Assignment 5 - Fundamentals of Machine Learning

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2022-20-11

```
library(cluster)
library(stats)
library(factoextra)
```

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

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

```
library(cluster)
library(fpc)
```

```
rm(list=ls())
cereal <- read.csv("Cereals.csv", header=TRUE)
```

```
head(cereal)
```

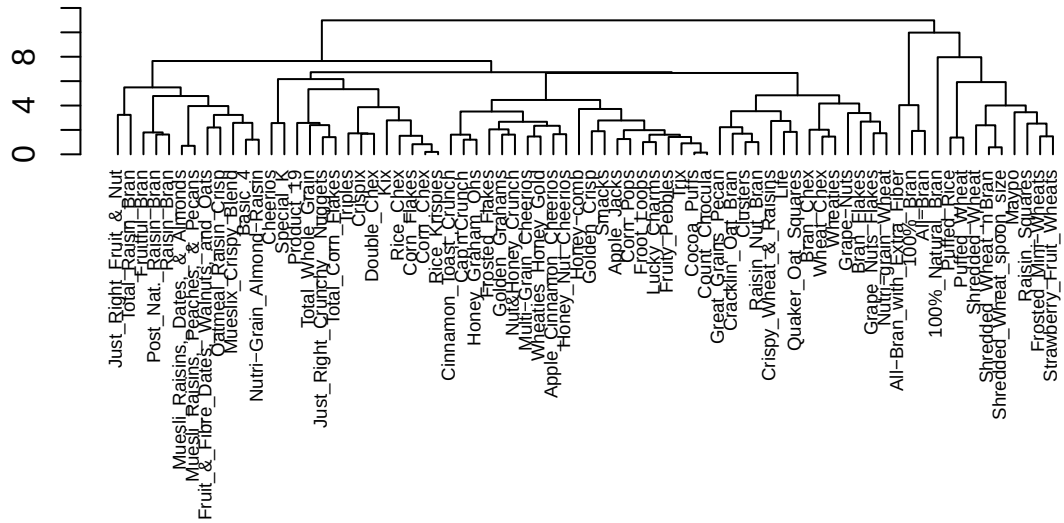
```
##                         name mfr type calories protein fat sodium fiber carbo
## 1                  100%_Bran   N    C       70       4   1    130  10.0   5.0
## 2          100%_Natural_Bran   Q    C      120       3   5     15   2.0   8.0
## 3                   All-Bran   K    C       70       4   1    260   9.0   7.0
## 4 All-Bran_with_Extra_Fiber   K    C       50       4   0    140  14.0   8.0
## 5             Almond_Delight   R    C      110       2   2    200   1.0  14.0
## 6   Apple_Cinnamon_Cheerios   G    C      110       2   2    180   1.5  10.5
##   sugars potass vitamins shelf weight cups   rating
## 1      6    280       25     3      1 0.33 68.40297
## 2      8    135        0     3      1 1.00 33.98368
## 3      5    320       25     3      1 0.33 59.42551
## 4      0    330       25     3      1 0.50 93.70491
## 5      8     NA       25     3      1 0.75 34.38484
## 6     10     70       25     1      1 0.75 29.50954
```

```
cereal <- na.omit(cereal)
row.names(cereal) <- cereal[,1]
cereal$name  = NULL
cereal <- subset(cereal, select = -c(1:2))
cereal <- scale(cereal)
head(cereal)
```

