Shaoqian_Chen_HW5

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#Question 1

```
library(cluster)
df1 = read.csv("universities.csv",header = TRUE)
head(df1)
```

```
##   University   SAT Top10 Accept SFRatio Expenses Grad
## 1    Harvard 14.00    91     14      11   39.525   97
## 2  Princeton 13.75    91     14       8   30.220   95
## 3       Yale 13.75    95     19      11   43.514   96
## 4   Stanford 13.60    90     20      12   36.450   93
## 5        MIT 13.80    94     30      10   34.870   91
## 6       Duke 13.15    90     30      12   31.585   95
```

```
rownames(df1)=df1$University
df1 = df1[-c(1)]
head(df1)
```

```
##             SAT Top10 Accept SFRatio Expenses Grad
## Harvard   14.00    91     14      11   39.525   97
## Princeton 13.75    91     14       8   30.220   95
## Yale      13.75    95     19      11   43.514   96
## Stanford  13.60    90     20      12   36.450   93
## MIT       13.80    94     30      10   34.870   91
## Duke      13.15    90     30      12   31.585   95
```

a)

```
m1=prcomp(df1, scale=T)
names(m1)
```

```
## [1] "sdev"     "rotation" "center"    "scale"     "x"
```

```
summary(m1)
```

```
## Importance of components:
##                           PC1    PC2     PC3     PC4     PC5     PC6
## Standard deviation     2.1476 0.8870 0.53531 0.4047 0.35257 0.16264
## Proportion of Variance 0.7687 0.1311 0.04776 0.0273 0.02072 0.00441
## Cumulative Proportion  0.7687 0.8998 0.94758 0.9749 0.99559 1.00000
```

```
m1$rotation
```

```
##                PC1         PC2        PC3        PC4         PC5          PC6
## SAT      -0.4577486  0.03968044 -0.1870388  0.1312403 -0.02064583 -0.858054698
## Top10    -0.4271444 -0.19993153 -0.4978085  0.3748957 -0.48201620  0.396074921
## Accept    0.4243080  0.32089297  0.1562790  0.0612872 -0.80109360 -0.216933606
## SFRatio   0.3906483 -0.43256441 -0.6060808 -0.5073910 -0.07682369 -0.172047897
## Expenses -0.3625232  0.63448640 -0.2047411 -0.6234006 -0.07254775  0.173763087
## Grad     -0.3794040 -0.51555367  0.5324726 -0.4386334 -0.33810965  0.003537541
```

```
m1$x
```

```
##                       PC1         PC2         PC3         PC4         PC5
## Harvard        -2.32618255 -0.37872921 -0.11375273 -0.44420577  0.22545917
## Princeton      -2.19108329 -0.36428154  0.39093234  0.39874409  0.40834040
## Yale           -2.25931167 -0.11532621 -0.24885705 -0.50575435 -0.05476472
## Stanford       -1.66530400 -0.29942313 -0.31207269 -0.29145272  0.16012283
## MIT            -1.69122895  0.08645436 -0.16696081  0.25563062 -0.22860439
## Duke           -1.22163003 -0.48106378  0.03144539 -0.20148893 -0.28757533
## CalTech        -2.76521703  2.21340261 -0.81992145  0.14093839  0.12341697
## Dartmouth      -1.66241078 -0.33740573  0.24828764  0.01231048  0.05159664
## Brown          -0.98947084 -1.04280620 -0.07942843  0.05580000  0.12615288
## JohnsHopkins   -1.37492543  2.07669213  0.43388022 -0.61976330 -0.22540550
## UChicago       -0.09578694  0.63730477 -0.09847776 -0.48999317 -0.47737402
## UPenn          -0.53133248 -0.07798082  0.29922327  0.12903790 -0.05167435
## Cornell        -0.30561016 -0.62240905 -0.01003362  0.16790142 -0.01246901
## Northwestern   -0.44174831 -0.01090802  0.17219525  0.23139411 -0.25793195
## Columbia       -0.72675500 -0.04133511 -0.05927850 -0.15403187  0.56594127
## NotreDame       0.03942516 -0.98881431  0.48648548  0.22466598 -0.43897984
## UVir            0.52146787 -0.99661625  0.41515555  0.16611039 -0.35058391
## Georgetown     -0.33190565 -0.76930496  0.48361239  0.03905105  0.53396782
## CarnegieMellon  1.08998940  1.59825177  0.26139665  1.05335409  0.18793872
## UMichigan       1.92351826 -0.22022633  0.25071158 -0.04749473 -0.80612282
## UCBerkeley      0.80598316 -0.68478537 -1.39896381  0.74540795 -0.18053752
## UWisconsin      3.47699841  0.76273355  0.44028434  0.31713898  0.35109278
## PennState       3.16839572 -0.36701242  0.48536425 -0.51070657  0.62637843
## Purdue          5.06847646  0.76415786  0.37811532 -0.22752008 -0.17566464
## TexasA&M        4.48564867 -0.34056859 -1.46934284 -0.44507397  0.18728012
##                       PC6
## Harvard        -0.261589762
## Princeton      -0.049595929
## Yale            0.010575134
## Stanford       -0.112110786
## MIT            -0.234140306
## Duke            0.076435822
## CalTech         0.177052222
## Dartmouth       0.026617292
## Brown           0.033949573
## JohnsHopkins    0.230854732
## UChicago       -0.214812542
## UPenn           0.035984419
## Cornell         0.016579391
```

```
## Northwestern    0.308482390
## Columbia       -0.106957550
## NotreDame      -0.004839423
## UVir            0.064763528
## Georgetown      0.152232508
## CarnegieMellon -0.338695316
## UMichigan      -0.149170516
## UCBerkeley      0.246029951
## UWisconsin      0.075891478
## PennState       0.088228450
## Purdue          0.030280293
## TexasA&M       -0.102045054
```

```
biplot(m1,scale=0,cex=0.6)
grid()
```
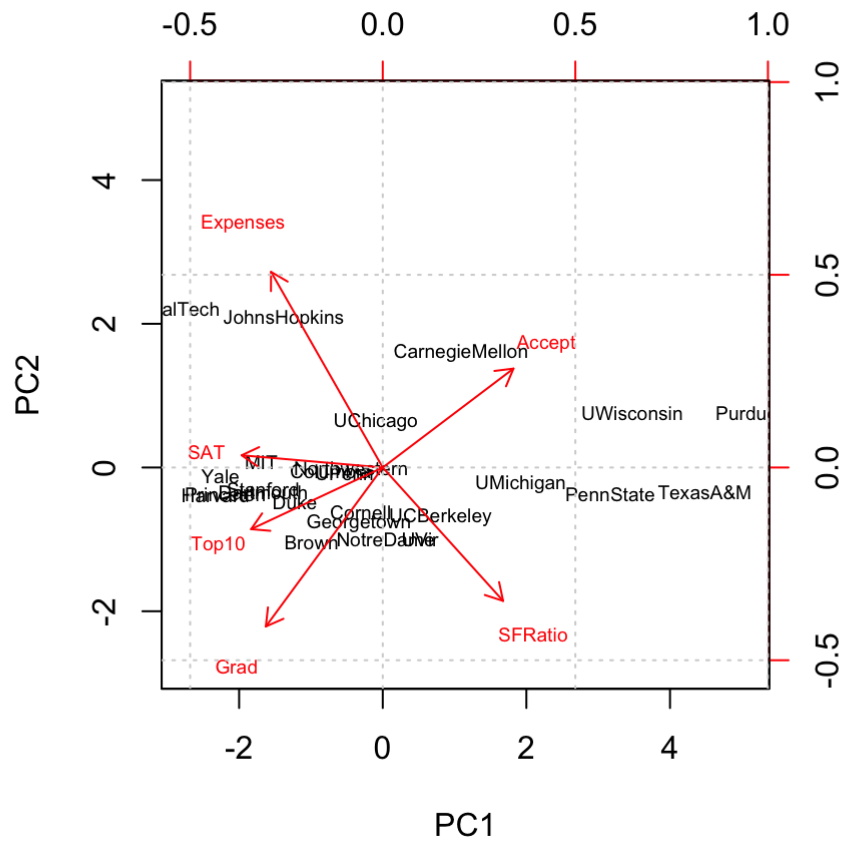
```
#mirror image
m1$rotation=-m1$rotation
m1$x=-m1$x
biplot(m1, scale=0,cex=0.6)
#abline(0,slope1)
grid()

#
rot=m1$rotation
slope1=rot[1,2]/rot[1,1]
slope1
```

```
## [1] -0.08668609
```

```
abline(0,slope1)
```
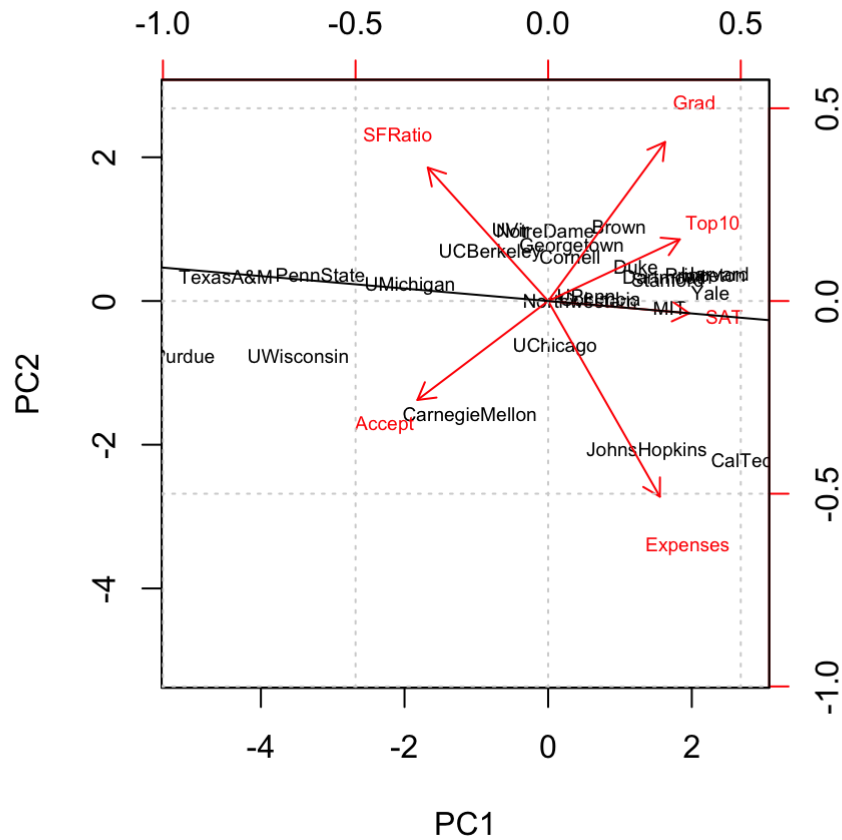

