181085  0.176988  0.241738 0.114429
  5    0.148592  0.203734  0.503055  0.216331  0.063362  0.109570 0.390006
  6    0.149953  0.332798  0.288702  0.190883  0.303727  0.070813 0.212731
  7    0.162348  0.094238  0.377384  0.083228  0.018078  0.344290 0.090010
  8    0.352474  0.158881  0.335218  0.134559  0.076222  0.091845 0.122457
  9    0.025277  0.135465  0.329418  0.239896  0.097604  0.152169 0.283084
 10     .         .         .         .         .         .         .
```
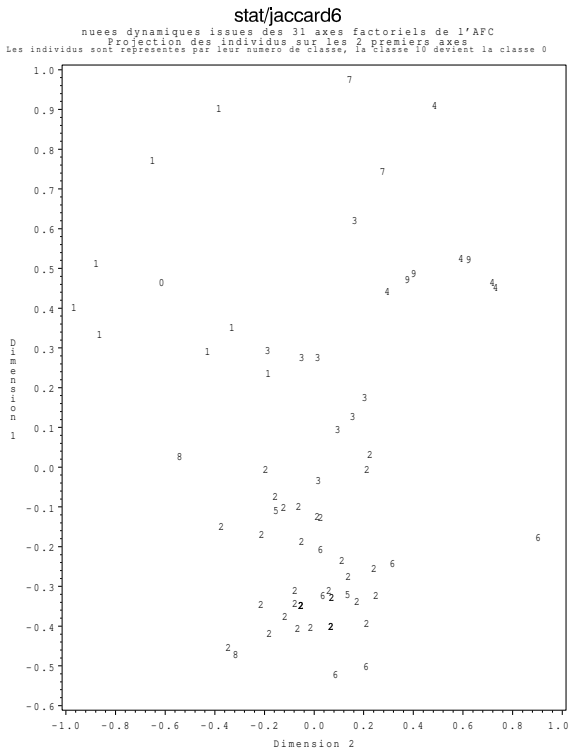


Projection des individus

```
/* cette etape permet de projeter les individus sur les axes */
data fast2;
  set fast;
clus=put(cluster,2.);   * text ne peut prendre que des chaines de;
text = substr(clus,2);  * caracteres. On traduit donc cluster en clus;

*text=_name_;        * Cette ligne aurait fait imprimer le numero des ;
                     * individus au lieu de celui des classes.;
y = dim1;
x = dim2;
xsys = '2';
ysys = '2';
size = 1;
label y = "Dimension 1";
label x = "Dimension 2";
keep x y text xsys ysys size;
run;
*proc print;
*run;
filename figure "plot1.eps";
title3 "Projection des individus sur les 2 premiers axes";
title4 "Les individus sont representes par leur numero de classe, la "
       "classe 10 devient la classe 0";
proc gplot data=fast2;
  symbol1 i=none;
  plot y*x=1 / annotate=fast2 frame;
run;
quit;
```



CAH sur les composantes principales