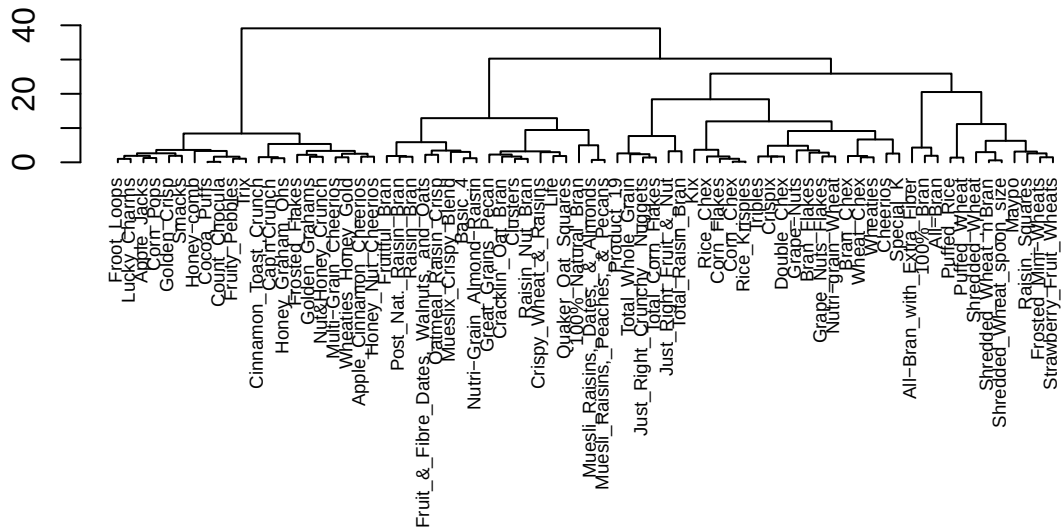
```
##                              calories    protein        fat     sodium
## 100%_Bran                  -1.8659155  1.3817478  0.0000000 -0.3910227
## 100%_Natural_Bran           0.6537514  0.4522084  3.9728810 -1.7804186
## All-Bran                   -1.8659155  1.3817478  0.0000000  1.1795987
## All-Bran_with_Extra_Fiber -2.8737823  1.3817478 -0.9932203 -0.2702057
## Apple_Cinnamon_Cheerios    0.1498180 -0.4773310  0.9932203  0.2130625
## Apple_Jacks                0.1498180 -0.4773310 -0.9932203 -0.4514312
##                                 fiber      carbo     sugars     potass
## 100%_Bran                  3.22866747 -2.5001396 -0.2542051  2.5605229
## 100%_Natural_Bran         -0.07249167 -1.7292632  0.2046041  0.5147738
## All-Bran                   2.81602258 -1.9862220 -0.4836096  3.1248675
## All-Bran_with_Extra_Fiber  4.87924705 -1.7292632 -1.6306324  3.2659536
## Apple_Cinnamon_Cheerios   -0.27881412 -1.0868662  0.6634132 -0.4022862
## Apple_Jacks               -0.48513656 -0.9583868  1.5810314 -0.9666308
##                              vitamins      shelf     weight       cups
## 100%_Bran                  -0.1818422  0.9419715 -0.2008324 -2.0856582
## 100%_Natural_Bran          -1.3032024  0.9419715 -0.2008324  0.7567534
## All-Bran                   -0.1818422  0.9419715 -0.2008324 -2.0856582
## All-Bran_with_Extra_Fiber  -0.1818422  0.9419715 -0.2008324 -1.3644493
## Apple_Cinnamon_Cheerios    -0.1818422 -1.4616799 -0.2008324 -0.3038480
## Apple_Jacks                -0.1818422 -0.2598542 -0.2008324  0.7567534
##                                rating
## 100%_Bran                   1.8549038
## 100%_Natural_Bran          -0.5977113
## All-Bran                    1.2151965
## All-Bran_with_Extra_Fiber   3.6578436
## Apple_Cinnamon_Cheerios    -0.9165248
## Apple_Jacks                -0.6553998
```

```
d <- dist(cereal, method = "euclidean")
hc1 <- hclust(d, method = "complete")
SingleMethod <- hclust(d, method = "single")
HCfit <- hclust(d, method = "ward.D")
HCward <- hclust(d, method = "ward.D2")
```

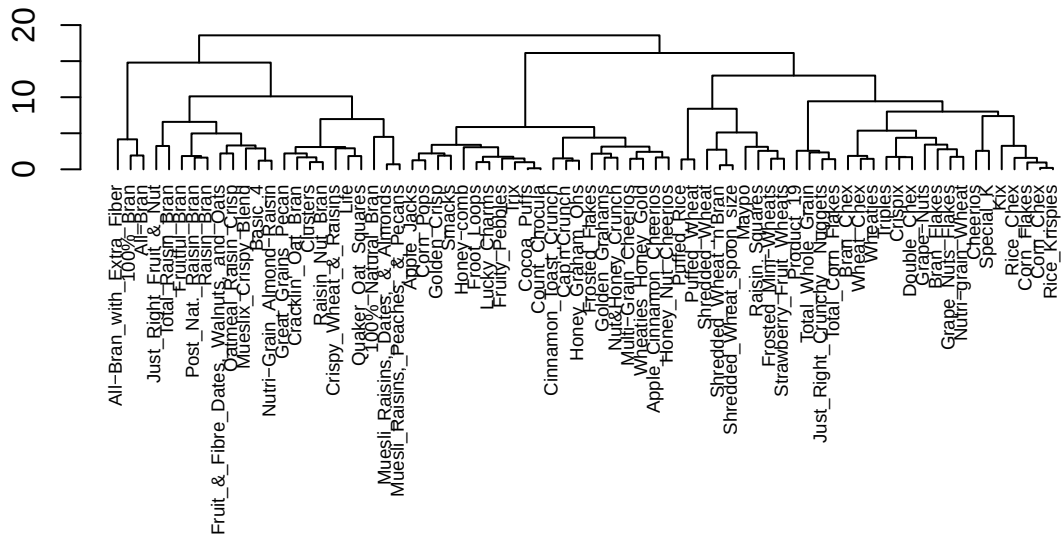
```
plot(hc1, cex = 0.6, hang = -1, ann = FALSE)
```




```
plot(HCfit, cex = 0.6, hang = -1, ann = FALSE)
```




```
plot(HCward, cex = 0.6, hang = -1, ann = FALSE)
```




```
HCsingle <- agnes(cereal, method = "single")
HCcomplete <- agnes(cereal, method = "complete")
HCaverage <- agnes(cereal, method = "average")
```

```
print(HCsingle$ac)
```

```
## [1] 0.6067859
```

```
print(HCcomplete$ac)
```

```
## [1] 0.8353712
```

```
print(HCaverage$ac)
```

```
## [1] 0.7766075
```

```
print(HCward$ac)
```

```
## NULL
```