The Pricipal Components are

shown above, From this biplot we can identify the clusters of universities

b)

```
df2 = df1[,c('SAT','Top10','Accept','SFRatio','Expenses','Grad')]
df = dist(df2)
length(df)
```

```
## [1] 300
```

```
head(df)
```

```
## [1]  9.982261  7.614107  7.975940 17.991916 18.048992 32.579518
```

```
dd = as.matrix(df)
dim(dd)
```

```
## [1] 25 25
```

```
# daisy() to find distances even if columns are not numeric #
df2 = daisy(df1)
class(df2)
```

```
## [1] "dissimilarity" "dist"
```

```
as.matrix(df2)[1:25,1:25]
```

```
##                 Harvard  Princeton      Yale   Stanford        MIT       Duke
## Harvard        0.000000   9.982261  7.614107   7.975940  17.991916  18.048992
## Princeton      9.982261   0.000000 15.090740   9.789556  17.510711  16.589853
## Yale           7.614107  15.090740  0.000000   9.269444  14.923848  17.048784
## Stanford       7.975940   9.789556  9.269444   0.000000  11.248840  11.307994
## MIT           17.991916  17.510711 14.923848  11.248840   0.000000   6.871224
## Duke          18.048992  16.589853 17.048784  11.307994   6.871224   0.000000
## CalTech       32.579518  38.919353 26.713362  32.265587  31.640157  37.166653
## Dartmouth     12.023883   9.638146 13.527395   6.035474   9.873868   7.375326
## Brown         19.098587  12.284655 22.056260  14.007231  15.984416  12.077858
## JohnsHopkins  40.499853  45.078685 36.780855  36.837000  33.911687  35.280947
## UChicago      40.724944  41.331684 38.380730  34.149889  28.268889  27.133642
## UPenn         28.260419  25.434679 28.382451  21.112061  16.983551  13.354663
## Cornell       28.130960  23.360763 29.148328  21.009317  17.611247  13.364892
## Northwestern  29.301702  26.683754 28.096191  21.783627  14.660325  12.481370
## Columbia      21.726717  19.801177 24.403248  16.175710  19.615800  16.763297
## NotreDame     38.660172  33.754846 39.249786  31.984154  26.880216  22.324658
## UVir          42.640890  37.787308 43.430142  35.853573  31.105561  26.671365
## Georgetown    28.167778  22.744864 32.116017  23.250279  25.689454  20.800689
## CarnegieMellon 60.886624 58.517520 60.100987  53.726230  48.221824  46.971512
## UMichigan     65.912692  63.066354 65.094304  58.757131  52.319786  49.462266
## UCBerkeley    41.063222  35.933674 40.098708  33.623743  26.650195  26.645835
## UWisconsin    84.222567  81.219516 84.714672  77.500827  73.486738  70.714100
## PennState     74.953397  71.721997 76.801470  69.011842  67.195903  63.280610
## Purdue       107.407417 104.896052 107.346890 100.655283  95.921368  93.197185
## TexasA&M      81.421720  78.217250 81.717416  74.249330  69.921113  67.322360
##                CalTech Dartmouth    Brown JohnsHopkins UChicago     UPenn
## Harvard       32.57952 12.023883 19.09859     40.49985 40.72494 28.260419
## Princeton     38.91935  9.638146 12.28466     45.07868 41.33168 25.434679
## Yale          26.71336 13.527395 22.05626     36.78086 38.38073 28.382451
## Stanford      32.26559  6.035474 14.00723     36.83700 34.14989 21.112061
## MIT           31.64016  9.873868 15.98442     33.91169 28.26889 16.983551
## Duke          37.16665  7.375326 12.07786     35.28095 27.13364 13.354663
## CalTech        0.00000 36.391470 44.93931     32.37381 44.39989 43.889344
## Dartmouth     36.39147  0.000000 10.02715     37.60200 32.20114 17.249504
## Brown         44.93931 10.027151  0.00000     45.38796 35.70402 17.904617
## JohnsHopkins  32.37381 37.601999 45.38796      0.00000 22.01271 32.918309
## UChicago      44.39989 32.201142 35.70402     22.01271  0.00000 18.741036
## UPenn         43.88934 17.249504 17.90462     32.91831 18.74104  0.000000
## Cornell       47.16598 16.625547 13.18316     39.82826 25.19500  7.373413
```

```
## Northwestern      42.12227 18.070199 19.04865      32.92341 18.32369  5.942348
## Columbia          41.12501 14.950422 16.95717      34.14395 26.94878 13.443227
## NotreDame         56.72965 26.945948 22.84271      44.98342 26.26894 14.547156
## UVir              60.01051 31.068496 26.85588      46.20105 26.32439 16.973910
## Georgetown        52.19555 19.610910 15.52252      44.02850 32.19210 15.500011
## CarnegieMellon    64.64076 51.054505 51.02589      41.91103 25.87314 34.459371
## UMichigan         74.22677 54.937991 53.25430      51.28954 31.03350 38.027640
## UCBerkeley        52.23994 30.882819 26.26222      49.94109 33.72458 23.985101
## UWisconsin        91.66592 74.409647 72.56528      66.09284 50.53387 57.587884
## PennState         87.70204 65.883963 63.30853      63.22064 47.52185 50.426273
## Purdue           112.73882 97.527677 95.92339      85.23286 70.96783 80.464956
## TexasA&M          89.13129 71.430388 68.55306      66.58070 48.93146 54.833337
##                    Cornell Northwestern Columbia NotreDame      UVir Georgetown
## Harvard          28.130960    29.301702 21.72672 38.660172 42.640890   28.16778
## Princeton        23.360763    26.683754 19.80118 33.754846 37.787308   22.74486
## Yale             29.148328    28.096191 24.40325 39.249786 43.430142   32.11602
## Stanford         21.009317    21.783627 16.17571 31.984154 35.853573   23.25028
## MIT              17.611247    14.660325 19.61580 26.880216 31.105561   25.68945
## Duke             13.364892    12.481370 16.76330 22.324658 26.671365   20.80069
## CalTech          47.165984    42.122275 41.12501 56.729650 60.010508   52.19555
## Dartmouth        16.625547    18.070199 14.95042 26.945948 31.068496   19.61091
## Brown            13.183156    19.048651 16.95717 22.842706 26.855884   15.52252
## JohnsHopkins     39.828262    32.923408 34.14395 44.983417 46.201049   44.02850
## UChicago         25.195005    18.323689 26.94878 26.268937 26.324389   32.19210
## UPenn             7.373413     5.942348 13.44323 14.547156 16.973910   15.50001
## Cornell           0.000000     9.128600 15.10415 12.104423 15.323437   13.04159
## Northwestern      9.128600     0.000000 17.89435 14.872370 17.980565   20.46519
## Columbia         15.104149    17.894350  0.00000 25.590409 27.414311   12.24328
## NotreDame        12.104423    14.872370 25.59041  0.000000  5.313523   20.07586
## UVir             15.323437    17.980565 27.41431  5.313523  0.000000   21.42470
## Georgetown       13.041593    20.465189 12.24328 20.075857 21.424699    0.00000
## CarnegieMellon   38.301935    35.087842 41.57273 35.328342 31.803692   42.45012
## UMichigan        40.309840    37.959804 48.38359 31.979425 27.887294   45.87200
## UCBerkeley       19.959263    20.609700 31.78784 21.726086 23.414316   30.70640
## UWisconsin       60.116076    59.416669 63.32695 54.374169 49.398239   60.84625
## PennState        52.262407    53.725541 53.88877 47.343443 42.344828   49.77802
## Purdue           83.200669    81.737205 87.08063 76.268769 71.373553   84.72646
## TexasA&M         56.235114    56.015780 60.93961 50.659952 45.637989   58.32411
##                  CarnegieMellon UMichigan UCBerkeley UWisconsin PennState
## Harvard                60.88662  65.91269   41.06322   84.22257  74.95340
## Princeton              58.51752  63.06635   35.93367   81.21952  71.72200
```

```
## Yale              60.10099  65.09430  40.09871  84.71467  76.80147
## Stanford          53.72623  58.75713  33.62374  77.50083  69.01184
## MIT               48.22182  52.31979  26.65020  73.48674  67.19590
## Duke              46.97151  49.46227  26.64584  70.71410  63.28061
## CalTech           64.64076  74.22677  52.23994  91.66592  87.70204
## Dartmouth         51.05451  54.93799  30.88282  74.40965  65.88396
## Brown             51.02589  53.25430  26.26222  72.56528  63.30853
## JohnsHopkins      41.91103  51.28954  49.94109  66.09284  63.22064
## UChicago          25.87314  31.03350  33.72458  50.53387  47.52185
## UPenn             34.45937  38.02764  23.98510  57.58788  50.42627
## Cornell           38.30194  40.30984  19.95926  60.11608  52.26241
## Northwestern      35.08784  37.95980  20.60970  59.41667  53.72554
## Columbia          41.57273  48.38359  31.78784  63.32695  53.88877
## NotreDame         35.32834  31.97942  21.72609  54.37417  47.34344
## UVir              31.80369  27.88729  23.41432  49.39824  42.34483
## Georgetown        42.45012  45.87200  30.70640  60.84625  49.77802
## CarnegieMellon     0.00000  19.99893  40.59277  28.23978  31.13614
## UMichigan         19.99893   0.00000  41.64696  28.93020  31.35142
## UCBerkeley        40.59277  41.64696   0.00000  62.70710  58.96677
## UWisconsin        28.23978  28.93020  62.70710   0.00000  17.93871
## PennState         31.13614  31.35142  58.96677  17.93871   0.00000
## Purdue            49.87208  46.49810  84.35885  24.76751  38.98499
## TexasA&M          27.99697  26.62482  55.44497  14.52417  22.58754
##                    Purdue TexasA&M
## Harvard          107.40742 81.42172
## Princeton        104.89605 78.21725
## Yale             107.34689 81.71742
## Stanford         100.65528 74.24933
## MIT               95.92137 69.92111
## Duke              93.19719 67.32236
## CalTech          112.73882 89.13129
## Dartmouth         97.52768 71.43039
## Brown             95.92339 68.55306
## JohnsHopkins      85.23286 66.58070
## UChicago          70.96783 48.93146
## UPenn             80.46496 54.83334
## Cornell           83.20067 56.23511
## Northwestern      81.73721 56.01578
## Columbia          87.08063 60.93961
## NotreDame         76.26877 50.65995
## UVir              71.37355 45.63799
```

```
## Georgetown        84.72646 58.32411
## CarnegieMellon    49.87208 27.99697
## UMichigan         46.49810 26.62482
## UCBerkeley        84.35885 55.44497
## UWisconsin        24.76751 14.52417
## PennState         38.98499 22.58754
## Purdue             0.00000 31.79027
## TexasA&M          31.79027  0.00000
```

Euclidian distances between all pairs of universities are shown above

```
#complete linkage
seg.hc = hclust(df2,method='complete')
plot(seg.hc,cex=0.4)
#
# cut at h=0.5
abline(h=0.5,col='red',lty=2)
cut(as.dendrogram(seg.hc),h=0.5)
```

```
## $upper
## 'dendrogram' with 2 branches and 25 members total, at height 112.7388
##
## $lower
## $lower[[1]]
## 'dendrogram' leaf 'Purdue', at height 0
##
## $lower[[2]]
## 'dendrogram' leaf 'CarnegieMellon', at height 0
##
## $lower[[3]]
## 'dendrogram' leaf 'UMichigan', at height 0
##
## $lower[[4]]
## 'dendrogram' leaf 'PennState', at height 0
##
## $lower[[5]]
## 'dendrogram' leaf 'UWisconsin', at height 0
##
## $lower[[6]]
## 'dendrogram' leaf 'TexasA&M', at height 0
##
## $lower[[7]]
## 'dendrogram' leaf 'Harvard', at height 0
##
## $lower[[8]]
## 'dendrogram' leaf 'Yale', at height 0
##
## $lower[[9]]
## 'dendrogram' leaf 'MIT', at height 0
##
## $lower[[10]]
## 'dendrogram' leaf 'Duke', at height 0
##
## $lower[[11]]
## 'dendrogram' leaf 'Brown', at height 0
##
## $lower[[12]]
## 'dendrogram' leaf 'Princeton', at height 0
##
```

```
## $lower[[13]]
## 'dendrogram' leaf 'Stanford', at height 0
##
## $lower[[14]]
## 'dendrogram' leaf 'Dartmouth', at height 0
##
## $lower[[15]]
## 'dendrogram' leaf 'Columbia', at height 0
##
## $lower[[16]]
## 'dendrogram' leaf 'Georgetown', at height 0
##
## $lower[[17]]
## 'dendrogram' leaf 'UCBerkeley', at height 0
##
## $lower[[18]]
## 'dendrogram' leaf 'NotreDame', at height 0
##
## $lower[[19]]
## 'dendrogram' leaf 'UVir', at height 0
##
## $lower[[20]]
## 'dendrogram' leaf 'Cornell', at height 0
##
## $lower[[21]]
## 'dendrogram' leaf 'UPenn', at height 0
##
## $lower[[22]]
## 'dendrogram' leaf 'Northwestern', at height 0
##
## $lower[[23]]
## 'dendrogram' leaf 'CalTech', at height 0
##
## $lower[[24]]
## 'dendrogram' leaf 'JohnsHopkins', at height 0
##
## $lower[[25]]
## 'dendrogram' leaf 'UChicago', at height 0
```

```
# identigy the clusters
rect.hclust(seg.hc,k=4)
```

Cluster Dendrogram

df2
hclust (*, "complete")

```
#single linkage
seg.hc = hclust(df2,method='single')
plot(seg.hc,cex=0.4)
#
# cut at h=0.5
abline(h=0.5,col='red',lty=2)
cut(as.dendrogram(seg.hc),h=0.5)
```
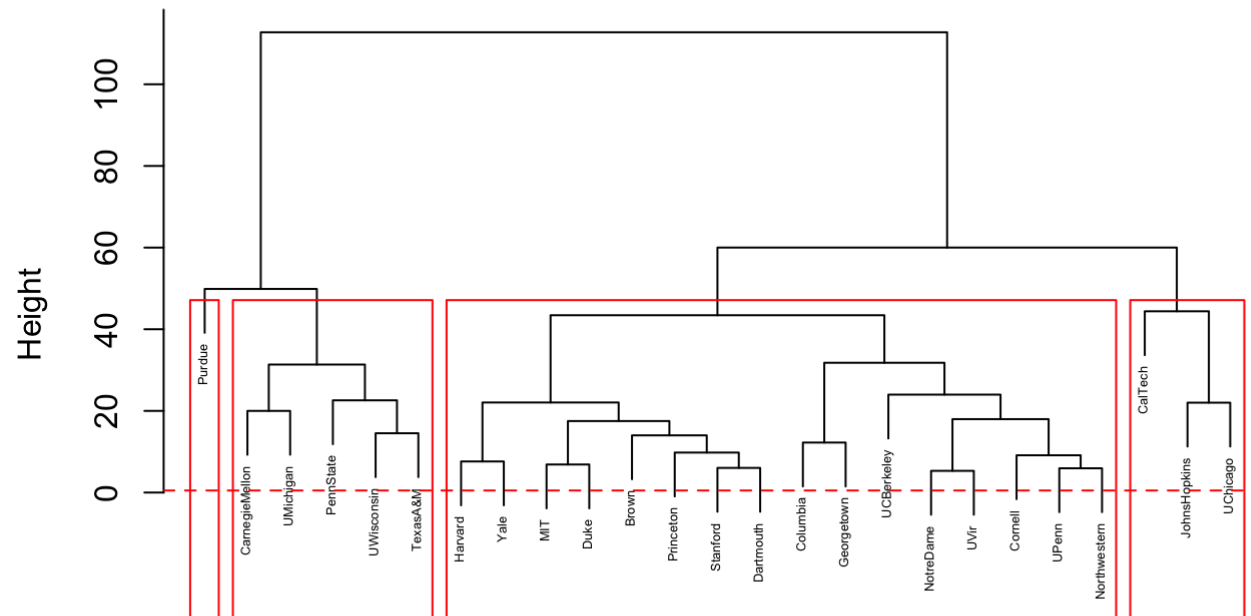
```
## $upper
## 'dendrogram' with 2 branches and 25 members total, at height 26.71336
##
## $lower
## $lower[[1]]
## 'dendrogram' leaf 'CalTech', at height 0
##
## $lower[[2]]
## 'dendrogram' leaf 'Purdue', at height 0
##
## $lower[[3]]
## 'dendrogram' leaf 'PennState', at height 0
##
## $lower[[4]]
## 'dendrogram' leaf 'UWisconsin', at height 0
##
## $lower[[5]]
## 'dendrogram' leaf 'TexasA&M', at height 0
##
## $lower[[6]]
## 'dendrogram' leaf 'CarnegieMellon', at height 0
##
## $lower[[7]]
## 'dendrogram' leaf 'UMichigan', at height 0
##
## $lower[[8]]
## 'dendrogram' leaf 'JohnsHopkins', at height 0
##
## $lower[[9]]
## 'dendrogram' leaf 'UCBerkeley', at height 0
##
## $lower[[10]]
## 'dendrogram' leaf 'UChicago', at height 0
##
## $lower[[11]]
## 'dendrogram' leaf 'Columbia', at height 0
##
## $lower[[12]]
## 'dendrogram' leaf 'Georgetown', at height 0
##
```

```
## $lower[[13]]
## 'dendrogram' leaf 'Brown', at height 0
##
## $lower[[14]]
## 'dendrogram' leaf 'Princeton', at height 0
##
## $lower[[15]]
## 'dendrogram' leaf 'Stanford', at height 0
##
## $lower[[16]]
## 'dendrogram' leaf 'Dartmouth', at height 0
##
## $lower[[17]]
## 'dendrogram' leaf 'MIT', at height 0
##
## $lower[[18]]
## 'dendrogram' leaf 'Duke', at height 0
##
## $lower[[19]]
## 'dendrogram' leaf 'Harvard', at height 0
##
## $lower[[20]]
## 'dendrogram' leaf 'Yale', at height 0
##
## $lower[[21]]
## 'dendrogram' leaf 'NotreDame', at height 0
##
## $lower[[22]]
## 'dendrogram' leaf 'UVir', at height 0
##
## $lower[[23]]
## 'dendrogram' leaf 'Cornell', at height 0
##
## $lower[[24]]
## 'dendrogram' leaf 'UPenn', at height 0
##
## $lower[[25]]
## 'dendrogram' leaf 'Northwestern', at height 0
```

```
rect.hclust(seg.hc,k=4)
```

Cluster Dendrogram
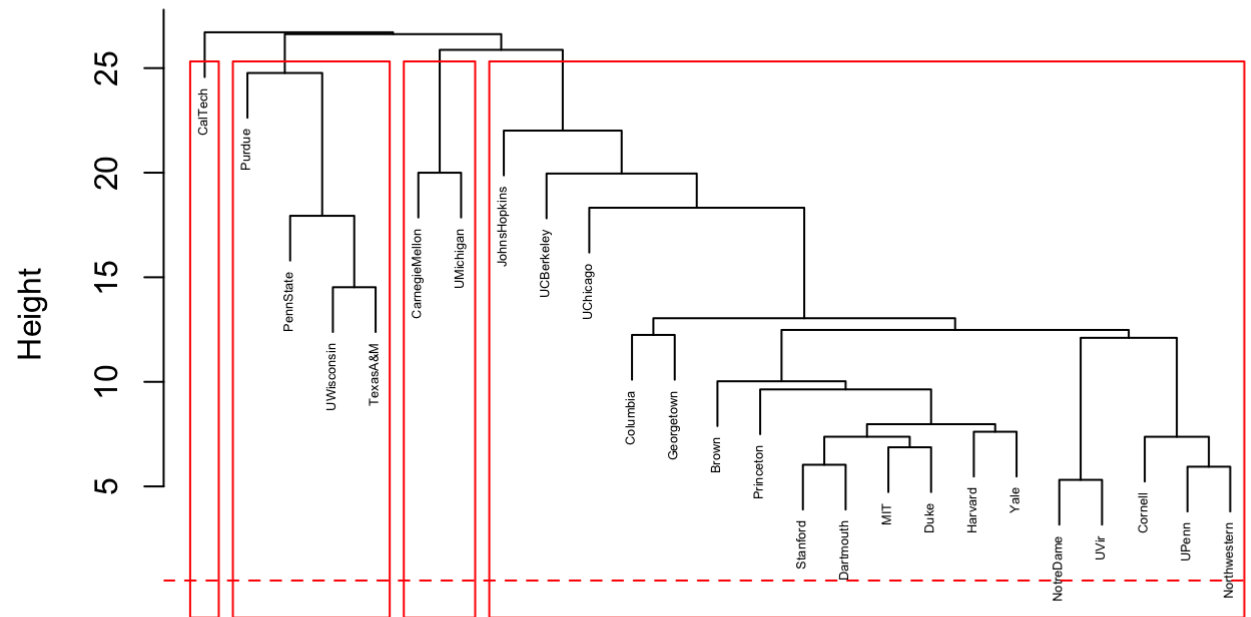
df2
hclust (*, "single")

c)

```
set.seed(2)
bb = c(-8,8)
km.out = kmeans(df1,4,nstart=20)
km.out
```

```
## K-means clustering with 4 clusters of sizes 8, 2, 9, 6
##
## Cluster means:
##         SAT     Top10    Accept SFRatio Expenses      Grad
## 1 12.61250 81.25000 38.50000    13.0 22.44825 89.00000
## 2 13.60000 87.50000 34.50000     6.5 61.13300 84.00000
## 3 13.51667 89.44444 21.77778    11.0 33.61556 93.77778
## 4 11.14333 47.00000 67.83333    17.0 13.38467 74.00000
##
## Clustering vector:
##        Harvard       Princeton            Yale        Stanford             MIT
##              3               3               3               3               3
##           Duke         CalTech       Dartmouth           Brown     JohnsHopkins
##              3               2               3               3               2
##       UChicago           UPenn          Cornell    Northwestern        Columbia
##              1               1               1               1               3
##      NotreDame            UVir      Georgetown  CarnegieMellon       UMichigan
##              1               1               1               4               4
##     UCBerkeley       UWisconsin       PennState          Purdue         TexasA&M
##              1               4               4               4               4
##
## Within cluster sum of squares by cluster:
## [1] 1444.7549  524.0317  876.0280 2385.9341
##  (between_SS / total_SS =  79.7 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
colors = km.out$cluster
plot(m1$x[,1],m1$x[,2],col=colors,pch=20,ylim=bb,xlim=bb,main='K-means with K=4 cluster
s')
```