```
title2 "CAH (critere de Ward) issue des 31 axes factoriels de l'AFC";
proc cluster data=coor
             outtree=treeward
             method=ward;
  where _type_ ='OBS';
  var dim1-dim31;
*  id sou;
  id _name_;
run;
*proc print data=treeward;
*title3 "treeward";
*run;
```

Ward's Minimum Variance Cluster Analysis
Eigenvalues of the Covariance Matrix

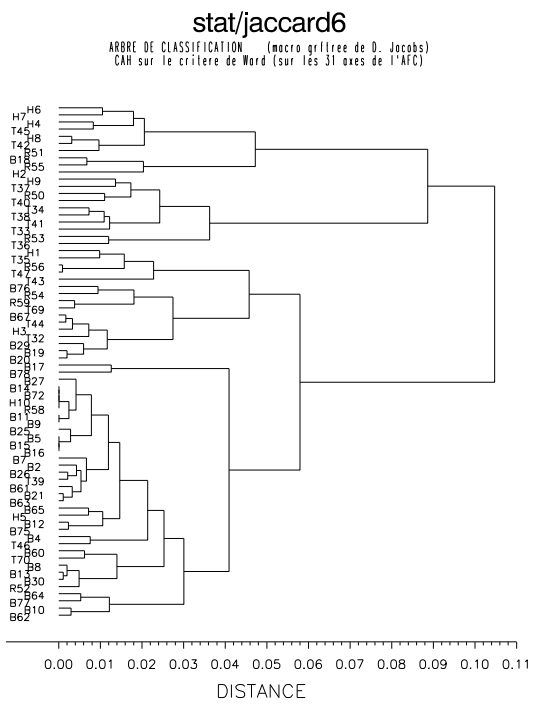
	Eigenvalue	Difference	Proportion	Cumulative
1	0.159544	0.037948	0.157328	0.15733
2	0.121596	0.043928	0.119908	0.27724
3	0.077668	0.009187	0.076590	0.35383
4	0.068482	0.006320	0.067530	0.42136
5	0.062162	0.002554	0.061298	0.48265
6	0.059608	0.008695	0.058780	0.54143
7	0.050912	0.007601	0.050205	0.59164
8	0.043311	0.002901	0.042709	0.63435
9	0.040410	0.005847	0.039849	0.67420
10	0.034563	0.001784	0.034083	0.70828
11	0.032779	0.003325	0.032323	0.74060
12	0.029454	0.002333	0.029045	0.76965
13	0.027121	0.001677	0.026745	0.79639
14	0.025445	0.002228	0.025091	0.82149
15	0.023216	0.002991	0.022894	0.84438
16	0.020225	0.001215	0.019944	0.86432
17	0.019010	0.002186	0.018746	0.88307
18	0.016825	0.001751	0.016591	0.89966
19	0.015073	0.000623	0.014864	0.91452
20	0.014451	0.000826	0.014250	0.92877
21	0.013624	0.001079	0.013435	0.94221
22	0.012545	0.001480	0.012371	0.95458
23	0.011065	0.002188	0.010911	0.96549
24	0.008877	0.002807	0.008753	0.97424
25	0.006069	0.000521	0.005985	0.98023
26	0.005548	0.000694	0.005471	0.98570
27	0.004854	0.001369	0.004787	0.99049
28	0.003485	0.000341	0.003437	0.99392
29	0.003144	0.000975	0.003100	0.99703
30	0.002169	0.001321	0.002139	0.99916
31	0.000848	.	0.000836	1.00000

Root-Mean-Square Total-Sample Standard Deviation = 0.180866
Root-Mean-Square Distance Between Observations = 1.424138

Ward's Minimum Variance Cluster Analysis

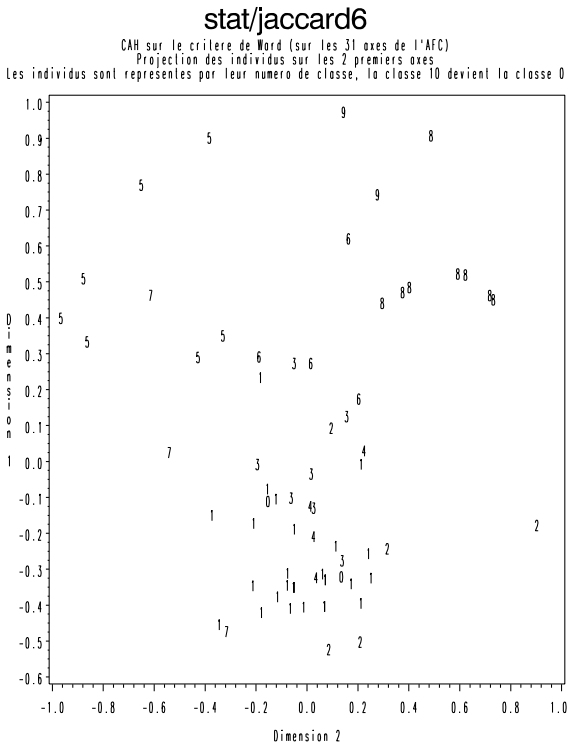
Number of Clusters	Clusters Joined		Frequency of New Cluster	Semipartial R-Squared	R-Squared	Tie
71	B15	B16	2	0.000000	1.000000	T
70	CL71	B5	3	0.000000	1.000000	T
69	B14	B72	2	0.000000	1.000000	T
68	B11	B9	2	0.000000	1.000000	T
67	CL69	H10	3	0.000000	1.000000	T
66	CL67	R58	4	0.000000	1.000000	
65	R56	T47	2	0.000914	0.999086	
64	B13	B30	2	0.001084	0.998002	
63	B21	B63	2	0.001117	0.996885	
62	B67	T44	2	0.001731	0.995155	
61	B19	B20	2	0.002006	0.993149	
60	CL64	B8	3	0.002017	0.991131	
59	B26	T39	2	0.002156	0.988976	
58	B12	B75	2	0.002359	0.986617	
57	CL68	CL66	6	0.002436	0.984180	
56	CL70	B25	4	0.002827	0.981353	
55	B10	B62	2	0.002962	0.978392	
54	H8	T42	2	0.003115	0.975277	
53	CL63	B61	3	0.003246	0.972031	
52	CL62	H3	3	0.003308	0.968723	
51	R59	T69	2	0.003846	0.964877	
50	CL57	B27	7	0.004162	0.960715	
49	B2	CL59	3	0.004255	0.956460	
48	CL60	R52	4	0.004908	0.951551	
47	B64	B77	2	0.005320	0.946231	
46	CL49	CL53	6	0.005365	0.940866	
45	CL61	B29	3	0.005976	0.934890	
44	B60	T70	2	0.006210	0.928680	
43	CL46	B7	7	0.006677	0.922003	
42	B18	R55	2	0.006800	0.915203	
41	B65	H5	2	0.007192	0.908010	
40	CL52	T32	4	0.007238	0.900772	
..	....	....	.	.....	.....	