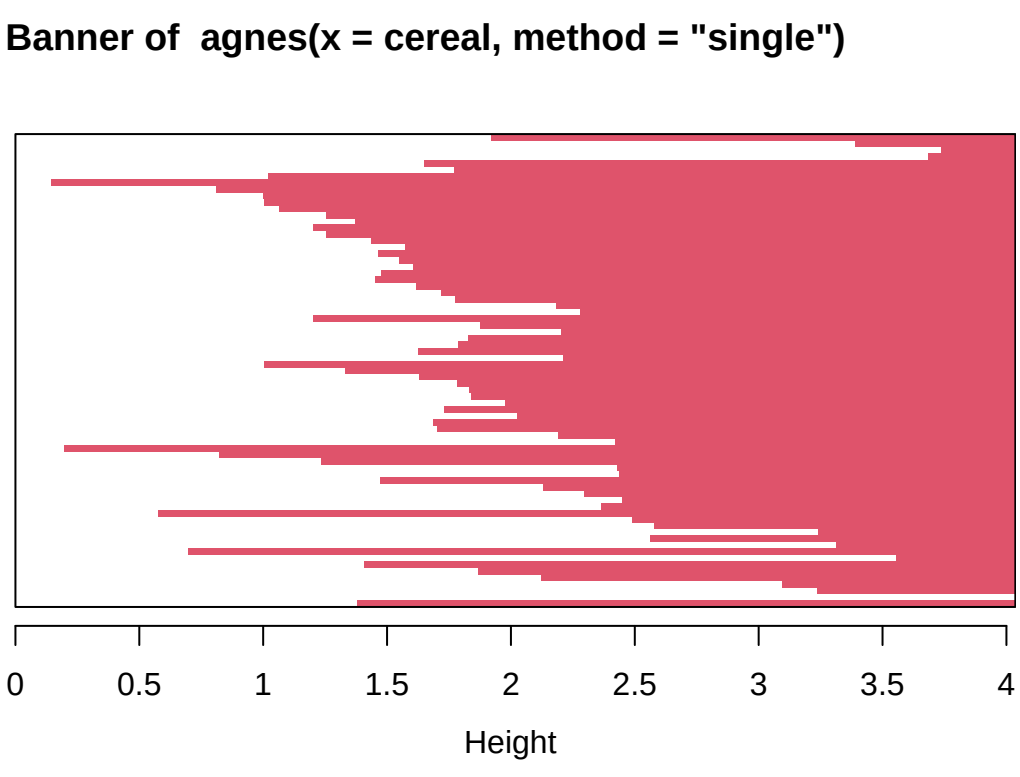
```
print(hc1)
```

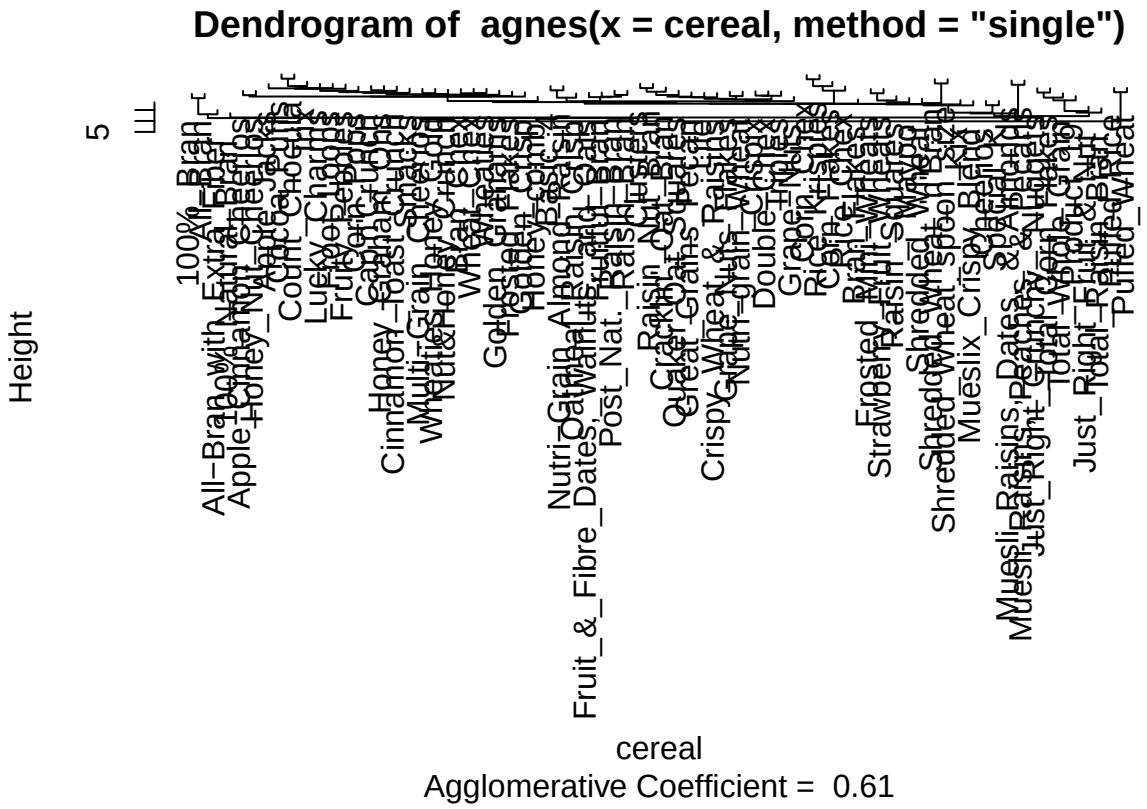
```
##
## Call:
## hclust(d = d, method = "complete")
##
## Cluster method   : complete
## Distance         : euclidean
## Number of objects: 74
```

```
print(HCfit)
```

```
##
## Call:
## hclust(d = d, method = "ward.D")
##
## Cluster method   : ward.D
## Distance         : euclidean
## Number of objects: 74
```