K-means with K=4 clusters
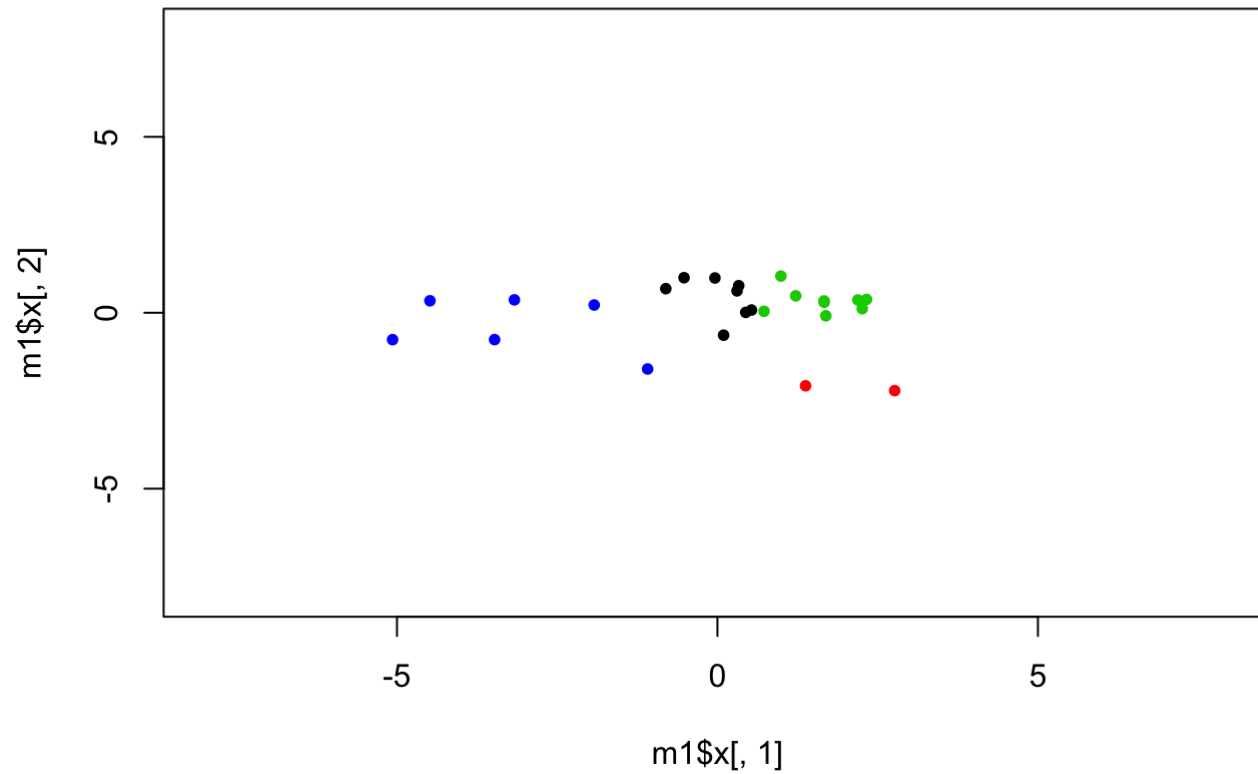
Question 2

```
d2 = read.csv("brands.csv",header = TRUE)
dim(d2)
```

```
## [1] 43 10
```

```
head(d2)
```

```
##                Brand Manuf Calories Protein Fat Sodium Fiber Chydrates Sugar
## 1         ACCheerios     G      110       2   2    180   1.5      10.5    10
## 2           Cheerios     G      110       6   2    290   2.0      17.0     1
## 3          CocoaPuffs    G      110       1   1    180   0.0      12.0    13
## 4       CountChocula     G      110       1   1    180   0.0      12.0    13
## 5       GoldenGrahams    G      110       1   1    280   0.0      15.0     9
## 6  HoneyNutCheerios     G      110       3   1    250   1.5      11.5    10
##     Potassium
## 1         70
## 2        105
## 3         55
## 4         65
## 5         45
## 6         90
```

```
rownames(d2) = d2[,1]
d22 = d2[-c(1,2)]
head(d22)
```

```
##                  Calories Protein Fat Sodium Fiber Chydrates Sugar Potassium
## ACCheerios           110       2   2    180   1.5      10.5    10        70
## Cheerios             110       6   2    290   2.0      17.0     1       105
## CocoaPuffs           110       1   1    180   0.0      12.0    13        55
## CountChocula         110       1   1    180   0.0      12.0    13        65
## GoldenGrahams        110       1   1    280   0.0      15.0     9        45
## HoneyNutCheerios     110       3   1    250   1.5      11.5    10        90
```

```
m2=prcomp(d22, scale=T)
m2
```

```
## Standard deviations (1, .., p=8):
## [1] 1.5961107 1.3618964 1.3299737 0.9318172 0.7051956 0.5978532 0.2459743
## [8] 0.2128916
##
## Rotation (n x k) = (8 x 8):
##                     PC1            PC2           PC3          PC4          PC5
## Calories   -0.11428766  0.6565978346  0.13512273 -0.10047942  0.45370278
## Protein    -0.42083604 -0.2279411416  0.25306331 -0.37167686  0.55136283
## Fat        -0.31568965  0.3017868744 -0.16564583 -0.68746001 -0.43196553
## Sodium     -0.02253715  0.2730761901  0.59171072  0.07540825 -0.50184839
## Fiber      -0.55812331 -0.1346700401  0.06964853  0.37635107 -0.07569865
## Chydrates   0.23809310  0.1134578294  0.63159218  0.05877830  0.13150590
## Sugar      -0.03833510  0.5659218032 -0.36206814  0.37491534  0.12379085
## Potassium  -0.58310200 -0.0001015048  0.07271691  0.29633765 -0.11557910
##                    PC6         PC7         PC8
## Calories   -0.1357808  0.46893535  0.28858336
## Protein     0.4203738 -0.24231470 -0.17124143
## Fat        -0.2513099 -0.12505885 -0.20936646
## Sodium      0.5557961  0.08693274  0.02819652
## Fiber      -0.1942594  0.45295861 -0.52462634
## Chydrates  -0.5348405 -0.36979311 -0.29661480
## Sugar       0.2536404 -0.43507631 -0.37102432
## Potassium  -0.2113266 -0.40862740  0.58471744
```

summary(m2)

```
## Importance of components:
##                           PC1     PC2     PC3     PC4     PC5     PC6     PC7
## Standard deviation     1.5961  1.3619  1.3300  0.9318  0.70520  0.59785  0.24597
## Proportion of Variance 0.3185  0.2319  0.2211  0.1085  0.06216  0.04468  0.00756
## Cumulative Proportion  0.3185  0.5503  0.7714  0.8799  0.94209  0.98677  0.99433
##                            PC8
## Standard deviation     0.21289
## Proportion of Variance 0.00567
## Cumulative Proportion  1.00000
```

m2$rotation

```
##                     PC1            PC2          PC3          PC4          PC5
## Calories   -0.11428766   0.6565978346   0.13512273  -0.10047942   0.45370278
## Protein    -0.42083604  -0.2279411416   0.25306331  -0.37167686   0.55136283
## Fat         -0.31568965   0.3017868744  -0.16564583  -0.68746001  -0.43196553
## Sodium     -0.02253715   0.2730761901   0.59171072   0.07540825  -0.50184839
## Fiber      -0.55812331  -0.1346700401   0.06964853   0.37635107  -0.07569865
## Chydrates   0.23809310   0.1134578294   0.63159218   0.05877830   0.13150590
## Sugar      -0.03833510   0.5659218032  -0.36206814   0.37491534   0.12379085
## Potassium  -0.58310200  -0.0001015048   0.07271691   0.29633765  -0.11557910
##                     PC6            PC7          PC8
## Calories    -0.1357808   0.46893535   0.28858336
## Protein      0.4203738  -0.24231470  -0.17124143
## Fat         -0.2513099  -0.12505885  -0.20936646
## Sodium       0.5557961   0.08693274   0.02819652
## Fiber       -0.1942594   0.45295861  -0.52462634
## Chydrates   -0.5348405  -0.36979311  -0.29661480
## Sugar        0.2536404  -0.43507631  -0.37102432
## Potassium   -0.2113266  -0.40862740   0.58471744
```

```
m2$x
```

```
##                              PC1         PC2         PC3         PC4
## ACCheerios               -0.2920929  0.75770232 -1.06893245 -0.71104079
## Cheerios                 -1.7253617 -0.59636554  2.32177089 -2.21575252
## CocoaPuffs                1.1023802  1.09423804 -1.16083971  0.33861055
## CountChocula              1.0141779  1.09422268 -1.14984028  0.38343572
## GoldenGrahams             1.3637169  1.01992530  0.33948469  0.09981144
## HoneyNutCheerios         -0.3830204  0.46251880  0.03812224  0.01263289
## Kix                       1.4553395  0.17580753  1.76076349 -0.65888895
## LuckyCharms               0.7663923  0.78292282 -0.87390119 -0.04824084
## MultiGrainCheerios        0.1046586 -0.24365371  0.39354507  0.16356657
## OatmealRaisinCrisp       -1.0274180  1.30885039 -0.29396013 -0.86516149
## RaisinNutBran            -1.4756058 -0.23736782 -0.95650171 -0.64270301
## TotalCornFlakes           1.5165114 -0.03102544  1.30707447 -0.73841926
## TotalRaisinBran          -2.3950722  1.69910091  0.25440111  1.32598468
## TotalWholeGrain          -0.6394065 -0.92164978  0.89978606 -0.09499502
## Trix                      1.4427457  0.85828746 -1.26445555  0.09721575
## Cheaties                 -0.5834790 -0.89499876  1.04814577 -0.08118812
## WheatiesHoneyGold         0.6639221  0.38460404  0.23240539 -0.07298504
## AllBran                  -5.0538101 -2.37958311  0.30976508  2.05420015
## AppleJacks                1.0134288  0.36481097 -1.37483623  1.00577686
## CornFlakes                1.6433194 -0.64307471  2.23333313  0.38453159
## CornPops                  1.5847842  0.23452487 -1.39805163  1.09415506
## CracklinOatBran          -2.5909668  0.23496220 -1.00625352 -1.23960774
## Crispix                   1.6386340 -0.41347394  1.69636591  0.32515740
## FrootLoops                0.6279756  0.61661365 -1.50170628  0.06534638
## FrostedFlakes             1.5737651  0.51562217 -0.34269618  1.15244266
## FrostedMiniWheats        -0.2460563 -1.54194630 -1.01447400  0.83054721
## FruitfulBran             -1.8913000  0.45166110  0.69808941  2.18807373
## JustRightCrunchyNuggets   0.7452865  0.05832696  0.31630171 -0.25303243
## MueslixCrispyBlend       -1.8501851  2.63357241  0.15222382 -0.25379783
## NutNHoneyCrunch           1.0287339  0.86926396 -0.05994044 -0.36545338
## NutriGrainAlmondRaisin   -1.2105764  1.54070672  1.57197436 -0.65635073
## NutriGrainWheat           0.1199946 -1.81920111  1.16567761  0.64251661
## Product19                 1.1377649 -0.62812821  2.44737477  0.22255277
## RaisinBran               -2.7176797  0.72472058  0.32230626  1.52585793
## RiceKrispies              1.9407368 -0.07067002  2.33440382  0.21884700
## Smacks                    0.4266649  0.62320011 -2.35789772  0.19549526
## SpecialK                 -0.2421091 -1.25853930  1.88525574 -0.83910924
## CapNCrunch                0.8216995  1.83011848 -0.93968011 -0.70636375
## HoneyGrahamOhs            0.4317560  1.63050275 -0.81015599 -0.53501907
```

```
## Life                          -1.1700906 -0.56149462 -0.36136176 -1.38826901
## PuffedRice                      2.4276015 -3.57484827 -1.58417072  0.10295788
## PuffedWheat                     1.2964803 -3.91626288 -1.74491989  0.12338882
## QuakerOatmeal                  -2.3942400 -2.23450370 -2.46399531 -2.18672669
##                                         PC5         PC6         PC7         PC8
## ACCheerios                     -0.724849108  0.17583626  0.115572513 -0.1698242224
## Cheerios                        0.256299612  0.83818637 -0.348900618 -0.2442852131
## CocoaPuffs                     -0.419597032  0.33453688 -0.232983940  0.1863806004
## CountChocula                   -0.437079969  0.30257081 -0.294794482  0.2748271951
## GoldenGrahams                  -1.052137303  0.46759362  0.061619818  0.2516668369
## HoneyNutCheerios               -0.182143995  1.13505533 -0.060373370  0.0833953260
## Kix                            -0.443808745 -0.40196987 -0.073472382  0.1328642086
## LuckyCharms                     0.004384007  0.62268376 -0.335399681  0.1280158274
## MultiGrainCheerios             -0.704615624 -0.06526680  0.063298150 -0.0017550042
## OatmealRaisinCrisp              0.273408637 -0.23016203 -0.168933013  0.2239496422
## RaisinNutBran                  -0.478382096 -0.13273236 -0.362980299  0.0147747801
## TotalCornFlakes                -0.054943894 -0.80697275 -0.108414027  0.0672835496
## TotalRaisinBran                 0.782877421 -0.43417702 -0.308212829  0.4567494218
## TotalWholeGrain                -0.254651576 -0.32680539  0.172012288 -0.0880151900
## Trix                           -0.110131076 -0.03176856 -0.082404078 -0.0810816702
## Cheaties                       -0.223761108 -0.45243832  0.085148643 -0.1576894004
## WheatiesHoneyGold              -0.158730584 -0.08712099 -0.056427333 -0.0637539377
## AllBran                        -1.744078193  0.57643503  0.100271765 -0.0918140518
## AppleJacks                      0.917141424  0.75976366  0.061597950 -0.2369207762
## CornFlakes                     -0.394690177  0.04578396  0.246834030 -0.0013661691
## CornPops                        0.712296168 -0.16099842  0.301415710 -0.1734395849
## CracklinOatBran                -0.918988712 -0.73686496  0.121532243 -0.2381672375
## Crispix                         0.324006070 -0.44505237  0.352227163 -0.0001574431
## FrootLoops                      0.350864665  0.39027664  0.001464763 -0.4163691966
## FrostedFlakes                   0.010263389  0.41327969  0.400275962 -0.0779453700
## FrostedMiniWheats               1.616271856 -0.90963252 -0.039535880 -0.1742260437
## FruitfulBran                    0.469110506  0.40708876  0.185933835  0.0194003483
## JustRightCrunchyNuggets         0.007643755 -0.53507374  0.015605208  0.0194731010
## MueslixCrispyBlend              1.174626480 -1.14702496  0.089396785  0.1004411980
## NutNHoneyCrunch                 0.217247777  0.12457552  0.042648237  0.1873916694
## NutriGrainAlmondRaisin          0.265049243 -1.25482370  0.085215998 -0.2322165363
## NutriGrainWheat                 0.304667274 -0.39538934  0.093716371 -0.2240460408
## Product19                      -0.154566415  0.74991752  0.010575204 -0.0545113860
## RaisinBran                      0.032769664 -0.27680813 -0.312085346  0.1897162558
## RiceKrispies                   -0.055250651  0.01244679  0.059535711  0.2908837670
## Smacks                          0.674625047  0.33549955 -0.138797808 -0.3717316925
```

```
## SpecialK            1.867572287  1.54960267 -0.150308739  0.0122707041
## CapNCrunch          -0.965134917  0.23805670  0.121620989 -0.0035838583
## HoneyGrahamOhs      -1.051978323  0.04221231  0.407464206 -0.1249224999
## Life                 0.001000832  0.17904575 -0.336531725 -0.3149738587
## PuffedRice          -0.429304186 -0.90999511 -0.350589981  0.1105223949
## PuffedWheat         -0.173967478 -0.40888213 -0.252917574  0.1973781683
## QuakerOatmeal        0.870665047  0.44951188  0.819079563  0.5954113885
```