```
title2 "ARBRE DE CLASSIFICATION    (macro grftree de D. Jacobs)";
title3 "CAH sur le critere de Ward (sur les 31 axes de l'AFC)";
filename figure "cah.eps";
%grftree(clusdsn=treeward,items=72,axis=d);*!!!!!!!!!!!!!!!!!!!!;
run;
```




```
proc tree data=treeward n=10 noprint out=trees;
  id _name_;
  copy dim1--dim31;
run;

title2 "sortie de la procedure tree (10 1eres obs, 5 1ers axes)";
proc print data=trees(obs=10);
  var _name_ dim1-dim5 cluster clusname;
* on n imprime pas les axes 6 a 31;

stat/jaccard6                                117
          sortie de la procedure tree (10 1eres obs, 5 1ers axes)
                                             11:45 Monday, October 20, 1997

  OBS _NAME_   DIM1     DIM2      DIM3     DIM4     DIM5   CLUSTER CLUSNAME

    1  B15   -0.39893  0.06801 -0.044307 -0.18210 -0.03402    1     CL10
    2  B16   -0.39893  0.06801 -0.044307 -0.18210 -0.03402    1     CL10
    3  B5    -0.39893  0.06801 -0.044307 -0.18210 -0.03402    1     CL10
    4  B14   -0.34549 -0.05197  0.091357 -0.15301 -0.10554    1     CL10
    5  B72   -0.34549 -0.05197  0.091357 -0.15301 -0.10554    1     CL10
    6  B11   -0.32436  0.07125  0.028772 -0.11354 -0.15597    1     CL10
    7  B9    -0.32436  0.07125  0.028772 -0.11354 -0.15597    1     CL10
    8  H10   -0.34549 -0.05197  0.091357 -0.15301 -0.10554    1     CL10
    9  R58   -0.34549 -0.05197  0.091357 -0.15301 -0.10554    1     CL10
   10  R56   -0.49772  0.20921 -0.059343  0.33077  0.46264    2     CL12
```

```
*proc print data=trees;

data trees2;
  set trees;
clus=put(cluster,2.);   * text ne peut prendre que des chaines de;
text = substr(clus,2);  * caracteres. On traduit donc cluster en clus.;
*text=_name_;
y = dim1;
x = dim2;
xsys = '2';
ysys = '2';
size = 1;
label y = "Dimension 1";
label x = "Dimension 2";
keep x y text xsys ysys size;
run;
*proc print;
*run;
filename figure "plot2.eps";
title2 "CAH sur le critere de Ward (sur les 31 axes de l'AFC)";
title3 "Projection des individus sur les 2 premiers axes";
title4 "Les individus sont representes par leur numero de classe, la "
       "classe 10 devient la classe 0";
proc gplot data=trees2;
  symbol1 i=none;
  plot y*x=1 / annotate=trees2 frame;
run;
quit;
```

Classification mixte
(Ward, puis nuées dynamiques)

```
proc summary nway data=trees;
  var dim1-dim31;
  class cluster;
  output out=summa mean= ;
run;

title2 "CLASSIFICATION MIXTE : CAH-Ward puis nuees dynamiques";
title3 "1) Centre de gravite des classes d'origine issues de la CAH";
proc print data=summa;
  var cluster dim1-dim5;
run;
```