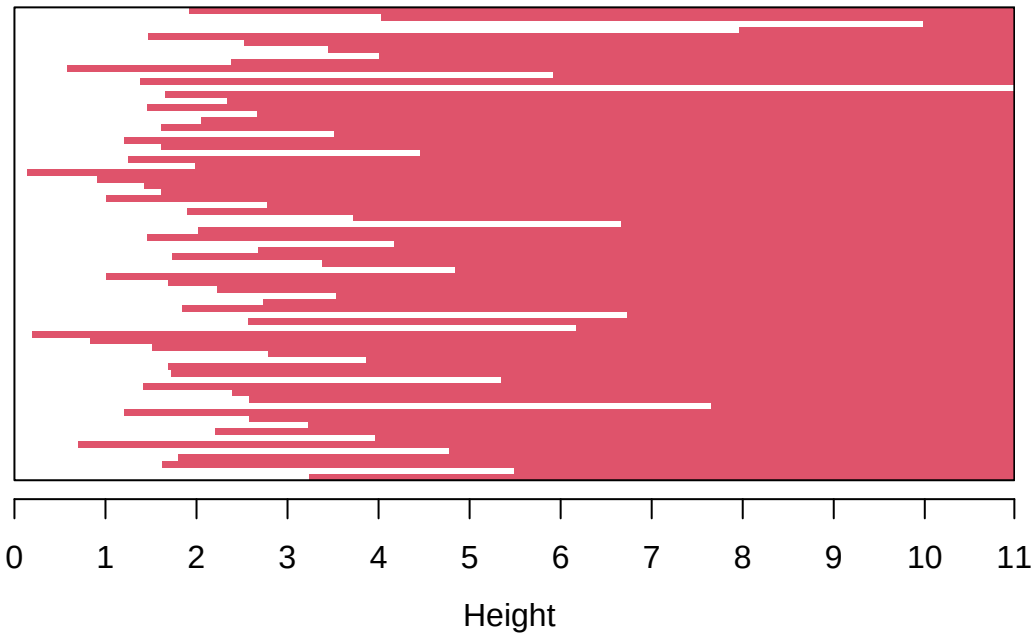
```
plot(HCsingle)
```



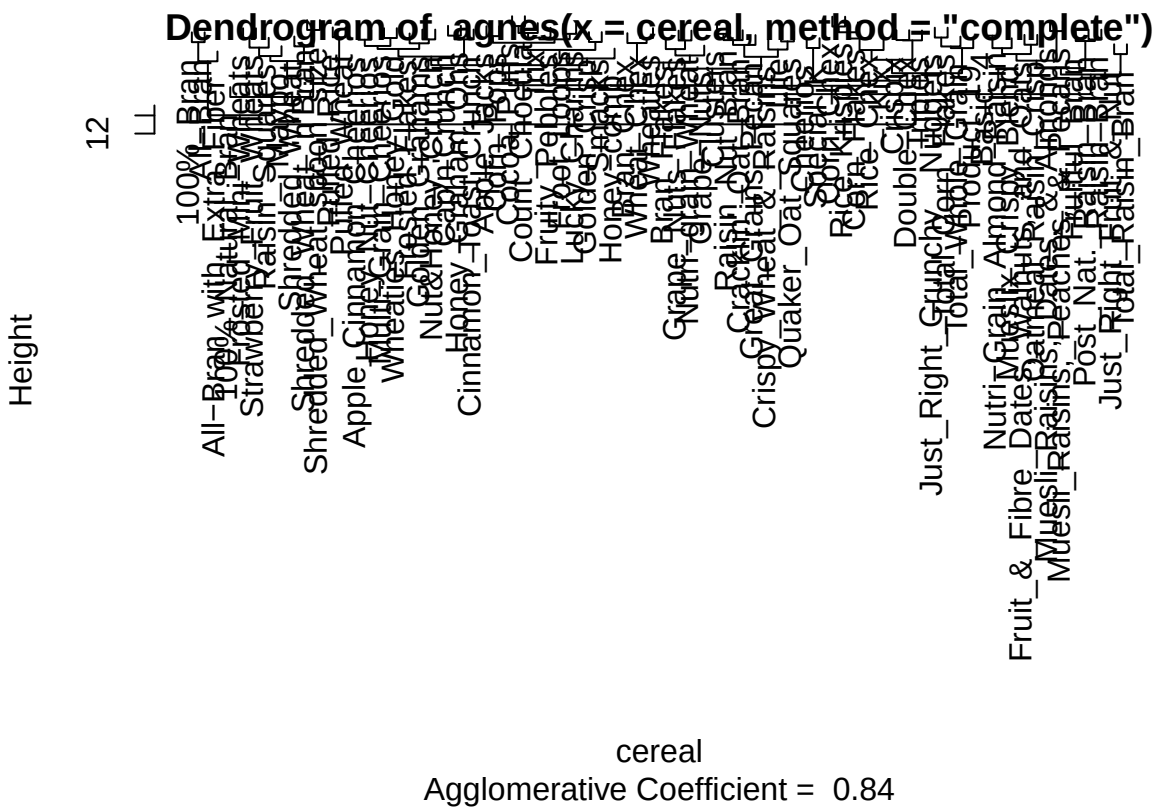



```
plot(HCcomplete)
```

Banner of agnes(x = cereal, method = "complete")