Principle components are show above

```r
library(devtools)
```

```
## Loading required package: usethis
```

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

```
## Loading required package: ggplot2
```

```
## Loading required package: plyr
```

```
## Loading required package: scales
```

```
## Loading required package: grid
```

```r
ggbiplot(m2,obs.scale = 1,var.scale =1, groups = d22$Manuf,ellipse = TRUE, circle = TRUE) + scale_color_discrete
(name = '')+theme(legend.direction = 'vertical',legend.position ='right')
```
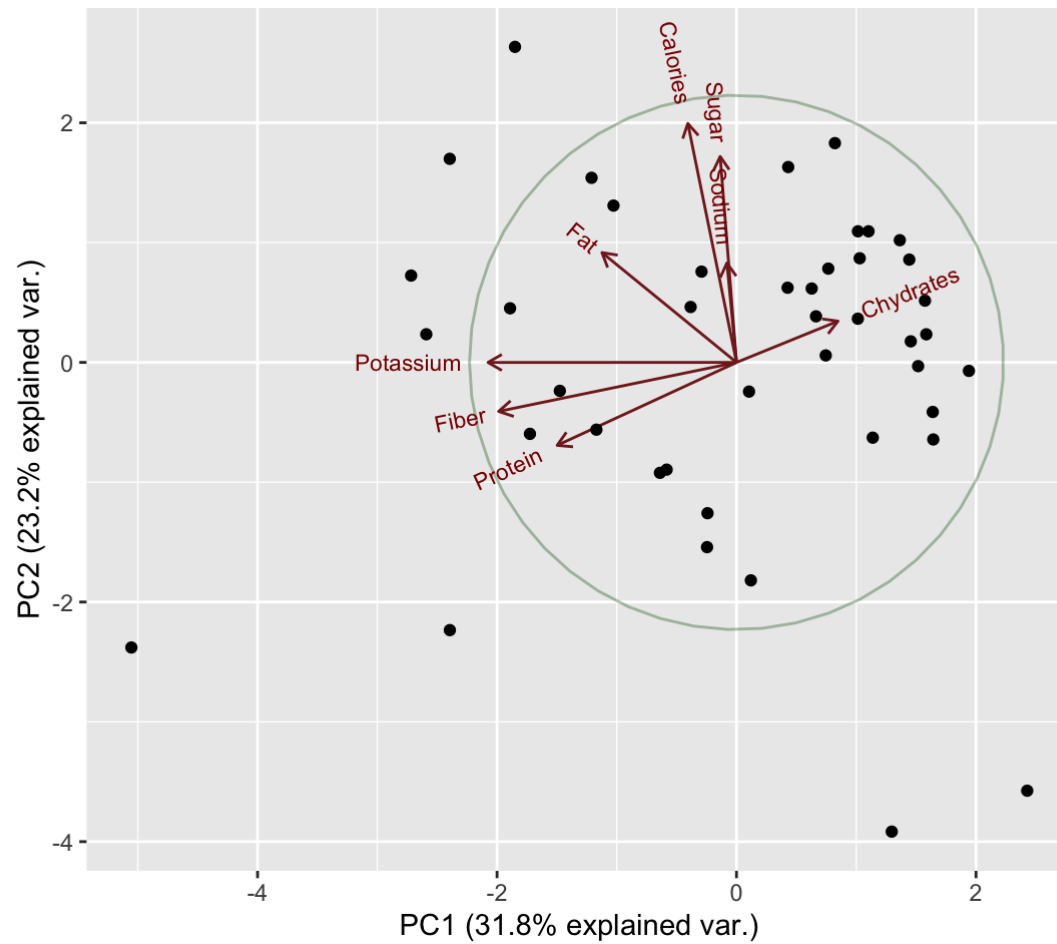
```
df2 = daisy(d22)
class(df2)
```

```
## [1] "dissimilarity" "dist"
```

```
head(df2)
```

```
## [1] 116.036632   15.508062    6.363961 103.201260   72.821700   86.385763
```

```
as.matrix(df2)[1:43,1:43]
```

```
##                        ACCheerios  Cheerios CocoaPuffs CountChocula
## ACCheerios               0.000000 116.03663  15.508062     6.363961
## Cheerios               116.036632   0.00000 121.651141   117.894020
## CocoaPuffs              15.508062 121.65114   0.000000    10.000000
## CountChocula             6.363961 117.89402  10.000000     0.000000
## GoldenGrahams          103.201260  61.62792 100.623059   102.102889
## HoneyNutCheerios        72.821700  44.11916  78.361343    74.434535
## Kix                     86.385763  71.87489  82.504545    84.894052
## LuckyCharms             15.313393 121.51955   1.414214    10.099505
## MultiGrainCheerios      46.233105  72.60165  54.662601    48.867167
## OatmealRaisinCrisp      54.863467 122.99390  68.873072    59.527305
## RaisinNutBran           81.277303 154.67870  94.675762    85.810838
## TotalCornFlakes         42.278836 114.19720  31.336879    38.496753
## TotalRaisinBran        163.231431 163.43806 177.918521   168.092237
## TotalWholeGrain         46.727936  90.77995  60.448325    51.516987
## Trix                    60.328269 170.49047  50.019996    56.586217
## Cheaties                46.856163  90.77445  60.522723    51.604263
## WheatiesHoneyGold       23.140873 100.96039  21.633308    21.633308
## AllBran                265.703782 221.12214 280.007143   270.562377
## AppleJacks              68.157905 181.86808  60.456596    65.230361
## CornFlakes             116.634043  70.97887 113.159180   115.347302
## CornPops               103.031549 217.69704  96.586749   100.642933
## CracklinOatBran         98.577381 160.07498 112.645462   103.387620
## Crispix                 57.995689 102.79105  49.081565    54.854353
## FrootLoops              68.084506 181.79109  60.440053    65.215029
## FrostedFlakes           49.431771 120.99174  36.193922    44.833024
## FrostedMiniWheats      182.834625 290.31707 185.954295   183.790642
## FruitfulBran           134.660685  99.88493 148.189068   139.140217
## JustRightCrunchyNuggets 16.109004 128.32771  14.177447    14.177447
## MueslixCrispyBlend     107.491860 158.99371 120.266371   111.642286
## NutNHoneyCrunch         33.533565 120.05832  21.236761    29.171904
## NutriGrainAlmondRaisin  78.882824  80.54191  90.862534    82.800966
## NutriGrainWheat         32.054641 122.64175  43.543082    36.000000
## Product19              143.071660  68.02206 141.315250   142.372750
## RaisinBran             173.004335 157.71493 187.773800   177.929761
## RiceKrispies           116.243279  70.37755 112.703150   114.899956
## Smacks                 114.142455 230.00652 111.085553   112.871608
## SpecialK                53.146025  78.16649  51.410116    52.373658
## CapNCrunch              54.171025 100.37430  45.847574    51.009803
## HoneyGrahamOhs          48.264894  93.54678  42.497059    45.891176
```

```
## Life                      40.589407 140.90422  51.604263    44.305756
## PuffedRice                197.834527 309.59651 194.347627   196.649434
## PuffedWheat               191.061508 301.32375 190.265604   190.790461
## QuakerOatmeal             185.153153 290.65872 189.246638   186.585878
##                           GoldenGrahams HoneyNutCheerios       Kix LuckyCharms
## ACCheerios                     103.20126         72.82170  86.38576   15.313393
## Cheerios                        61.62792         44.11916  71.87489  121.519546
## CocoaPuffs                     100.62306         78.36134  82.50455    1.414214
## CountChocula                   102.10289         74.43453  84.89405   10.099505
## GoldenGrahams                    0.00000         54.26325  22.31591  100.593240
## HoneyNutCheerios                54.26325          0.00000  52.36888   78.310280
## Kix                             22.31591         52.36888   0.00000   82.383251
## LuckyCharms                    100.59324         78.31028  82.38325    0.000000
## MultiGrainCheerios              75.75619         32.08582  65.18435   54.534393
## OatmealRaisinCrisp             134.66811         87.77813 122.51326   68.814969
## RaisinNutBran                  169.58036        121.27242 156.98248   94.612367
## TotalCornFlakes                 81.07404         75.28280  60.20797   31.016125
## TotalRaisinBran                208.01442        155.35282 205.11948  177.918521
## TotalWholeGrain                103.80270         55.42112  92.92470   60.266077
## Trix                           141.46731        127.81823 121.53600   50.019996
## Cheaties                       103.81715         55.51126  92.87626   60.340699
## WheatiesHoneyGold               81.41867         58.52777  63.64747   21.400935
## AllBran                        278.91755        233.88566 283.34608  279.971427
## AppleJacks                     155.86533        138.72094 136.19104   60.473135
## CornFlakes                      19.69772         69.86773  32.06244  113.061930
## CornPops                       191.67681        174.67541 171.60420   96.586749
## CracklinOatBran                181.32292        130.46647 170.17050  112.583302
## Crispix                         62.44998         68.12855  41.25530   48.877398
## FrootLoops                     155.83324        138.69211 136.11025   60.440053
## FrostedFlakes                   82.50455         82.08228  62.77738   36.166283
## FrostedMiniWheats              285.55910        250.43662 267.16287  185.916648
## FruitfulBran                   150.88075        101.11132 152.17424  148.175572
## JustRightCrunchyNuggets        111.08555         85.71756  92.33634   13.674794
## MueslixCrispyBlend             180.71801        132.07006 170.66634  120.258056
## NutNHoneyCrunch                 90.69730         78.84478  71.21798   21.047565
## NutriGrainAlmondRaisin         108.53110         59.18192 103.08734   90.785461
## NutriGrainWheat                120.81805         83.12340 104.98095   43.266615
## Product19                       42.03570         84.54289  61.06554  141.237389
## RaisinBran                     207.51867        155.63579 206.77524  187.763149
## RiceKrispies                    16.94107         69.19899  30.44667  112.614386
## Smacks                         210.23558        186.90238 190.75901  111.103555
```

```
## SpecialK                 51.61395        41.28559  34.17601   51.137071
## CapNCrunch               61.79806        63.53346  43.46263   45.847574
## HoneyGrahamOhs           60.95080        55.05906  43.27817   42.473521
## Life                    139.75693       100.71494 123.79015   51.429563
## PuffedRice              288.07291       268.01959 268.14175  194.285872
## PuffedWheat             286.59030       260.39297 267.26766  190.197266
## QuakerOatmeal           288.11333       251.39151 270.22452  189.167360
##                    MultiGrainCheerios OatmealRaisinCrisp RaisinNutBran
## ACCheerios                 46.23311           54.86347       81.27730
## Cheerios                   72.60165          122.99390      154.67870
## CocoaPuffs                 54.66260           68.87307       94.67576
## CountChocula               48.86717           59.52730       85.81084
## GoldenGrahams              75.75619          134.66811      169.58036
## HoneyNutCheerios           32.08582           87.77813      121.27242
## Kix                        65.18435          122.51326      156.98248
## LuckyCharms                54.53439           68.81497       94.61237
## MultiGrainCheerios          0.00000           65.73051       94.48016
## OatmealRaisinCrisp         65.73051            0.00000       47.05316
## RaisinNutBran              94.48016           47.05316        0.00000
## TotalCornFlakes            59.78294           92.92201      121.93646
## TotalRaisinBran           148.89258          112.36325      110.72263
## TotalWholeGrain            28.49561           44.25494       67.50185
## Trix                      103.77861          101.66858      115.57898
## Cheaties                   28.54820           44.32268       67.59068
## WheatiesHoneyGold          37.49667           70.08923      100.67025
## AllBran                   235.62258          227.65215      218.55320
## AppleJacks                113.16802          102.72536      111.66244
## CornFlakes                 89.32525          150.50083      183.51703
## CornPops                  148.13170          129.66302      130.50862
## CracklinOatBran           106.93456           54.11562       22.46108
## Crispix                    61.21274          105.40636      136.90325
## FrootLoops                113.09730          102.67668      111.59973
## FrostedFlakes              68.94926          101.65874      130.21713
## FrostedMiniWheats         220.23851          173.82606      145.66228
## FruitfulBran              104.15373           99.60171      113.74753
## JustRightCrunchyNuggets    59.20304           63.48622       86.31628
## MueslixCrispyBlend        116.00000           54.06940       64.55618
## NutNHoneyCrunch            61.74949           83.11137      113.70796
## NutriGrainAlmondRaisin     56.92100           52.60703       90.61733
## NutriGrainWheat            51.26402           50.89695       59.97083
## Product19                 109.82714          170.64730      203.82959
```

```
## RaisinBran                     151.81238          126.95472      123.83659
## RiceKrispies                     89.93331          148.84052      183.83008
## Smacks                          158.80176          129.79792      122.70086
## SpecialK                         38.11824           91.06866      124.48092
## CapNCrunch                       58.95761           99.18417      133.61699
## HoneyGrahamOhs                   49.61854           90.73313      125.86699
## Life                             70.27802           44.09649       46.17900
## PuffedRice                      237.84659          215.48898      194.44665
## PuffedWheat                     229.26622          200.79218      173.98707
## QuakerOatmeal                   221.43055          173.61650      143.67773
##                       TotalCornFlakes TotalRaisinBran TotalWholeGrain
## ACCheerios                    42.27884        163.23143        46.72794
## Cheerios                     114.19720        163.43806        90.77995
## CocoaPuffs                    31.33688        177.91852        60.44833
## CountChocula                  38.49675        168.09224        51.51699
## GoldenGrahams                 81.07404        208.01442       103.80270
## HoneyNutCheerios              75.28280        155.35282        55.42112
## Kix                           60.20797        205.11948        92.92470
## LuckyCharms                   31.01612        177.91852        60.26608
## MultiGrainCheerios            59.78294        148.89258        28.49561
## OatmealRaisinCrisp            92.92201        112.36325        44.25494
## RaisinNutBran                121.93646        110.72263        67.50185
## TotalCornFlakes                0.00000        197.98737        75.89466
## TotalRaisinBran              197.98737          0.00000       127.36954
## TotalWholeGrain               75.89466        127.36954         0.00000
## Trix                          62.01613        213.19709       105.01428
## Cheaties                      75.83535        127.38132         1.00000
## WheatiesHoneyGold             26.00000        173.05202        51.28353
## AllBran                      294.46562        134.42842       220.73061
## AppleJacks                    76.63550        212.49000       110.80162
## CornFlakes                    90.57041        223.19498       117.29024
## CornPops                     111.68259        234.56769       142.82507
## CracklinOatBran              139.22284         91.53142        79.10120
## Crispix                       20.66398        204.86093        83.25263
## FrootLoops                    76.49183        212.49000       110.70230
## FrostedFlakes                 14.69694        207.48253        86.03488
## FrostedMiniWheats            210.71545        233.77767       200.30227
## FruitfulBran                 160.87884         67.13419        92.14120
## JustRightCrunchyNuggets       39.38274        174.00575        59.28744
## MueslixCrispyBlend           144.05554         83.10836        93.28451
## NutNHoneyCrunch               17.23369        191.15962        73.80379
```

```
## NutriGrainAlmondRaisin         101.74478       104.81889        49.41660
## NutriGrainWheat                 65.92420       150.51578        37.49667
## Product19                      120.84701       229.95869       136.55036
## RaisinBran                     205.86646        30.09983       132.24598
## RiceKrispies                    90.01111       221.61453       117.77945
## Smacks                         131.20213       226.81931       148.65396
## SpecialK                        36.64696       182.38969        63.55313
## CapNCrunch                      25.76820       198.39103        80.84553
## HoneyGrahamOhs                  27.34959       188.56564        71.51224
## Life                            79.36624       146.64242        52.46904
## PuffedRice                     209.94047       301.07474       227.06167
## PuffedWheat                    209.65925       277.18586       214.82784
## QuakerOatmeal                  214.81688       229.06700       200.58437
##                                    Trix   Cheaties WheatiesHoneyGold   AllBran
## ACCheerios                      60.32827   46.85616          23.14087 265.7038
## Cheerios                       170.49047   90.77445         100.96039 221.1221
## CocoaPuffs                      50.02000   60.52272          21.63331 280.0071
## CountChocula                    56.58622   51.60426          21.63331 270.5624
## GoldenGrahams                  141.46731  103.81715          81.41867 278.9176
## HoneyNutCheerios               127.81823   55.51126          58.52777 233.8857
## Kix                            121.53600   92.87626          63.64747 283.3461
## LuckyCharms                     50.02000   60.34070          21.40093 279.9714
## MultiGrainCheerios             103.77861   28.54820          37.49667 235.6226
## OatmealRaisinCrisp             101.66858   44.32268          70.08923 227.6521
## RaisinNutBran                  115.57898   67.59068         100.67025 218.5532
## TotalCornFlakes                 62.01613   75.83535          26.00000 294.4656
## TotalRaisinBran                213.19709  127.38132         173.05202 134.4284
## TotalWholeGrain                105.01428    1.00000          51.28353 220.7306
## Trix                             0.00000  105.04761          69.65630 321.2476
## Cheaties                       105.04761    0.00000          51.29327 220.7736
## WheatiesHoneyGold               69.65630   51.29327           0.00000 270.1074
## AllBran                        321.24757  220.77364         270.10739   0.0000
## AppleJacks                      16.15549  110.85125          81.16034 322.6314
## CornFlakes                     151.21839  117.25187          94.27089 288.6157
## CornPops                        50.26927  142.84957         117.16228 347.3600
## CracklinOatBran                135.21464   79.18333         116.83749 204.0662
## Crispix                         81.07404   83.19856          36.75595 295.9206
## FrootLoops                      16.03122  110.75198          81.08637 322.6035
## FrostedFlakes                   60.03332   86.06393          35.21363 303.9474
## FrostedMiniWheats              159.26393  200.31475         204.23271 342.0395
## FruitfulBran                   193.27700   92.16832         136.52106 141.1241
```