```
stat/jaccard6                                  118
            CLASSIFICATION MIXTE : CAH-Ward puis nuees dynamiques
         1) Centre de gravite des classes d'origine issues de la CAH
                                       11:45 Monday, October 20, 1997
```

OBS	CLUSTER	DIM1	DIM2	DIM3	DIM4	DIM5
1	1	-0.28426	-0.02630	0.08113	-0.08707	-0.07106
2	2	-0.26604	0.32174	-0.09106	0.31966	0.37942
3	3	-0.01700	0.00420	-0.45366	0.06092	-0.11749
4	4	-0.15252	0.07467	0.36376	0.20679	-0.12437
5	5	0.51210	-0.64255	0.07405	0.25917	-0.04448
6	6	0.34442	0.04826	-0.38867	-0.07470	0.10357
7	7	0.00918	-0.49023	-0.07208	-0.32915	0.58328
8	8	0.53691	0.52825	0.09967	0.01225	0.14497
9	9	0.86239	0.20992	0.06668	-0.33803	-0.49027
10	10	-0.21138	-0.00907	0.03192	-0.09483	-0.23878


```
title2 "CLASSIFICATION MIXTE : CAH-Ward puis nuees dynamiques";
title3 "2) Nuees dyn. avec les centres de gravite des classes d'origine"
       "comme noyaux initiaux";
proc fastclus seed=summa data=trees mean=moy2 out=mixt maxc=10 maxiter=7;
id _name_;
var dim1-dim31;
run;
```

```
stat/jaccard6                                  119
            CLASSIFICATION MIXTE : CAH-Ward puis nuees dynamiques
2) Nuees dyn. avec les centres de gravite des classes d'origine comme
noyaux i
                                       11:45 Monday, October 20, 1997

   FASTCLUS Procedure:  Replace=FULL  Radius=0  Maxclusters=10 Maxiter=7
   Converge=0.02