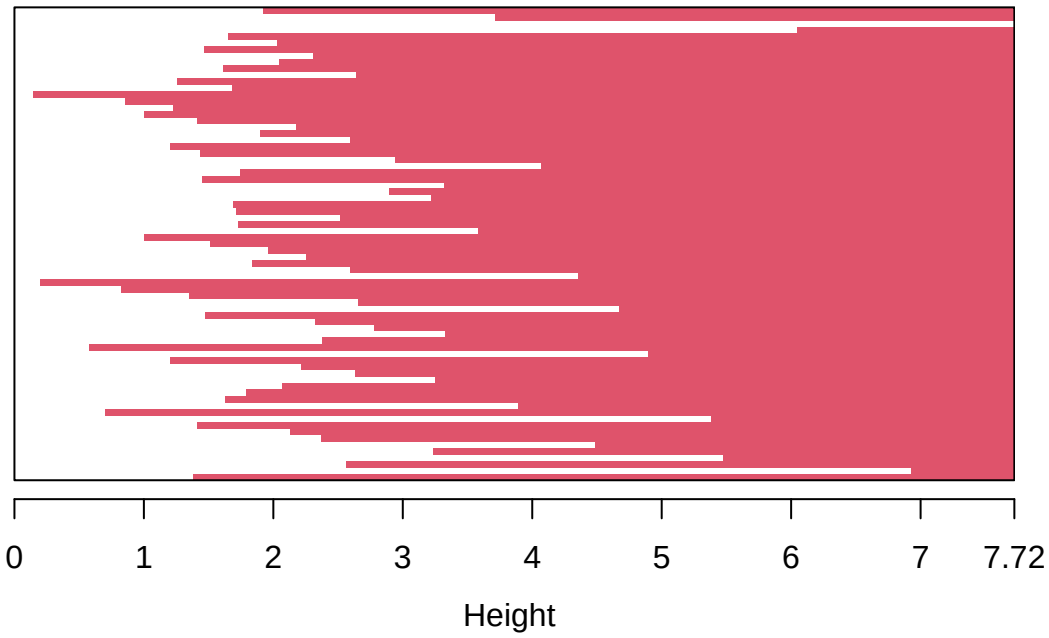


Agglomerative Coefficient = 0.84

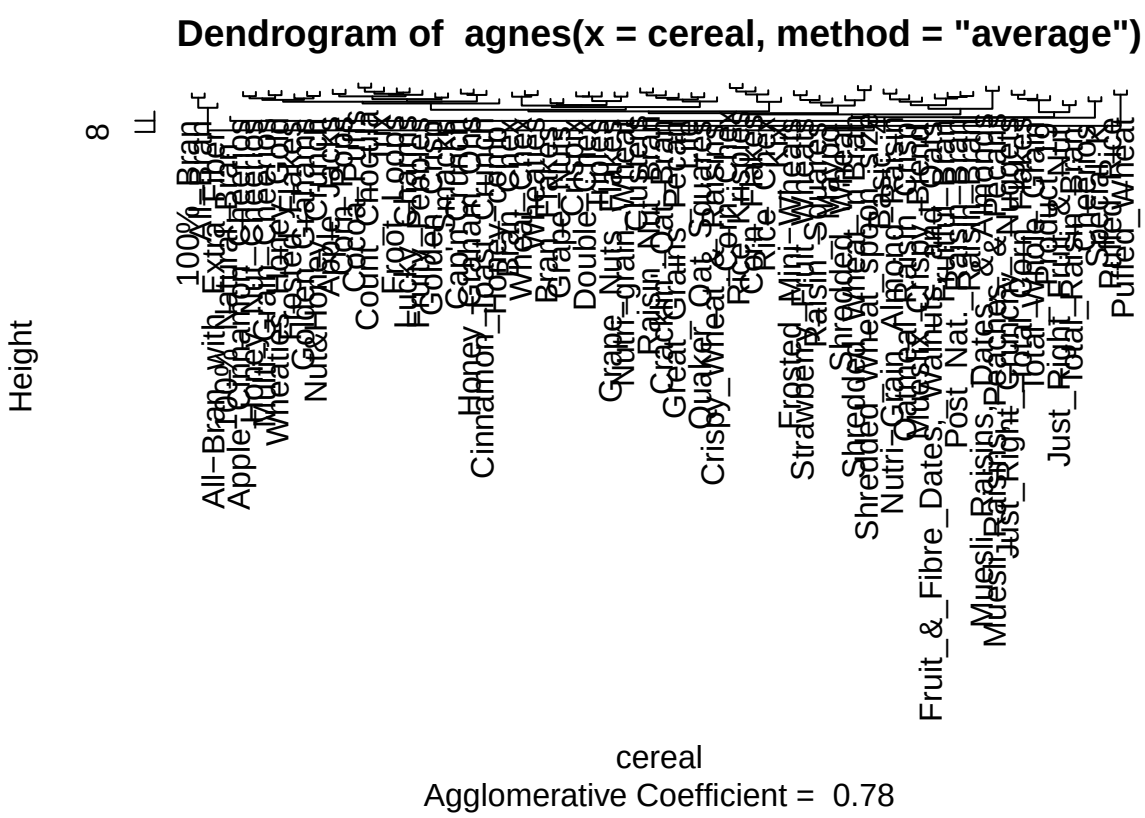