```
## JustRightCrunchyNuggets  46.67976  59.27900        30.08322 278.3325
## MueslixCrispyBlend       144.41607  93.27915       122.60506 214.4808
## NutNHoneyCrunch           53.28227  73.82412        24.55606 293.1979
## NutriGrainAlmondRaisin   135.74977  49.32545        78.94302 206.9734
## NutriGrainWheat           75.25955  37.45664        47.39198 248.1290
## Product19               181.75808 136.52472       121.52366 283.4854
## RaisinBran              226.39567 132.26489       180.65713 107.3080
## RiceKrispies            150.87743 117.73275        93.74433 289.8965
## Smacks                   71.77743 148.70440       131.90148 340.9868
## SpecialK                 95.48298  63.56099        31.09662 269.9611
## CapNCrunch               81.25269  80.90117        34.05877 292.3867
## HoneyGrahamOhs           83.09031  71.57514        27.42262 282.5951
## Life                     71.77047  52.55473        62.05643 252.3906
## PuffedRice              153.11760 227.07708       213.77792 401.4686
## PuffedWheat             154.85800 214.85809       209.28688 375.5037
## QuakerOatmeal           164.96754 200.66163       207.09150 335.6988
##                         AppleJacks CornFlakes  CornPops CracklinOatBran
## ACCheerios               68.157905  116.63404 103.03155        98.57738
## Cheerios                181.868084   70.97887 217.69704       160.07498
## CocoaPuffs               60.456596  113.15918  96.58675       112.64546
## CountChocula             65.230361  115.34730 100.64293       103.38762
## GoldenGrahams           155.865326   19.69772 191.67681       181.32292
## HoneyNutCheerios        138.720943   69.86773 174.67541       130.46647
## Kix                     136.191042   32.06244 171.60420       170.17050
## LuckyCharms              60.473135  113.06193  96.58675       112.58330
## MultiGrainCheerios      113.168017   89.32525 148.13170       106.93456
## OatmealRaisinCrisp      102.725362  150.50083 129.66302        54.11562
## RaisinNutBran           111.662438  183.51703 130.50862        22.46108
## TotalCornFlakes          76.635501   90.57041 111.68259       139.22284
## TotalRaisinBran         212.490000  223.19498 234.56769        91.53142
## TotalWholeGrain         110.801625  117.29024 142.82507        79.10120
## Trix                     16.155494  151.21839  50.26927       135.21464
## Cheaties                110.851252  117.25187 142.84957        79.18333
## WheatiesHoneyGold        81.160335   94.27089 117.16228       116.83749
## AllBran                 322.631369  288.61566 347.36004       204.06617
## AppleJacks                0.000000  166.11442  36.52396       131.12589
## CornFlakes              166.114418    0.00000 201.22127       195.93366
## CornPops                 36.523965  201.22127   0.00000       148.84892
## CracklinOatBran         131.125894  195.93366 148.84892         0.00000
## Crispix                  96.156123   70.89429 130.94274       153.15352
## FrootLoops                1.414214  166.04819  36.49658       131.05724
```

```
## FrostedFlakes              75.292762   91.82048 110.12266           147.91552
## FrostedMiniWheats         143.833237  297.32810 120.97107           152.72852
## FruitfulBran              197.370211  164.59344 226.98238           105.12374
## JustRightCrunchyNuggets    55.009090  123.11783  89.74408           104.70912
## MueslixCrispyBlend        141.672157  197.41074 160.40262            51.83628
## NutNHoneyCrunch            66.843100  102.52804 102.54755           130.57565
## NutriGrainAlmondRaisin    141.714502  124.73572 173.20797            91.23048
## NutriGrainWheat            78.885994  132.43489 108.77959            79.36624
## Product19                 196.349179   31.67018 231.85987           214.14715
## RaisinBran                226.839150  221.34137 250.84258           106.98598
## RiceKrispies              165.810132   10.14889 200.97015           195.73196
## Smacks                     55.955339  220.99548  28.75761           139.20848
## SpecialK                  108.683025   64.35837 144.70660           138.57850
## CapNCrunch                 95.713113   74.07429 131.26690           148.91273
## HoneyGrahamOhs             96.772930   74.61233 132.78178           140.56671
## Life                       70.880181  152.66303  96.82975            66.60330
## PuffedRice                140.185591  295.07626 108.94953           210.50416
## PuffedWheat               140.790625  294.87285 112.93361           188.06382
## QuakerOatmeal             149.699332  300.23639 128.79398           149.41114
##                             Crispix FrootLoops FrostedFlakes FrostedMiniWheats
## ACCheerios                 57.99569  68.084506      49.43177         182.83462
## Cheerios                  102.79105 181.791089     120.99174         290.31707
## CocoaPuffs                 49.08156  60.440053      36.19392         185.95430
## CountChocula               54.85435  65.215029      44.83302         183.79064
## GoldenGrahams              62.44998 155.833244      82.50455         285.55910
## HoneyNutCheerios           68.12855 138.692105      82.08228         250.43662
## Kix                        41.25530 136.110249      62.77738         267.16287
## LuckyCharms                48.87740  60.440053      36.16628         185.91665
## MultiGrainCheerios         61.21274 113.097303      68.94926         220.23851
## OatmealRaisinCrisp        105.40636 102.676677     101.65874         173.82606
## RaisinNutBran             136.90325 111.599731     130.21713         145.66228
## TotalCornFlakes            20.66398  76.491830      14.69694         210.71545
## TotalRaisinBran           204.86093 212.490000     207.48253         233.77767
## TotalWholeGrain            83.25263 110.702303      86.03488         200.30227
## Trix                       81.07404  16.031220      60.03332         159.26393
## Cheaties                   83.19856 110.751975      86.06393         200.31475
## WheatiesHoneyGold          36.75595  81.086374      35.21363         204.23271
## AllBran                   295.92060 322.603472     303.94736         342.03947
## AppleJacks                 96.15612   1.414214      75.29276         143.83324
## CornFlakes                 70.89429 166.048186      91.82048         297.32810
## CornPops                  130.94274  36.496575     110.12266         120.97107
```

```
## CracklinOatBran           153.15352 131.057239     147.91552          152.72852
## Crispix                     0.00000  96.052069      23.21637          231.23581
## FrootLoops                  96.05207   0.000000      75.26619          143.79152
## FrostedFlakes               23.21637  75.266194       0.00000          213.89016
## FrostedMiniWheats          231.23581 143.791516     213.89016            0.00000
## FruitfulBran               162.00926 197.365144     170.13524          257.15559
## JustRightCrunchyNuggets     58.53204  54.863467      46.48656          174.97428
## MueslixCrispyBlend         156.28500 141.658039     152.47951          172.47898
## NutNHoneyCrunch             34.26368  66.768256      20.80865          200.28979
## NutriGrainAlmondRaisin     104.52272 141.658039     111.36427          225.72771
## NutriGrainWheat             80.71555  78.746428      75.03333          170.70735
## Product19                  101.62185 196.298242     122.49082          324.77839
## RaisinBran                 210.82694 226.830333     215.51566          253.23902
## RiceKrispies                70.19259 165.749811      91.26883          297.51471
## Smacks                     151.29111  55.973208     131.02671           93.24698
## SpecialK                    27.67671 108.590976      43.50862          234.64441
## CapNCrunch                  17.11724  95.681764      24.69818          230.37144
## HoneyGrahamOhs              21.79449  96.731587      30.13304          227.72132
## Life                        96.56086  70.753092      86.85045          150.11995
## PuffedRice                 228.69193 140.092826     209.33944           98.93432
## PuffedWheat                229.19424 140.698259     210.62526           71.20393
## QuakerOatmeal              235.20181 149.605782     218.21295           17.69435
##                          FruitfulBran JustRightCrunchyNuggets MueslixCrispyBlend
## ACCheerios                  134.66068                16.10900          107.49186
## Cheerios                     99.88493               128.32771          158.99371
## CocoaPuffs                  148.18907                14.17745          120.26637
## CountChocula                139.14022                14.17745          111.64229
## GoldenGrahams               150.88075               111.08555          180.71801
## HoneyNutCheerios            101.11132                85.71756          132.07006
## Kix                         152.17424                92.33634          170.66634
## LuckyCharms                 148.17557                13.67479          120.25806
## MultiGrainCheerios          104.15373                59.20304          116.00000
## OatmealRaisinCrisp           99.60171                63.48622           54.06940
## RaisinNutBran               113.74753                86.31628           64.55618
## TotalCornFlakes             160.87884                39.38274          144.05554
## TotalRaisinBran              67.13419               174.00575           83.10836
## TotalWholeGrain              92.14120                59.28744           93.28451
## Trix                        193.27700                46.67976          144.41607
## Cheaties                     92.16832                59.27900           93.27915
## WheatiesHoneyGold           136.52106                30.08322          122.60506
## AllBran                     141.12406               278.33253          214.48077
```

```
## AppleJacks                197.37021                 55.00909              141.67216
## CornFlakes                164.59344                123.11783              197.41074
## CornPops                  226.98238                 89.74408              160.40262
## CracklinOatBran           105.12374                104.70912               51.83628
## Crispix                   162.00926                 58.53204              156.28500
## FrootLoops                197.36514                 54.86347              141.65804
## FrostedFlakes             170.13524                 46.48656              152.47951
## FrostedMiniWheats         257.15559                174.97428              172.47898
## FruitfulBran                0.00000                148.19919              103.04368
## JustRightCrunchyNuggets   148.19919                  0.00000              113.82003
## MueslixCrispyBlend        103.04368                113.82003                0.00000
## NutNHoneyCrunch           158.23084                 30.23243              132.78178
## NutriGrainAlmondRaisin     66.94774                 91.23048               79.06959
## NutriGrainWheat           126.17448                 36.37307              101.61693
## Product19                 167.20646                151.14563              214.10745
## RaisinBran                 58.31809                184.82965              107.77291
## RiceKrispies              163.69484                122.72327              194.58674
## Smacks                    227.05066                102.68885              152.88558
## SpecialK                  136.14331                 60.43178              141.57330
## CapNCrunch                156.40332                 57.34980              148.87579
## HoneyGrahamOhs            146.47184                 53.63767              140.57738
## Life                      132.58582                 41.90465               88.88757
## PuffedRice                305.44885                185.95698              236.27738
## PuffedWheat               286.83968                180.79270              216.62641
## QuakerOatmeal             254.36841                178.30841              170.30587
##                 NutNHoneyCrunch NutriGrainAlmondRaisin NutriGrainWheat
## ACCheerios             33.53357               78.88282        32.05464
## Cheerios              120.05832               80.54191       122.64175
## CocoaPuffs             21.23676               90.86253        43.54308
## CountChocula           29.17190               82.80097        36.00000
## GoldenGrahams          90.69730              108.53110       120.81805
## HoneyNutCheerios       78.84478               59.18192        83.12340
## Kix                    71.21798              103.08734       104.98095
## LuckyCharms            21.04757               90.78546        43.26662
## MultiGrainCheerios     61.74949               56.92100        51.26402
## OatmealRaisinCrisp     83.11137               52.60703        50.89695
## RaisinNutBran         113.70796               90.61733        59.97083
## TotalCornFlakes        17.23369              101.74478        65.92420
## TotalRaisinBran       191.15962              104.81889       150.51578
## TotalWholeGrain        73.80379               49.41660        37.49667
## Trix                   53.28227              135.74977        75.25955
```