                              Initial Seeds

Cluster    DIM1      DIM2      DIM3      DIM4      DIM5      DIM6      DIM7
-------------------------------------------------------------------------------
  1    -.284264  -.026300  0.081128  -.087072  -.071056  0.018886 -.075814
  2    -.266041  0.321743  -.091063  0.319657  0.379421  0.322640 0.007877
  3    -.017004  0.004200  -.453656  0.060923  -.117495  -.128833 -.000910
  4    -.152519  0.074673  0.363764  0.206794  -.124366  0.049513 0.309153
  5    0.512101  -.642554  0.074052  0.259174  -.044475  -.056695 -.071105
  6    0.344420  0.048263  -.388671  -.074698  0.103573  0.404548 0.292461
  7    0.009177  -.490233  -.072082  -.329153  0.583284  -.038012 0.013792
  8    0.536911  0.528251  0.099674  0.012250  0.144975  -.262541 -.077054
  9    0.862391  0.209921  0.066677  -.338026  -.490274  0.319847 -.253780
 10    -.211382  -.009071  0.031916  -.094835  -.238779  -.561331 0.707652
```

Minimum Distance Between Initial Seeds = 0.684557

Iteration	Criterion	Relative Change in Cluster Seeds 1	2	3	4	5
		6	7	8	9	10
1	0.1295	0	0.3666	0	0	0
		0.2816	0	0	0	0
2	0.1287	0	0	0	0	0
		0	0	0	0	0

Convergence criterion is satisfied.

Criterion Based on Final Seeds = 0.12874

stat/jaccard6 121
CLASSIFICATION MIXTE : CAH-Ward puis nuees dynamiques
2) Nuees dyn. avec les centres de gravite des classes d'origine comme noyaux i
11:45 Monday, October 20, 1997

FASTCLUS Procedure: Replace=FULL Radius=0 Maxclusters=10 Maxiter=7 Converge=0.02

Cluster Summary

Cluster	Frequency	RMS Std Deviation	Maximum Distance from Seed to Observation	Nearest Cluster	Distance Between Cluster Centroids
1	30	0.1165	1.0085	3	0.6846
2	4	0.1569	1.0237	1	0.9557
3	7	0.1112	0.7351	1	0.6846
4	4	0.1259	0.6495	1	0.7830
5	7	0.1648	1.0481	3	1.0511
6	5	0.1555	0.8804	3	0.8431
7	3	0.1775	0.9880	1	1.1279
8	8	0.1791	1.0645	3	1.0262
9	2	0.1669	0.6569	8	1.2774
10	2	0.1712	0.6742	1	1.2647

Statistics for Variables

Variable	Total STD	Within STD	R-Squared	RSQ/(1-RSQ)
DIM1	0.399430	0.185968	0.810709	4.282874
DIM2	0.348707	0.182697	0.760296	3.171807
DIM3	0.278691	0.184186	0.618583	1.621799
DIM4	0.261690	0.212406	0.424702	0.738229
DIM5	0.249323	0.158127	0.648744	1.846924
DIM6	0.244147	0.154506	0.650279	1.859426
DIM7	0.225637	0.154370	0.591267	1.446586
DIM8	0.208113	0.155585	0.511940	1.048928
DIM9	0.201023	0.182558	0.279816	0.388535
DIM10	0.185912	0.148528	0.442639	0.794170
DIM11	0.181049	0.173358	0.199371	0.249018
DIM12	0.171622	0.162791	0.214313	0.272771
DIM13	0.164686	0.167767	0.093778	0.103482
DIM14	0.159514	0.161893	0.100520	0.111754
DIM15	0.152369	0.153998	0.107991	0.121065
DIM16	0.142215	0.142531	0.122867	0.140078
DIM17	0.137878	0.137006	0.137779	0.159795
DIM18	0.129710	0.127201	0.160216	0.190783
DIM19	0.122774	0.126123	0.078466	0.085147
DIM20	0.120211	0.119386	0.138701	0.161036
DIM21	0.116723	0.120450	0.070109	0.075394
DIM22	0.112005	0.118682	0.019546	0.019936
DIM23	0.105189	0.107198	0.093078	0.102631
DIM24	0.0942156	0.0963707	0.086355	0.094517
DIM25	0.0779056	0.0797048	0.085962	0.094046
DIM26	0.0744859	0.0758317	0.094919	0.104874
DIM27	0.0696720	0.0732036	0.035987	0.037331
DIM28	0.0590368	0.0618636	0.041135	0.042900
DIM29	0.0560713	0.0584869	0.049898	0.052518
DIM30	0.0465732	0.0477307	0.082817	0.090295
DIM31	0.0291172	0.0306241	0.034037	0.035236
OVER-ALL	0.180866	0.138733	0.486215	0.946340

Pseudo F Statistic = 6.52
Approximate Expected Over-All R-Squared = 0.46655
Cubic Clustering Criterion = 1.587
WARNING: The two above values are invalid for correlated variables.

Cluster Means

Cluster	DIM1	DIM2	DIM3	DIM4	DIM5	DIM6	DIM7
1	-.284264	-.026300	0.081128	-.087072	-.071056	0.018886	-.075814
2	-.356999	0.378226	0.077243	0.382998	0.406920	0.282554	-.034900
3	-.017004	0.004200	-.453656	0.060923	-.117495	-.128833	-.000910
4	-.152519	0.074673	0.363764	0.206794	-.124366	0.049513	0.309153
5	0.512101	-.642554	0.074052	0.259174	-.044475	-.056695	-.071105
6	0.295095	0.057774	-.463794	-.046500	0.136744	0.420235	0.269766
7	0.009177	-.490233	-.072082	-.329153	0.583284	-.038012	0.013792
8	0.536911	0.528251	0.099674	0.012250	0.144975	-.262541	-.077054
9	0.862391	0.209921	0.066677	-.338026	-.490274	0.319847	-.253780
10	-.211382	-.009071	0.031916	-.094835	-.238779	-.561331	0.707652

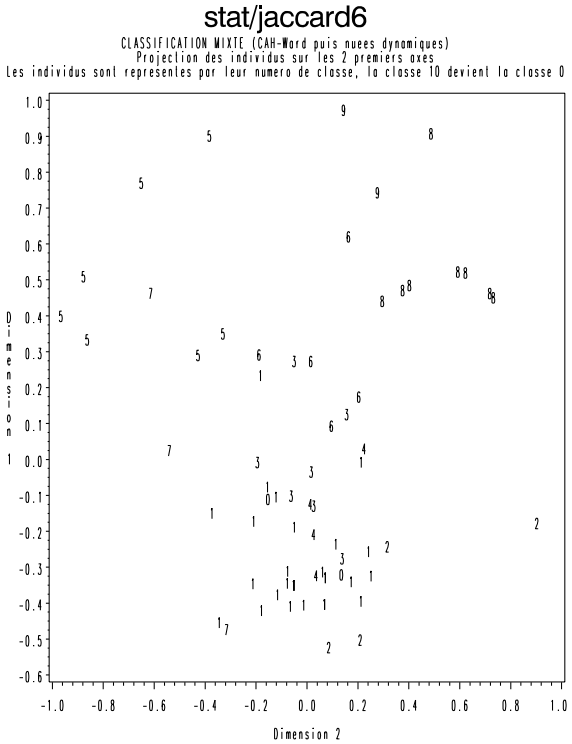
Cluster Standard Deviations

Cluster	DIM1	DIM2	DIM3	DIM4	DIM5	DIM6	DIM7
1	0.148395	0.161667	0.122344	0.109183	0.143916	0.113428	0.149325
2	0.176892	0.361813	0.289531	0.232684	0.255831	0.056605	0.096724
3	0.178904	0.121365	0.137892	0.176088	0.099856	0.161158	0.063935
4	0.148838	0.100374	0.077885	0.194960	0.123571	0.158956	0.080947
5	0.237361	0.264582	0.158159	0.255356	0.192556	0.111746	0.154884
6	0.200786	0.154835	0.189106	0.285562	0.259603	0.102086	0.109149
7	0.468352	0.155277	0.306184	0.193895	0.055265	0.342399	0.269127
8	0.154363	0.162851	0.241826	0.404028	0.143996	0.234241	0.193440
9	0.162348	0.094238	0.377384	0.083228	0.018078	0.344290	0.090010
10	0.148592	0.203734	0.503055	0.216331	0.063362	0.109570	0.390006