```
plot(HCaverage)
```

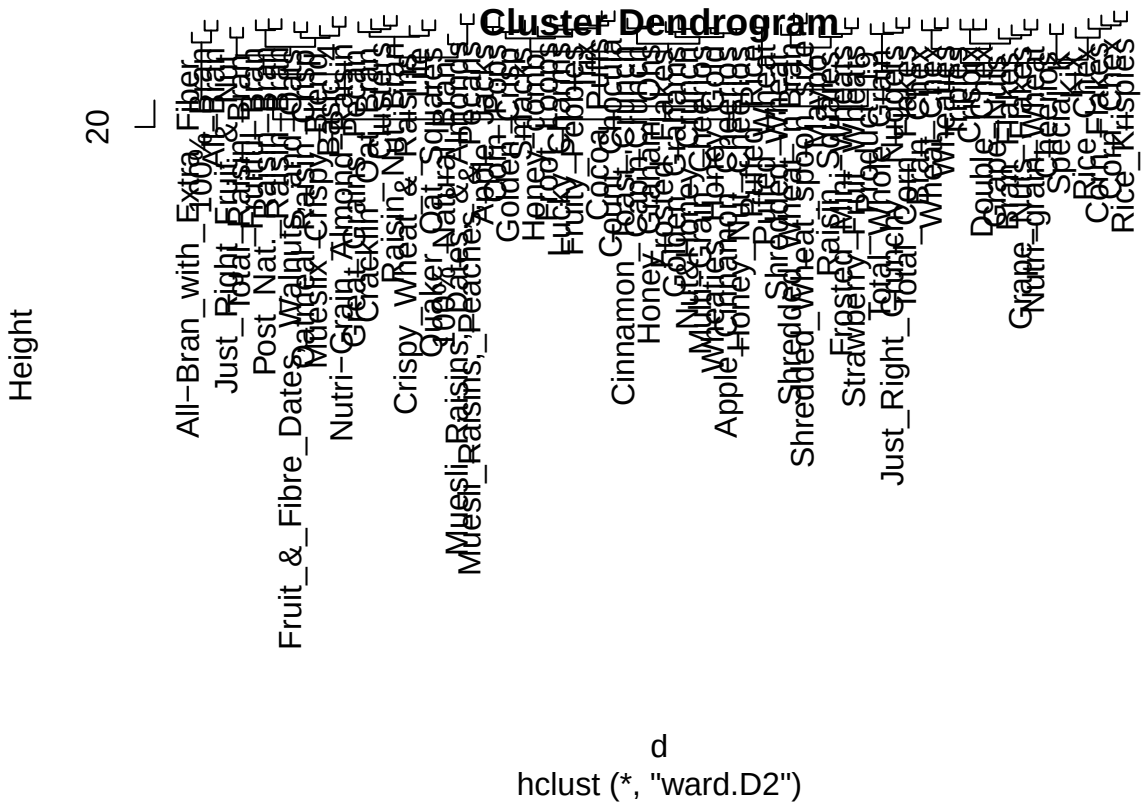
Banner of agnes(x = cereal, method = "average")