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## Cheaties                   73.82412           49.32545      37.45664
## WheatiesHoneyGold          24.55606           78.94302      47.39198
## AllBran                   293.19789          206.97343     248.12900
## AppleJacks                 66.84310          141.71450      78.88599
## CornFlakes                102.52804          124.73572     132.43489
## CornPops                  102.54755          173.20797     108.77959
## CracklinOatBran           130.57565           91.23048      79.36624
## Crispix                    34.26368          104.52272      80.71555
## FrootLoops                 66.76826          141.65804      78.74643
## FrostedFlakes              20.80865          111.36427      75.03333
## FrostedMiniWheats         200.28979          225.72771     170.70735
## FruitfulBran              158.23084           66.94774     126.17448
## JustRightCrunchyNuggets    30.23243           91.23048      36.37307
## MueslixCrispyBlend        132.78178           79.06959     101.61693
## NutNHoneyCrunch             0.00000           97.21625      62.20129
## NutriGrainAlmondRaisin     97.21625            0.00000      81.47392
## NutriGrainWheat            62.20129           81.47392       0.00000
## Product19                 131.86736          137.29530     156.95222
## RaisinBran                201.08705          112.60107     158.49606
## RiceKrispies              101.04949          121.88519     133.61138
## Smacks                    120.71868          178.08425     114.69961
## SpecialK                   44.49719           81.74962      72.40856
## CapNCrunch                 30.74085           97.69340      81.10487
## HoneyGrahamOhs             30.67572           87.92042      74.52516
## Life                       71.07742           88.36855      24.14539
## PuffedRice                204.23516          264.30096     190.17623
## PuffedWheat               202.99754          251.15533     179.36834
## QuakerOatmeal             204.15017          225.47747     172.33134
##                     Product19 RaisinBran RiceKrispies     Smacks   SpecialK
## ACCheerios          143.07166  173.00434    116.24328 114.14245   53.14603
## Cheerios             68.02206  157.71493     70.37755 230.00652   78.16649
## CocoaPuffs          141.31525  187.77380    112.70315 111.08555   51.41012
## CountChocula        142.37275  177.92976    114.89996 112.87161   52.37366
## GoldenGrahams        42.03570  207.51867     16.94107 210.23558   51.61395
## HoneyNutCheerios     84.54289  155.63579     69.19899 186.90238   41.28559
## Kix                  61.06554  206.77524     30.44667 190.75901   34.17601
## LuckyCharms         141.23739  187.76315    112.61439 111.10356   51.13707
## MultiGrainCheerios  109.82714  151.81238     89.93331 158.80176   38.11824
## OatmealRaisinCrisp  170.64730  126.95472    148.84052 129.79792   91.06866
## RaisinNutBran       203.82959  123.83659    183.83008 122.70086  124.48092
## TotalCornFlakes     120.84701  205.86646     90.01111 131.20213   36.64696
```

```
## TotalRaisinBran            229.95869   30.09983    221.61453 226.81931 182.38969
## TotalWholeGrain            136.55036  132.24598    117.77945 148.65396  63.55313
## Trix                       181.75808  226.39567    150.87743  71.77743  95.48298
## Cheaties                   136.52472  132.26489    117.73275 148.70440  63.56099
## WheatiesHoneyGold          121.52366  180.65713     93.74433 131.90148  31.09662
## AllBran                    283.48545  107.30797    289.89653 340.98680 269.96111
## AppleJacks                 196.34918  226.83915    165.81013  55.95534 108.68303
## CornFlakes                  31.67018  221.34137     10.14889 220.99548  64.35837
## CornPops                   231.85987  250.84258    200.97015  28.75761 144.70660
## CracklinOatBran            214.14715  106.98598    195.73196 139.20848 138.57850
## Crispix                    101.62185  210.82694     70.19259 151.29111  27.67671
## FrootLoops                 196.29824  226.83033    165.74981  55.97321 108.59098
## FrostedFlakes              122.49082  215.51566     91.26883 131.02671  43.50862
## FrostedMiniWheats          324.77839  253.23902    297.51471  93.24698 234.64441
## FruitfulBran               167.20646   58.31809    163.69484 227.05066 136.14331
## JustRightCrunchyNuggets    151.14563  184.82965    122.72327 102.68885  60.43178
## MueslixCrispyBlend         214.10745  107.77291    194.58674 152.88558 141.57330
## NutNHoneyCrunch            131.86736  201.08705    101.04949 120.71868  44.49719
## NutriGrainAlmondRaisin     137.29530  112.60107    121.88519 178.08425  81.74962
## NutriGrainWheat            156.95222  158.49606    133.61138 114.69961  72.40856
## Product19                    0.00000  225.07554     33.25658 250.78277  91.24144
## RaisinBran                 225.07554    0.00000    220.67397 244.44018 186.64405
## RiceKrispies                33.25658  220.67397      0.00000 220.77137  63.66318
## Smacks                     250.78277  244.44018    220.77137   0.00000 161.35365
## SpecialK                    91.24144  186.64405     63.66318 161.35365   0.00000
## CapNCrunch                 103.21822  205.32657     72.01389 150.48588  26.96294
## HoneyGrahamOhs             102.64502  195.32281     72.59477 150.50581  20.22375
## Life                       177.42322  158.35403    153.03921  98.08670  90.18869
## PuffedRice                 325.36595  315.91138    296.96970  96.79359 241.13067
## PuffedWheat                324.09104  292.02397    296.78106  93.95212 237.87812
## QuakerOatmeal              327.10991  248.39543    300.48343 100.86075 237.19589
##                           CapNCrunch HoneyGrahamOhs       Life PuffedRice
## ACCheerios                  54.17103      48.26489   40.58941  197.83453
## Cheerios                   100.37430      93.54678  140.90422  309.59651
## CocoaPuffs                  45.84757      42.49706   51.60426  194.34763
## CountChocula                51.00980      45.89118   44.30576  196.64943
## GoldenGrahams               61.79806      60.95080  139.75693  288.07291
## HoneyNutCheerios            63.53346      55.05906  100.71494  268.01959
## Kix                         43.46263      43.27817  123.79015  268.14175
## LuckyCharms                 45.84757      42.47352   51.42956  194.28587
## MultiGrainCheerios          58.95761      49.61854   70.27802  237.84659
```

```
## OatmealRaisinCrisp       99.18417        90.73313  44.09649  215.48898
## RaisinNutBran           133.61699       125.86699  46.17900  194.44665
## TotalCornFlakes          25.76820        27.34959  79.36624  209.94047
## TotalRaisinBran         198.39103       188.56564 146.64242  301.07474
## TotalWholeGrain          80.84553        71.51224  52.46904  227.06167
## Trix                     81.25269        83.09031  71.77047  153.11760
## Cheaties                 80.90117        71.57514  52.55473  227.07708
## WheatiesHoneyGold        34.05877        27.42262  62.05643  213.77792
## AllBran                 292.38673       282.59512 252.39057  401.46855
## AppleJacks               95.71311        96.77293  70.88018  140.18559
## CornFlakes               74.07429        74.61233 152.66303  295.07626
## CornPops                131.26690       132.78178  96.82975  108.94953
## CracklinOatBran         148.91273       140.56671  66.60330  210.50416
## Crispix                  17.11724        21.79449  96.56086  228.69193
## FrootLoops               95.68176        96.73159  70.75309  140.09283
## FrostedFlakes            24.69818        30.13304  86.85045  209.33944
## FrostedMiniWheats       230.37144       227.72132 150.11995   98.93432
## FruitfulBran            156.40332       146.47184 132.58582  305.44885
## JustRightCrunchyNuggets  57.34980        53.63767  41.90465  185.95698
## MueslixCrispyBlend      148.87579       140.57738  88.88757  236.27738
## NutNHoneyCrunch          30.74085        30.67572  71.07742  204.23516
## NutriGrainAlmondRaisin   97.69340        87.92042  88.36855  264.30096
## NutriGrainWheat          81.10487        74.52516  24.14539  190.17623
## Product19               103.21822       102.64502 177.42322  325.36595
## RaisinBran              205.32657       195.32281 158.35403  315.91138
## RiceKrispies             72.01389        72.59477 153.03921  296.96970
## Smacks                  150.48588       150.50581  98.08670   96.79359
## SpecialK                 26.96294        20.22375  90.18869  241.13067
## CapNCrunch                0.00000        10.09950  94.59915  232.05387
## HoneyGrahamOhs           10.09950         0.00000  88.51554  233.08153
## Life                     94.59915        88.51554   0.00000  177.35276
## PuffedRice              232.05387       233.08153 177.35276    0.00000
## PuffedWheat             231.68729       231.20337 164.54179   35.15679
## QuakerOatmeal           233.85955       230.79188 151.23654  108.15401
##                       PuffedWheat QuakerOatmeal
## ACCheerios              191.06151     185.15315
## Cheerios                301.32375     290.65872
## CocoaPuffs              190.26560     189.24664
## CountChocula            190.79046     186.58588
## GoldenGrahams           286.59030     288.11333
## HoneyNutCheerios        260.39297     251.39151
```

```
## Kix                        267.26766        270.22452
## LuckyCharms                190.19727        189.16736
## MultiGrainCheerios         229.26622        221.43055
## OatmealRaisinCrisp         200.79218        173.61650
## RaisinNutBran              173.98707        143.67773
## TotalCornFlakes            209.65925        214.81688
## TotalRaisinBran            277.18586        229.06700
## TotalWholeGrain            214.82784        200.58437
## Trix                       154.85800        164.96754
## Cheaties                   214.85809        200.66163
## WheatiesHoneyGold          209.28688        207.09150
## AllBran                    375.50366        335.69881
## AppleJacks                 140.79062        149.69933
## CornFlakes                 294.87285        300.23639
## CornPops                   112.93361        128.79398
## CracklinOatBran            188.06382        149.41114
## Crispix                    229.19424        235.20181
## FrootLoops                 140.69826        149.60578
## FrostedFlakes              210.62526        218.21295
## FrostedMiniWheats           71.20393         17.69435
## FruitfulBran               286.83968        254.36841
## JustRightCrunchyNuggets    180.79270        178.30841
## MueslixCrispyBlend         216.62641        170.30587
## NutNHoneyCrunch            202.99754        204.15017
## NutriGrainAlmondRaisin     251.15533        225.47747
## NutriGrainWheat            179.36834        172.33134
## Product19                  324.09104        327.10991
## RaisinBran                 292.02397        248.39543
## RiceKrispies               296.78106        300.48343
## Smacks                      93.95212        100.86075
## SpecialK                   237.87812        237.19589
## CapNCrunch                 231.68729        233.85955
## HoneyGrahamOhs             231.20337        230.79188
## Life                       164.54179        151.23654
## PuffedRice                  35.15679        108.15401
## PuffedWheat                  0.00000         78.72668
## QuakerOatmeal               78.72668          0.00000
```

```
#complete linkage
seg.hc = hclust(df2,method='complete')
plot(seg.hc,cex=0.4)
#
# cut at h=0.5
abline(h=0.5,col='red',lty=2)
cut(as.dendrogram(seg.hc),h=0.5)
```

```
## $upper
## 'dendrogram' with 2 branches and 43 members total, at height 401.4686
##
## $lower
## $lower[[1]]
## 'dendrogram' leaf 'Trix', at height 0
##
## $lower[[2]]
## 'dendrogram' leaf 'AppleJacks', at height 0
##
## $lower[[3]]
## 'dendrogram' leaf 'FrootLoops', at height 0
##
## $lower[[4]]
## 'dendrogram' leaf 'CornPops', at height 0
##
## $lower[[5]]
## 'dendrogram' leaf 'Smacks', at height 0
##
## $lower[[6]]
## 'dendrogram' leaf 'FrostedMiniWheats', at height 0
##
## $lower[[7]]
## 'dendrogram' leaf 'QuakerOatmeal', at height 0
##
## $lower[[8]]
## 'dendrogram' leaf 'PuffedRice', at height 0
##
## $lower[[9]]
## 'dendrogram' leaf 'PuffedWheat', at height 0
##
## $lower[[10]]
## 'dendrogram' leaf 'Cheerios', at height 0
##
## $lower[[11]]
## 'dendrogram' leaf 'HoneyNutCheerios', at height 0
##
## $lower[[12]]
## 'dendrogram' leaf 'Product19', at height 0
##
```

```
## $lower[[13]]
## 'dendrogram' leaf 'Kix', at height 0
##
## $lower[[14]]
## 'dendrogram' leaf 'GoldenGrahams', at height 0
##
## $lower[[15]]
## 'dendrogram' leaf 'CornFlakes', at height 0
##
## $lower[[16]]
## 'dendrogram' leaf 'RiceKrispies', at height 0
##
## $lower[[17]]
## 'dendrogram' leaf 'WheatiesHoneyGold', at height 0
##
## $lower[[18]]
## 'dendrogram' leaf 'ACCheerios', at height 0
##
## $lower[[19]]
## 'dendrogram' leaf 'CountChocula', at height 0
##
## $lower[[20]]
## 'dendrogram' leaf 'JustRightCrunchyNuggets', at height 0
##
## $lower[[21]]
## 'dendrogram' leaf 'CocoaPuffs', at height 0
##
## $lower[[22]]
## 'dendrogram' leaf 'LuckyCharms', at height 0
##
## $lower[[23]]
## 'dendrogram' leaf 'NutNHoneyCrunch', at height 0
##
## $lower[[24]]
## 'dendrogram' leaf 'TotalCornFlakes', at height 0
##
## $lower[[25]]
## 'dendrogram' leaf 'FrostedFlakes', at height 0
##
## $lower[[26]]
## 'dendrogram' leaf 'SpecialK', at height 0
```

```
## 
## $lower[[27]]
## 'dendrogram' leaf 'Crispix', at height 0
## 
## $lower[[28]]
## 'dendrogram' leaf 'CapNCrunch', at height 0
## 
## $lower[[29]]
## 'dendrogram' leaf 'HoneyGrahamOhs', at height 0
## 
## $lower[[30]]
## 'dendrogram' leaf 'OatmealRaisinCrisp', at height 0
## 
## $lower[[31]]
## 'dendrogram' leaf 'NutriGrainWheat', at height 0
## 
## $lower[[32]]
## 'dendrogram' leaf 'Life', at height 0
## 
## $lower[[33]]
## 'dendrogram' leaf 'NutriGrainAlmondRaisin', at height 0
## 
## $lower[[34]]
## 'dendrogram' leaf 'MultiGrainCheerios', at height 0
## 
## $lower[[35]]
## 'dendrogram' leaf 'TotalWholeGrain', at height 0
## 
## $lower[[36]]
## 'dendrogram' leaf 'Cheaties', at height 0
## 
## $lower[[37]]
## 'dendrogram' leaf 'AllBran', at height 0
## 
## $lower[[38]]
## 'dendrogram' leaf 'MueslixCrispyBlend', at height 0
## 
## $lower[[39]]
## 'dendrogram' leaf 'RaisinNutBran', at height 0
## 
## $lower[[40]]
```

```
## 'dendrogram' leaf 'CracklinOatBran', at height 0
##
## $lower[[41]]
## 'dendrogram' leaf 'FruitfulBran', at height 0
##
## $lower[[42]]
## 'dendrogram' leaf 'TotalRaisinBran', at height 0
##
## $lower[[43]]
## 'dendrogram' leaf 'RaisinBran', at height 0
```

```
# identigy the clusters
rect.hclust(seg.hc,k=4)
```

Cluster Dendrogram

df2
hclust (*, "complete")
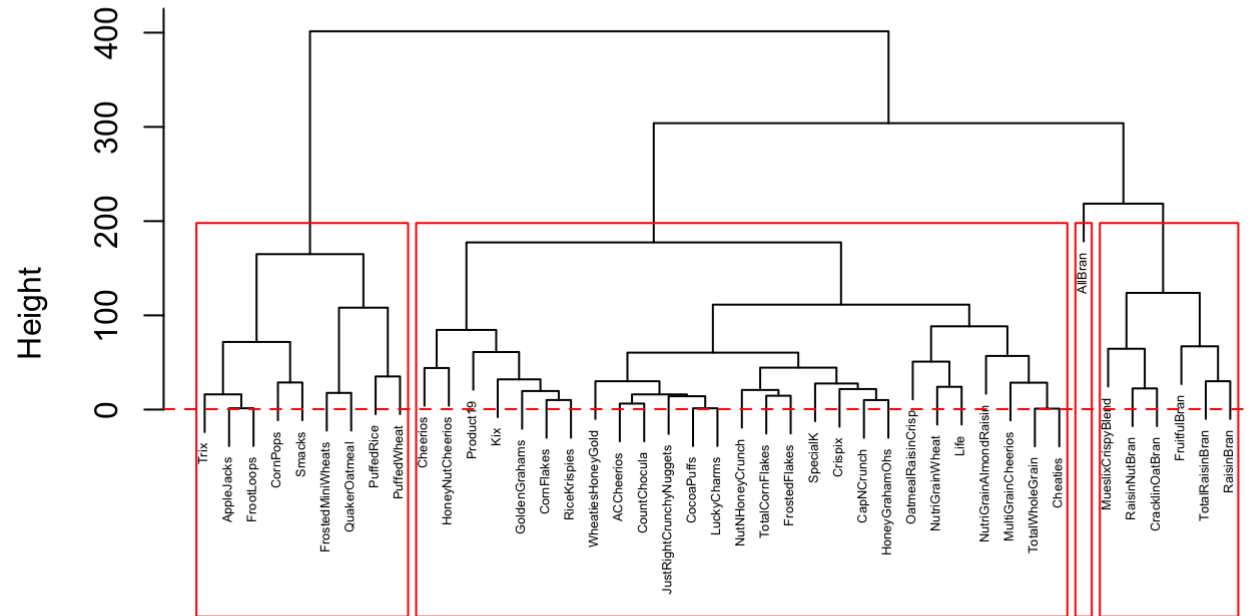
```
#single linkage
seg.hc2 = hclust(df2,method='single')
plot(seg.hc2,cex=0.4)
#
# cut at h=0.5
abline(h=0.5,col='red',lty=2)
cut(as.dendrogram(seg.hc2),h=0.5)
```