```
title2 "data=moy2 (table issue de la classif mixte)";
title3 "elle donne les moyennes des classes ainsi que d'autres
statistiques";
proc print data=moy2(drop=dim3-dim31);
* var dim1 dim2;
run;
```

```
stat/jaccard6                              126
                data=moy2 (table issue de la classif mixte)
     elle donne les moyennes des classes ainsi que d'autres statistiques
                                           11:45 Monday, October 20, 1997

OBS  _CRIT_ CLUSTER _FREQ_ _RMSSTD_ _RADIUS_ _NEAR_  _GAP_    DIM1    DIM2

  1 0.12874    1     30    0.11645  1.00853    3   0.68456 -0.28426 -0.02630
  2 0.12874    2      4    0.15686  1.02369    1   0.95574 -0.35700  0.37823
  3 0.12874    3      7    0.11117  0.73510    1   0.68456 -0.01700  0.00420
  4 0.12874    4      4    0.12585  0.64953    1   0.78302 -0.15252  0.07467
  5 0.12874    5      7    0.16482  1.04807    3   1.05107  0.51210 -0.64255
  6 0.12874    6      5    0.15551  0.88039    3   0.84306  0.29509  0.05777
  7 0.12874    7      3    0.17753  0.98804    1   1.12793  0.00918 -0.49023
  8 0.12874    8      8    0.17914  1.06450    3   1.02619  0.53691  0.52825
  9 0.12874    9      2    0.16686  0.65692    8   1.27736  0.86239  0.20992
 10 0.12874   10      2    0.17124  0.67418    1   1.26473 -0.21138 -0.00907
```

```
data mixt2;
set mixt;
clus=put(cluster,2.); * text ne peut prendre que des chaines de;
text = substr(clus,2); * caracteres. On traduit donc cluster en clus;
*text=_name_;
y = dim1;
x = dim2;
xsys = '2';
ysys = '2';
size = 1;
label y = "Dimension 1";
label x = "Dimension 2";
keep x y text xsys ysys size;
run;
*proc print;
*run;
filename figure "plot3.eps";
title2 "CLASSIFICATION MIXTE (CAH-Ward puis nuees dynamiques)";
title3 "Projection des individus sur les 2 premiers axes";
title4 "Les individus sont representes par leur numero de classe, la "
       "classe 10 devient la classe 0";
proc gplot data=mixt2;
symbol1 i=none;
plot y*x=1 / annotate=mixt2 frame;
run;
quit;
```

Méthode des bactériologistes
Distance Jaccard

```
data distjacc(type=distance);  *la table creee est une table de dist.;
  array dj(*) dj1-dj72;        * il y a 72 individus;
  retain dj1-dj72 .;           *initialisation des 72 ind. (a val.manq.);
do row=1 to 72;
  set naza1 point=row;
  array caract(*) c4--e11;             * liste des variables numeriques;
  array save(*) save1-save31;          * il y en a 31;
  do g=1 to 31;
    save(g)=caract(g);
  end;

    do col=1 to row;
      set naza1(drop=sou) point=col;
      cont00=0;
      cont01=0;
      cont10=0;
      cont11=0;
      do g=1 to 31;
        if caract(g)=0 and save(g)=1 then cont01=cont01+1;
        if caract(g)=1 and save(g)=0 then cont10=cont10+1;
        if caract(g)=0 and save(g)=0 then cont00=cont00+1;
        if caract(g)=1 and save(g)=1 then cont11=cont11+1;
      end;
      dj(col)=1-(cont11/(cont01+cont10+cont11));
    end;
    output;
  end;
  stop;
*  keep dj1-dj72 sou;*!!!!!!!!!!!!!!!!!!!!!!!!!!!;
   keep sou dj1-dj72;*!!!!!!!!!!!!!!!!!!!!!!!!!!!;
 run;

title2 "tableau de distance : 1 - indice de Jaccard";
proc print data=distjacc(obs=10);
  id sou;
  var dj1-dj10;
run;
```


Distance Jaccard