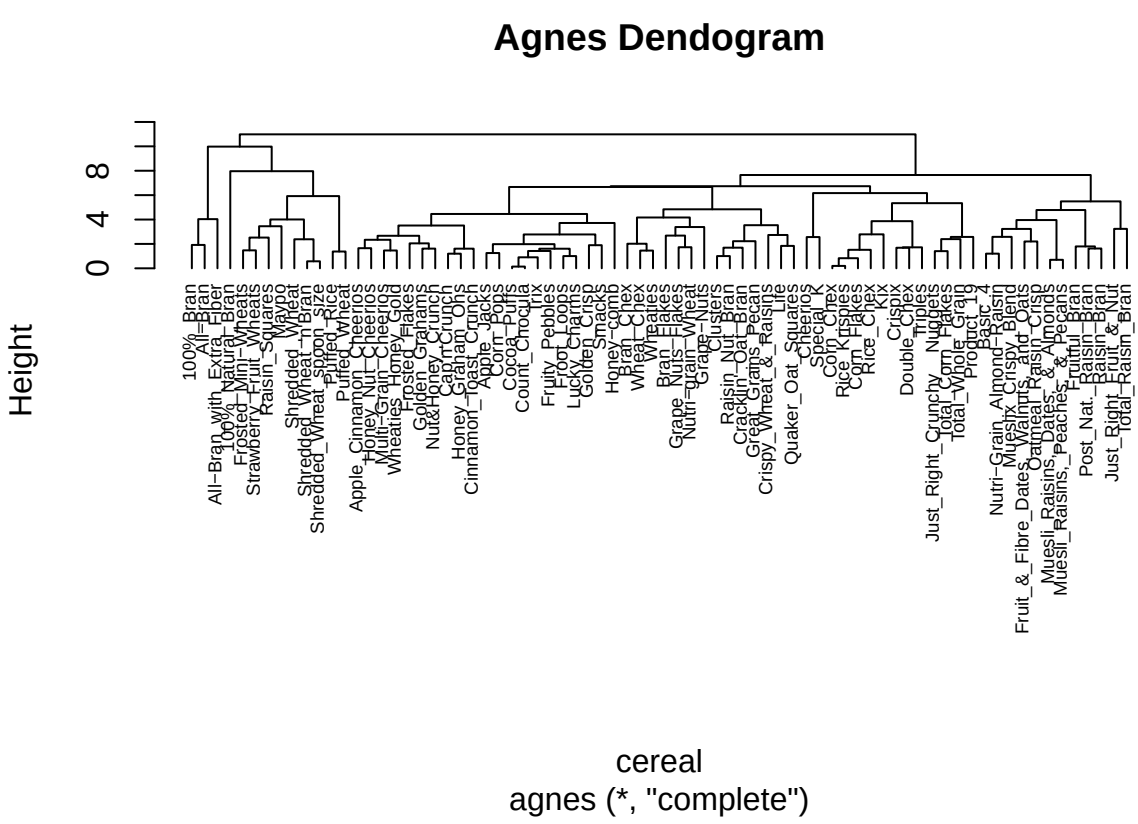
Agglomerative Coefficient = 0.78


Dendrogram of agnes(x = cereal, method = "average")
Height
8
cereal
Agglomerative Coefficient = 0.78

```
plot(HCward)
```

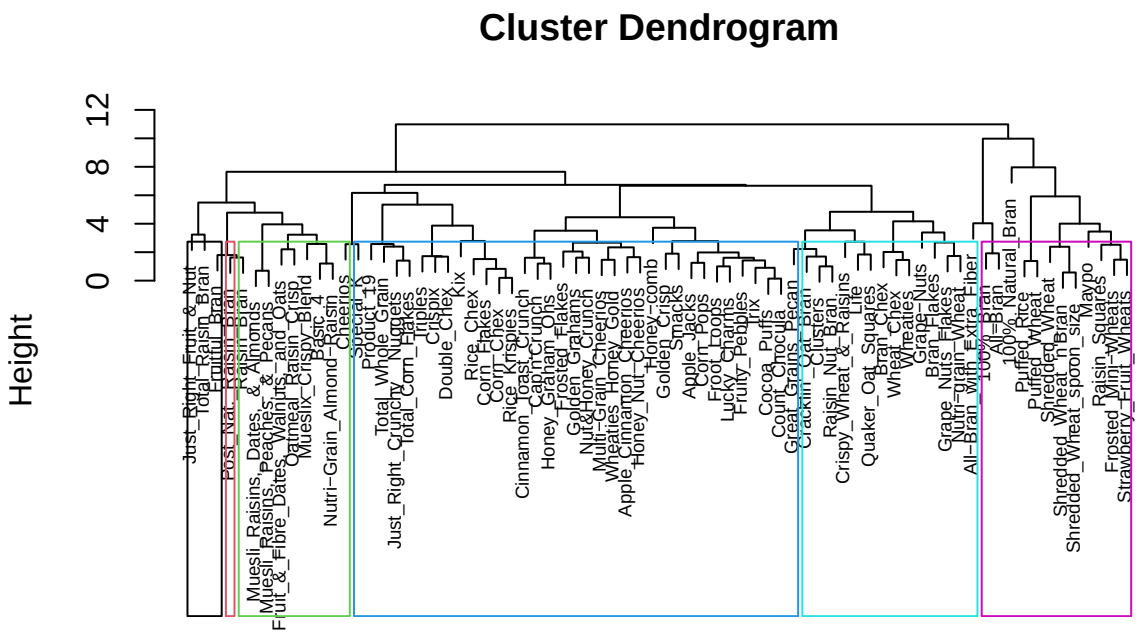



```
pltree(HCcomplete, cex = 0.6, hang = -1, main = "Agnes Dendogram")
```




```
df <- cereal
d <- dist(df, method = "euclidean")
hc_complete <- hclust(d, method = "complete")
```

```
plot(hc_complete, cex = 0.6)
rect.hclust(HCcomplete, k = 6, border = 1:6)
```




```
set.seed(1)

k3 <- kmeans(cereal, centers = 3, nstart = 10)
k3$centers
```

```
##     calories    protein        fat      sodium      fiber      carbo      sugars
## 1  1.0687554  0.5615659  1.0516450 -0.06055257  0.4615194 -0.1270496  0.5959413
## 2  0.1053533 -0.7233856 -0.2044865  0.40850178 -0.6307759  0.1374668  0.2990648
## 3 -0.9456893  0.6542821 -0.4750184 -0.55911595  0.5913284 -0.1093056 -0.8825741
##       potass   vitamins      shelf     weight       cups     rating
## 1  0.8550404  0.1479696  0.8712759  1.1219880 -0.5084816 -0.3609136
## 2 -0.6969072  0.2139320 -0.3658977 -0.2008324  0.4460596 -0.6196933
## 3  0.3982244 -0.4256162 -0.1030943 -0.5324128 -0.2835582  1.1828305
```

```
k3$size
```

```
## [1] 17 34 23
```