```
## $upper
## 'dendrogram' with 2 branches and 43 members total, at height 107.308
##
## $lower
## $lower[[1]]
## 'dendrogram' leaf 'AllBran', at height 0
##
## $lower[[2]]
## 'dendrogram' leaf 'MueslixCrispyBlend', at height 0
##
## $lower[[3]]
## 'dendrogram' leaf 'NutriGrainAlmondRaisin', at height 0
##
## $lower[[4]]
## 'dendrogram' leaf 'Trix', at height 0
##
## $lower[[5]]
## 'dendrogram' leaf 'AppleJacks', at height 0
##
## $lower[[6]]
## 'dendrogram' leaf 'FrootLoops', at height 0
##
## $lower[[7]]
## 'dendrogram' leaf 'CornPops', at height 0
##
## $lower[[8]]
## 'dendrogram' leaf 'Smacks', at height 0
##
## $lower[[9]]
## 'dendrogram' leaf 'RaisinNutBran', at height 0
##
## $lower[[10]]
## 'dendrogram' leaf 'CracklinOatBran', at height 0
##
## $lower[[11]]
## 'dendrogram' leaf 'Cheerios', at height 0
##
## $lower[[12]]
## 'dendrogram' leaf 'OatmealRaisinCrisp', at height 0
##
```

```
## $lower[[13]]
## 'dendrogram' leaf 'HoneyNutCheerios', at height 0
##
## $lower[[14]]
## 'dendrogram' leaf 'MultiGrainCheerios', at height 0
##
## $lower[[15]]
## 'dendrogram' leaf 'TotalWholeGrain', at height 0
##
## $lower[[16]]
## 'dendrogram' leaf 'Cheaties', at height 0
##
## $lower[[17]]
## 'dendrogram' leaf 'Product19', at height 0
##
## $lower[[18]]
## 'dendrogram' leaf 'Kix', at height 0
##
## $lower[[19]]
## 'dendrogram' leaf 'GoldenGrahams', at height 0
##
## $lower[[20]]
## 'dendrogram' leaf 'CornFlakes', at height 0
##
## $lower[[21]]
## 'dendrogram' leaf 'RiceKrispies', at height 0
##
## $lower[[22]]
## 'dendrogram' leaf 'WheatiesHoneyGold', at height 0
##
## $lower[[23]]
## 'dendrogram' leaf 'JustRightCrunchyNuggets', at height 0
##
## $lower[[24]]
## 'dendrogram' leaf 'CocoaPuffs', at height 0
##
## $lower[[25]]
## 'dendrogram' leaf 'LuckyCharms', at height 0
##
## $lower[[26]]
## 'dendrogram' leaf 'ACCheerios', at height 0
```

```
## 
## $lower[[27]]
## 'dendrogram' leaf 'CountChocula', at height 0
## 
## $lower[[28]]
## 'dendrogram' leaf 'NutNHoneyCrunch', at height 0
## 
## $lower[[29]]
## 'dendrogram' leaf 'TotalCornFlakes', at height 0
## 
## $lower[[30]]
## 'dendrogram' leaf 'FrostedFlakes', at height 0
## 
## $lower[[31]]
## 'dendrogram' leaf 'SpecialK', at height 0
## 
## $lower[[32]]
## 'dendrogram' leaf 'Crispix', at height 0
## 
## $lower[[33]]
## 'dendrogram' leaf 'CapNCrunch', at height 0
## 
## $lower[[34]]
## 'dendrogram' leaf 'HoneyGrahamOhs', at height 0
## 
## $lower[[35]]
## 'dendrogram' leaf 'NutriGrainWheat', at height 0
## 
## $lower[[36]]
## 'dendrogram' leaf 'Life', at height 0
## 
## $lower[[37]]
## 'dendrogram' leaf 'FruitfulBran', at height 0
## 
## $lower[[38]]
## 'dendrogram' leaf 'TotalRaisinBran', at height 0
## 
## $lower[[39]]
## 'dendrogram' leaf 'RaisinBran', at height 0
## 
## $lower[[40]]
```

```
## 'dendrogram' leaf 'FrostedMiniWheats', at height 0
##
## $lower[[41]]
## 'dendrogram' leaf 'QuakerOatmeal', at height 0
##
## $lower[[42]]
## 'dendrogram' leaf 'PuffedRice', at height 0
##
## $lower[[43]]
## 'dendrogram' leaf 'PuffedWheat', at height 0
```

```
# identigy the clusters
rect.hclust(seg.hc2,k=4)
```

Cluster Dendrogram
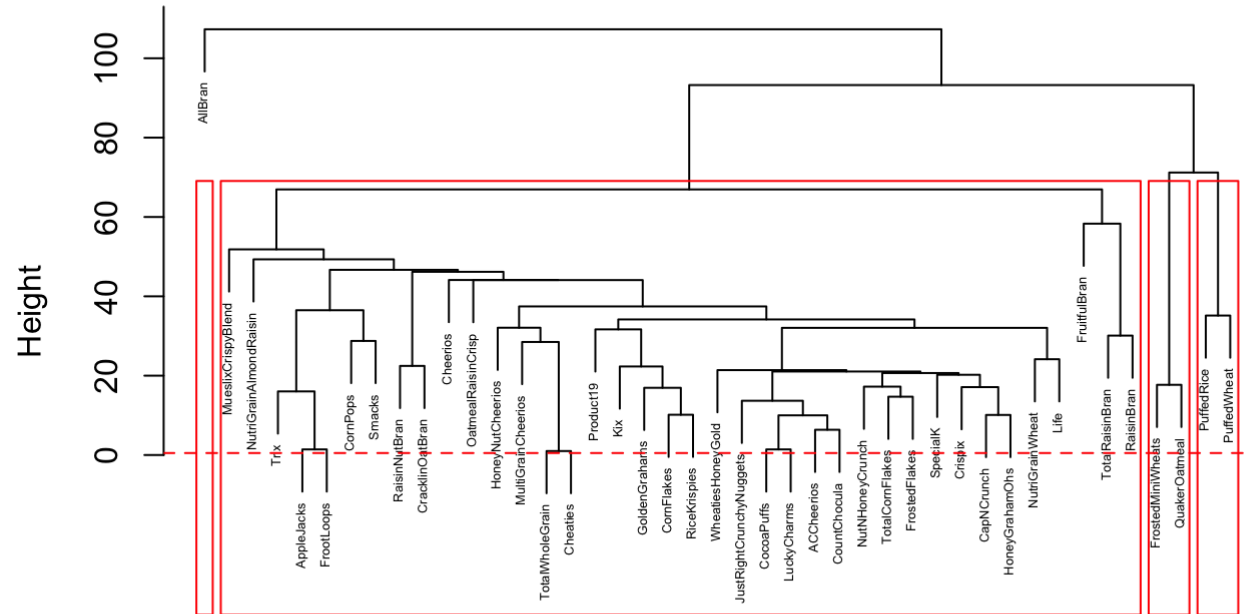
df2
hclust (*, "single")

```
complete = cutree(seg.hc, k=4)
single = cutree(seg.hc2, k=4)
data.frame(complete, single)
```

```
##                         complete single
## ACCheerios                     1      1
## Cheerios                       1      1
## CocoaPuffs                     1      1
## CountChocula                   1      1
## GoldenGrahams                  1      1
## HoneyNutCheerios               1      1
## Kix                            1      1
## LuckyCharms                    1      1
## MultiGrainCheerios             1      1
## OatmealRaisinCrisp             1      1
## RaisinNutBran                  2      1
## TotalCornFlakes                1      1
## TotalRaisinBran                2      1
## TotalWholeGrain                1      1
## Trix                           3      1
## Cheaties                       1      1
## WheatiesHoneyGold              1      1
## AllBran                        4      2
## AppleJacks                     3      1
## CornFlakes                     1      1
## CornPops                       3      1
## CracklinOatBran                2      1
## Crispix                        1      1
## FrootLoops                     3      1
## FrostedFlakes                  1      1
## FrostedMiniWheats              3      3
## FruitfulBran                   2      1
## JustRightCrunchyNuggets        1      1
## MueslixCrispyBlend             2      1
## NutNHoneyCrunch                1      1
## NutriGrainAlmondRaisin         1      1
## NutriGrainWheat                1      1
## Product19                      1      1
## RaisinBran                     2      1
## RiceKrispies                   1      1
## Smacks                         3      1
## SpecialK                       1      1
## CapNCrunch                     1      1
## HoneyGrahamOhs                 1      1
```

```
## Life                               1     1
## PuffedRice                         3     4
## PuffedWheat                        3     4
## QuakerOatmeal                      3     3
```

```
km.out = kmeans(df2,4,nstart=20)
km.out
```

```
## K-means clustering with 4 clusters of sizes 26, 7, 6, 4
##
## Cluster means:
##    ACCheerios   Cheerios CocoaPuffs CountChocula GoldenGrahams HoneyNutCheerios
## 1    47.8993 121.75578   48.82145     47.74614     110.07887         83.66333
## 2   107.7706  55.28578  107.18824    107.42079      30.98308         53.48013
## 3   162.3430 273.26660  161.24774    161.88849     258.37467        231.96975
## 4   184.1501 160.54002  198.47213    188.93115     211.33285        161.49640
##          Kix LuckyCharms MultiGrainCheerios OatmealRaisinCrisp RaisinNutBran
## 1  94.05925    48.70358           63.38776           69.76754      89.59015
## 2  38.59062   107.10286           76.38767          133.99172     167.67010
## 3 239.19333   161.20957          202.61922          170.53078     151.83053
## 4 211.85376   198.45717          160.12032          141.64296     141.71498
##    TotalCornFlakes TotalRaisinBran TotalWholeGrain     Trix  Cheaties
## 1         58.56535       163.32994        63.22945  75.96952  63.26027
## 2         90.31294       200.95614       102.07836 149.30942 102.06978
## 3        181.33613       250.41538       189.04253 125.70896 189.07759
## 4        214.79957        57.91561       143.12183 238.52933 143.14704
##    WheatiesHoneyGold    AllBran AppleJacks CornFlakes  CornPops CracklinOatBran
## 1          50.13712 265.11591   82.21697   122.6498 114.35161        102.9191
## 2          87.72760 268.46701  162.98845    33.4894 198.52925        178.2639
## 3         180.57546 357.17622  111.16468   268.2884  83.40097        164.7942
## 4         190.08440  95.71511  239.83268   224.4364 264.93817        126.9268
##       Crispix FrootLoops FrostedFlakes FrostedMiniWheats FruitfulBran
## 1  68.66627    82.1484      63.94409         189.44487     137.26380
## 2  73.90480   162.9318      93.41944         287.58526     142.79228
## 3 201.09294   111.1097     182.20286          67.00844     259.64093
## 4 218.40443   239.8222     224.27020         271.55294      66.64409
##    JustRightCrunchyNuggets MueslixCrispyBlend NutNHoneyCrunch
## 1                 50.24756           110.8868        54.80542
## 2                116.35055           178.3647        99.46618
## 3                152.07755           184.8295       172.48981
## 4                196.34178           127.1014       210.91885
##    NutriGrainAlmondRaisin NutriGrainWheat Product19 RaisinBran RiceKrispies
## 1                86.68727        57.96623 147.93492  173.22835    122.04347
## 2               105.03693       122.08038  45.79899  199.24793     32.90997
## 3               219.65895       156.01041 297.33132  267.47543    268.91507
## 4               122.83528       170.82883 226.43154   48.93147    223.96997
##       Smacks  SpecialK CapNCrunch HoneyGrahamOhs      Life PuffedRice
## 1 125.21950  66.04419   66.19271       62.24881  63.30901  205.97130
```

```
## 2 215.77902  60.64358   74.06783      71.81242 141.18453  293.03467
## 3  68.93517 209.48489  201.62082     201.01428 139.69458   74.66471
## 4 259.82424 193.78454  213.12691     203.23885 172.49321  330.97588
##    PuffedWheat QuakerOatmeal
## 1    199.05667     191.64569
## 2    290.18852     289.74540
## 3     65.32885      72.37163
## 4    307.88829     266.88241
##
## Clustering vector:
##            ACCheerios               Cheerios              CocoaPuffs
##                     1                      2                       1
##           CountChocula           GoldenGrahams         HoneyNutCheerios
##                     1                      2                       2
##                   Kix              LuckyCharms        MultiGrainCheerios
##                     2                      1                       1
##       OatmealRaisinCrisp          RaisinNutBran           TotalCornFlakes
##                     1                      1                       1
##         TotalRaisinBran         TotalWholeGrain                     Trix
##                     4                      1                       1
##               Cheaties        WheatiesHoneyGold                  AllBran
##                     1                      1                       4
##             AppleJacks              CornFlakes                 CornPops
##                     1                      2                       3
##         CracklinOatBran                Crispix               FrootLoops
##                     1                      1                       1
##           FrostedFlakes        FrostedMiniWheats             FruitfulBran
##                     1                      3                       4
## JustRightCrunchyNuggets       MueslixCrispyBlend          NutNHoneyCrunch
##                     1                      1                       1
##   NutriGrainAlmondRaisin          NutriGrainWheat               Product19
##                     1                      1                       2
##             RaisinBran              RiceKrispies                   Smacks
##                     4                      2                       3
##               SpecialK               CapNCrunch          HoneyGrahamOhs
##                     1                      1                       1
##                  Life                PuffedRice              PuffedWheat
##                     1                      3                       3
##          QuakerOatmeal
##                     3
##
```

```
## Within cluster sum of squares by cluster:
## [1] 1245040.3  153752.4  382829.7  386274.6
##  (between_SS / total_SS =  72.3 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
kmeans = km.out$cluster
df2_c = data.frame(complete,single,kmeans)
df2_c
```