```
stat/jaccard6                              127
                tableau de distance : 1 - indice de Jaccard
                                           11:45 Monday, October 20, 1997

SOU   DJ1     DJ2     DJ3     DJ4     DJ5     DJ6     DJ7     DJ8   DJ9  DJ10

B2  0.00000  .       .       .       .       .       .       .      .      .
B4  0.16667 0.00000  .       .       .       .       .       .      .      .
B5  0.17647 0.22222 0.00000  .       .       .       .       .      .      .
B7  0.11765 0.16667 0.17647 0.00000  .       .       .       .      .      .
B8  0.33333 0.36842 0.18750 0.33333 0.00000  .       .       .      .      .
B10 0.33333 0.36842 0.29412 0.33333 0.35294 0.00000  .       .      .      .
B11 0.23529 0.27778 0.06667 0.23529 0.13333 0.25000 0.00000  .      .      .
B12 0.30000 0.25000 0.26316 0.30000 0.31579 0.22222 0.22222 0.00000 .      .
B14 0.17647 0.22222 0.12500 0.17647 0.18750 0.18750 0.06667 0.166670.000   .
B15 0.17647 0.22222 0.00000 0.17647 0.18750 0.29412 0.06667 0.263160.125   0
```

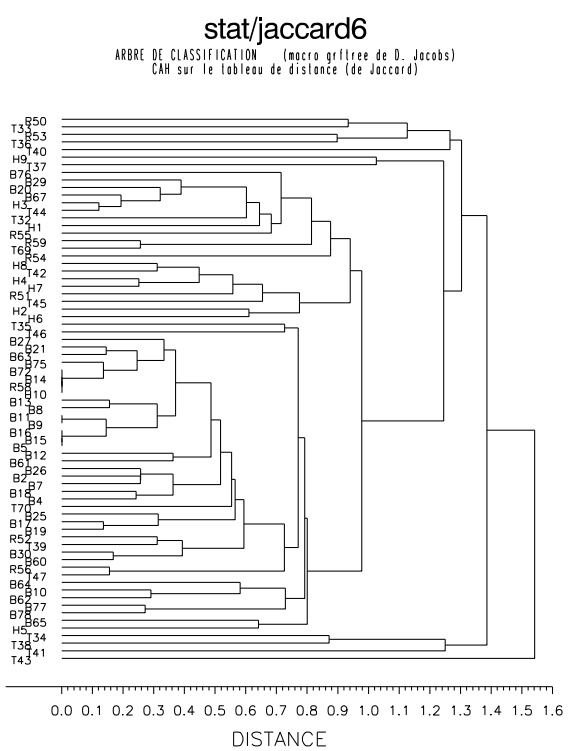
CAH sur le tableau de distance de Jaccard

```
title2 "CAH sur le tableau de distance (de Jaccard)";
proc cluster data=distjacc rsquare rmsstd
             outtree=treejacc
             method=average;
  var dj1-dj72;
  id sou;
  run;
```

```
stat/jaccard6                                  128
                 CAH sur le tableau de distance (de Jaccard)
                                              11:45 Monday, October 20, 1997

                        Average Linkage Cluster Analysis

         Root-Mean-Square Distance Between Observations   = 0.458716

                                                                    Norm   T
                                        RMS                         RMS    i
     NCL -Clusters Joined-     FREQ    STD      SPRSQ      RSQ      Dist   e