```
##                          complete single kmeans
## ACCheerios                     1      1      1
## Cheerios                       1      1      2
## CocoaPuffs                     1      1      1
## CountChocula                   1      1      1
## GoldenGrahams                  1      1      2
## HoneyNutCheerios               1      1      2
## Kix                            1      1      2
## LuckyCharms                    1      1      1
## MultiGrainCheerios             1      1      1
## OatmealRaisinCrisp             1      1      1
## RaisinNutBran                  2      1      1
## TotalCornFlakes                1      1      1
## TotalRaisinBran                2      1      4
## TotalWholeGrain                1      1      1
## Trix                           3      1      1
## Cheaties                       1      1      1
## WheatiesHoneyGold              1      1      1
## AllBran                        4      2      4
## AppleJacks                     3      1      1
## CornFlakes                     1      1      2
## CornPops                       3      1      3
## CracklinOatBran                2      1      1
## Crispix                        1      1      1
## FrootLoops                     3      1      1
## FrostedFlakes                  1      1      1
## FrostedMiniWheats              3      3      3
## FruitfulBran                   2      1      4
## JustRightCrunchyNuggets        1      1      1
## MueslixCrispyBlend             2      1      1
## NutNHoneyCrunch                1      1      1
## NutriGrainAlmondRaisin         1      1      1
## NutriGrainWheat                1      1      1
## Product19                      1      1      2
## RaisinBran                     2      1      4
## RiceKrispies                   1      1      2
## Smacks                         3      1      3
## SpecialK                       1      1      1
## CapNCrunch                     1      1      1
## HoneyGrahamOhs                 1      1      1
```
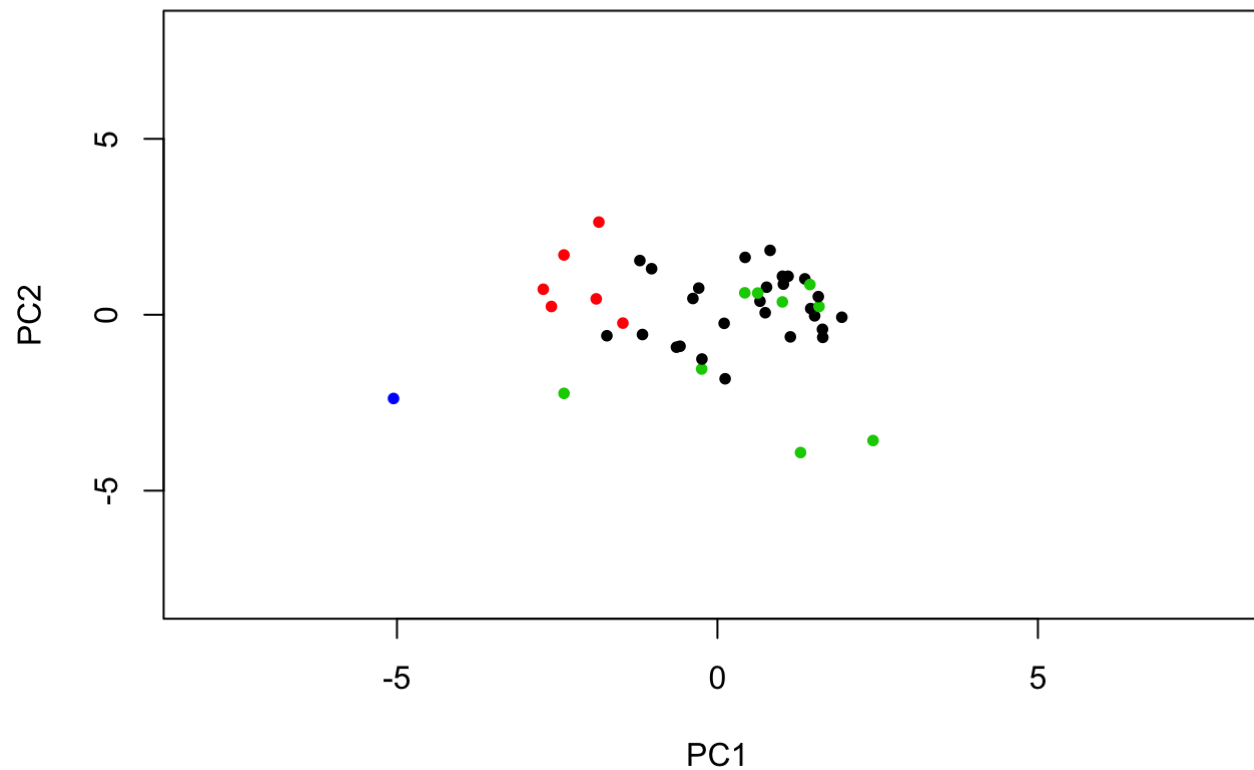
```
## Life                      1        1        1
## PuffedRice                3        4        3
## PuffedWheat               3        4        3
## QuakerOatmeal             3        3        3
```

```
c1 = complete
c2 = single
c3 = kmeans
plot(m2$x[,1], m2$x[,2], col=c1, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='complete linkage with K=4
  clusters')
```
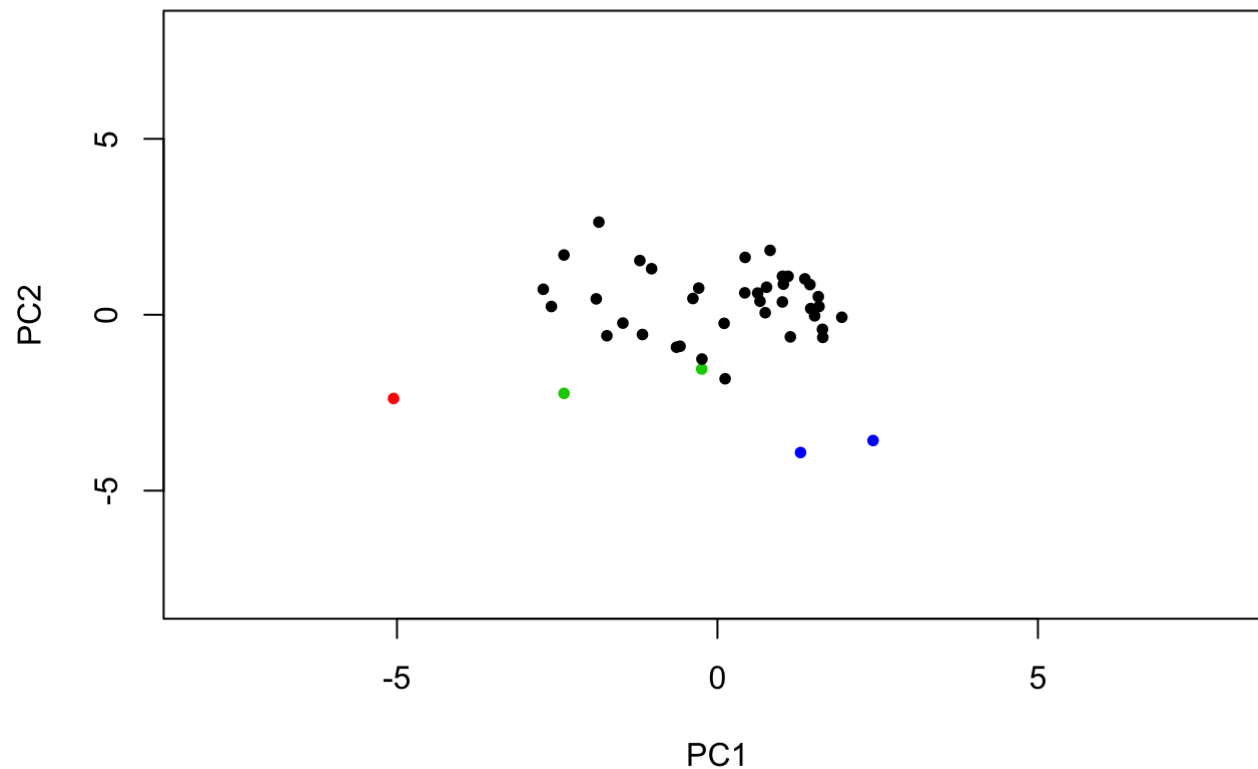

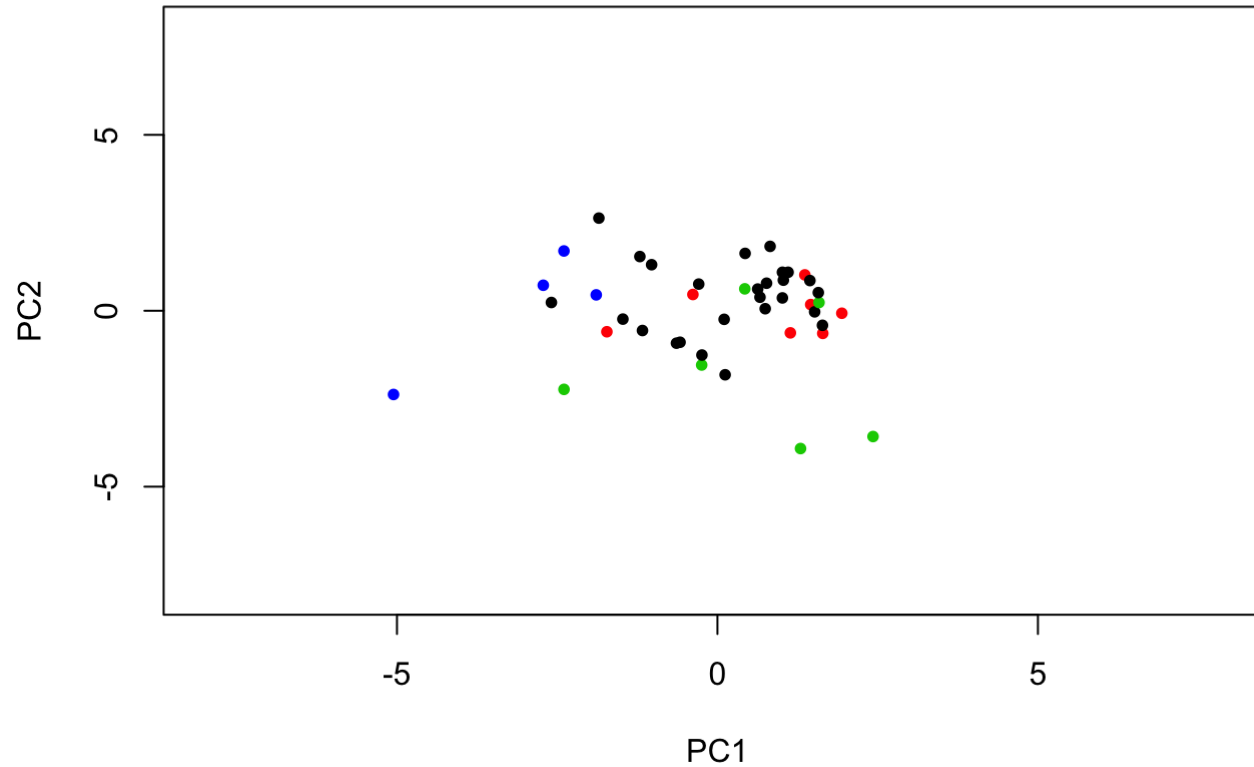**complete linkage with K=4 clusters**

```
plot(m2$x[,1], m2$x[,2], col=c2, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='single linkage with K=4 cl
usters')
```

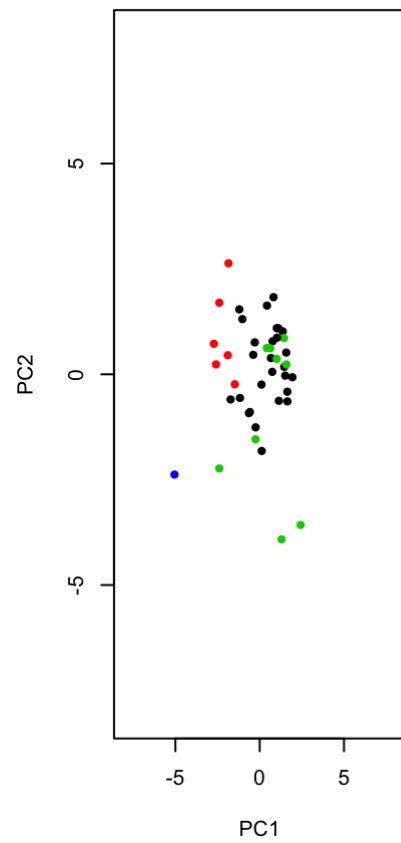

single linkage with K=4 clusters

```
plot(m2$x[,1], m2$x[,2], col=c3, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='kmeans with K=4 clusters')
```

kmeans with K=4 clusters
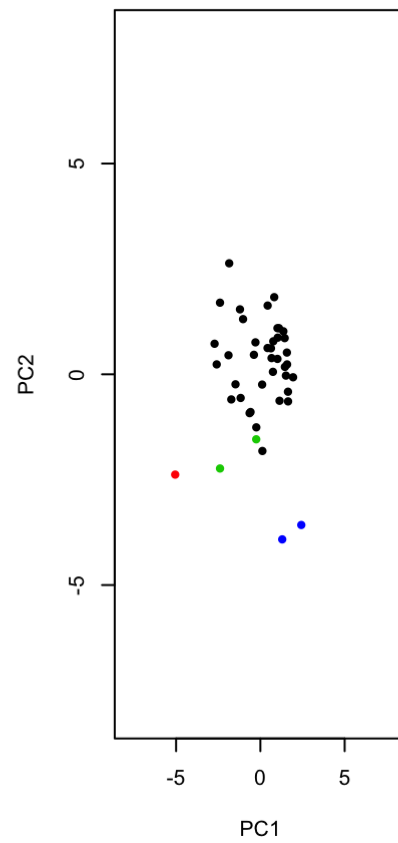
```
par(mfcol=c(1,3))
plot(m2$x[,1], m2$x[,2], col=c1, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='complete linkage with K=4
 clusters')
plot(m2$x[,1], m2$x[,2], col=c2, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='single linkage with K=4 cl
usters')
plot(m2$x[,1], m2$x[,2], col=c3, pch=20, ylim=bb,xlim=bb, xlab="PC1", ylab="PC2",main='kmeans with K=4 clusters')
```
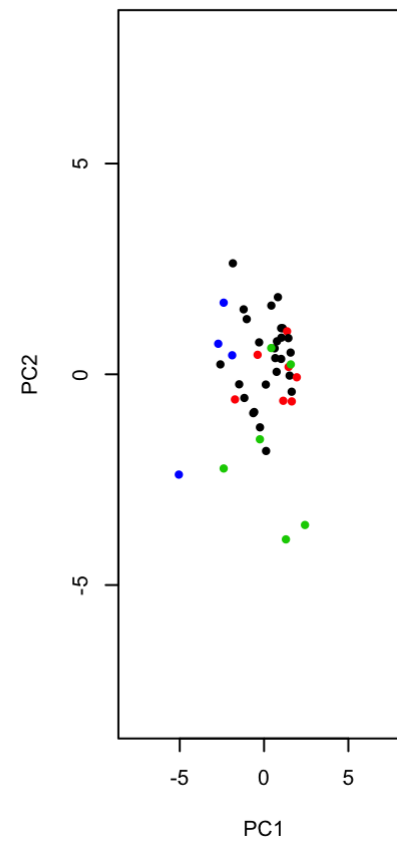
```
df2_c
```

```
##                           complete single kmeans
## ACCheerios                       1      1      1
## Cheerios                         1      1      2
## CocoaPuffs                       1      1      1
## CountChocula                     1      1      1
## GoldenGrahams                    1      1      2
## HoneyNutCheerios                 1      1      2
## Kix                              1      1      2
## LuckyCharms                      1      1      1
## MultiGrainCheerios               1      1      1
## OatmealRaisinCrisp               1      1      1
## RaisinNutBran                    2      1      1
## TotalCornFlakes                  1      1      1
## TotalRaisinBran                  2      1      4
## TotalWholeGrain                  1      1      1
## Trix                             3      1      1
## Cheaties                         1      1      1
## WheatiesHoneyGold                1      1      1
## AllBran                          4      2      4
## AppleJacks                       3      1      1
## CornFlakes                       1      1      2
## CornPops                         3      1      3
## CracklinOatBran                  2      1      1
## Crispix                          1      1      1
## FrootLoops                       3      1      1
## FrostedFlakes                    1      1      1
## FrostedMiniWheats                3      3      3
## FruitfulBran                     2      1      4
## JustRightCrunchyNuggets          1      1      1
## MueslixCrispyBlend               2      1      1
## NutNHoneyCrunch                  1      1      1
## NutriGrainAlmondRaisin           1      1      1
## NutriGrainWheat                  1      1      1
## Product19                        1      1      2
## RaisinBran                       2      1      4
## RiceKrispies                     1      1      2
## Smacks                           3      1      3
## SpecialK                         1      1      1
## CapNCrunch                       1      1      1
## HoneyGrahamOhs                   1      1      1
```

```
## Life                          1       1       1
## PuffedRice                    3       4       3
## PuffedWheat                   3       4       3
## QuakerOatmeal                 3       3       3
```

**