      71 B5       B15             2 0.00000  0.000000  1.000000 0.000000 T
      70 CL71     B16             3 0.00000  0.000000  1.000000 0.000000 T
      69 B11      B9              2 0.00000  0.000000  1.000000 0.000000 T
      68 B14      R58             2 0.00000  0.000000  1.000000 0.000000 T
      67 CL68     H10             3 0.00000  0.000000  1.000000 0.000000 T
      66 CL67     B72             4 0.00000  0.000000  1.000000 0.000000
      65 T44      H3              2 0.03928  0.000207  0.999793 0.121111
      64 B17      B19             2 0.04419  0.000261  0.999532 0.136250 T
      63 CL66     B75             5 0.02795  0.000418  0.999114 0.136250
      62 CL70     CL69            5 0.03651  0.000714  0.998400 0.145333 T
      61 B21      B63             2 0.04714  0.000297  0.998102 0.145333
      60 T47      R56             2 0.05051  0.000342  0.997761 0.155714 T
      59 B8       B13             2 0.05051  0.000342  0.997419 0.155714 T
      58 B30      B60             2 0.05439  0.000396  0.997023 0.167692
      57 CL65     B67             3 0.05611  0.000636  0.996387 0.193799
      56 B4       B18             2 0.07857  0.000826  0.995560 0.242222
      55 CL63     CL61            7 0.05918  0.002098  0.993463 0.245717
      54 H4       H7              2 0.08159  0.000891  0.992571 0.251538
      53 B2       B7              2 0.08319  0.000926  0.991645 0.256471 T
      52 CL53     B26             3 0.08319  0.000926  0.990719 0.256471 T
      51 T69      R59             2 0.08319  0.000926  0.989792 0.256471
      50 B77      B78             2 0.08839  0.001046  0.988746 0.272500
      49 B10      B62             2 0.09428  0.001190  0.987556 0.290667
      48 T39      R52             2 0.10102  0.001366  0.986190 0.311429 T
      47 T42      H8              2 0.10102  0.001366  0.984824 0.311429
      46 CL62     CL59            7 0.07501  0.003464  0.981360 0.311795
      45 CL64     B25             3 0.08711  0.001770  0.979590 0.314474 T
      44 CL57     B20             4 0.08364  0.001966  0.977624 0.321021
      43 CL55     B27             8 0.07450  0.002387  0.975237 0.333339
      42 CL52     CL56            5 0.10501  0.003225  0.972011 0.363333 T
      .. ....     ....            . .......  ........  ........ ........
```

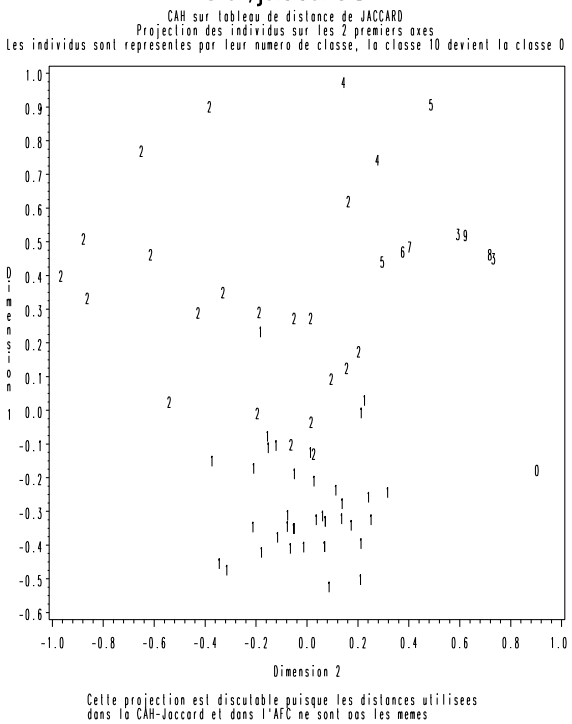


```
title2 "ARBRE DE CLASSIFICATION    (macro grftree de D. Jacobs)";
title3 "CAH sur le tableau de distance (de Jaccard)";
filename figure "jacc.eps";
%grftree(clusdsn=treejacc,items=72,axis=d);*!!!!!!!!!!!!!!!!!!!;
run;
```



```
proc tree data=treejacc noprint n=10 out=treej;
  id sou;
run;

proc sort data=trees; by _name_;
proc sort data=treej; by sou;

data treej2;
  merge treej trees(keep=_name_ dim1 dim2 rename=(_name_=sou));
  by sou;
clus=put(cluster,2.);   * text ne peut prendre que des chaines de;
text = substr(clus,2);  * caracteres. On traduit donc cluster en clus;
*text=_name_;
y = dim1;
x = dim2;
xsys = '2';
ysys = '2';
size = 1;
label y = "Dimension 1";
label x = "Dimension 2";
keep x y text xsys ysys size;
run;
*proc print;
*run;
filename figure "plot4.eps";
title2 "CAH sur tableau de distance de JACCARD";
title3 "Projection des individus sur les 2 premiers axes";
title4 "Les individus sont representes par leur numero de classe, la "
       "classe 10 devient la classe 0";
footnote1 "Cette projection est discutable puisque les distances "
          "utilisees ";
footnote2 "dans la CAH-Jaccard et dans l'AFC ne sont pas les meme"
          "s         ";
proc gplot data=treej2;
  symbol1 i=none;
  plot y*x=1 / annotate=treej2 frame;
run;
*footnote;
run;
quit;
```


stat/jaccard6



Cette projection est discutable puisque les distances utilisees
dans la CAH-Jaccard et dans l'AFC ne sont pas les memes