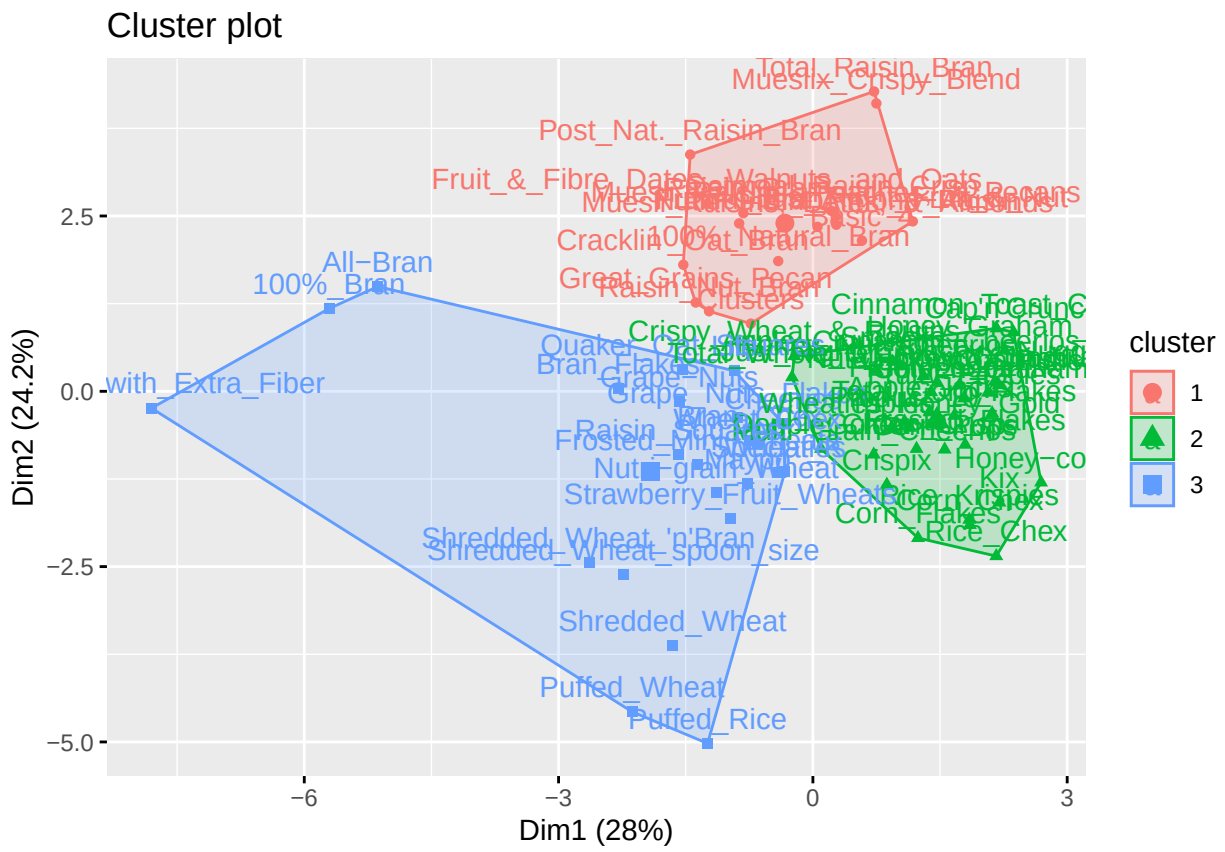
```
k3$cluster[15]
```

```
## Corn_Chex
##         2
```

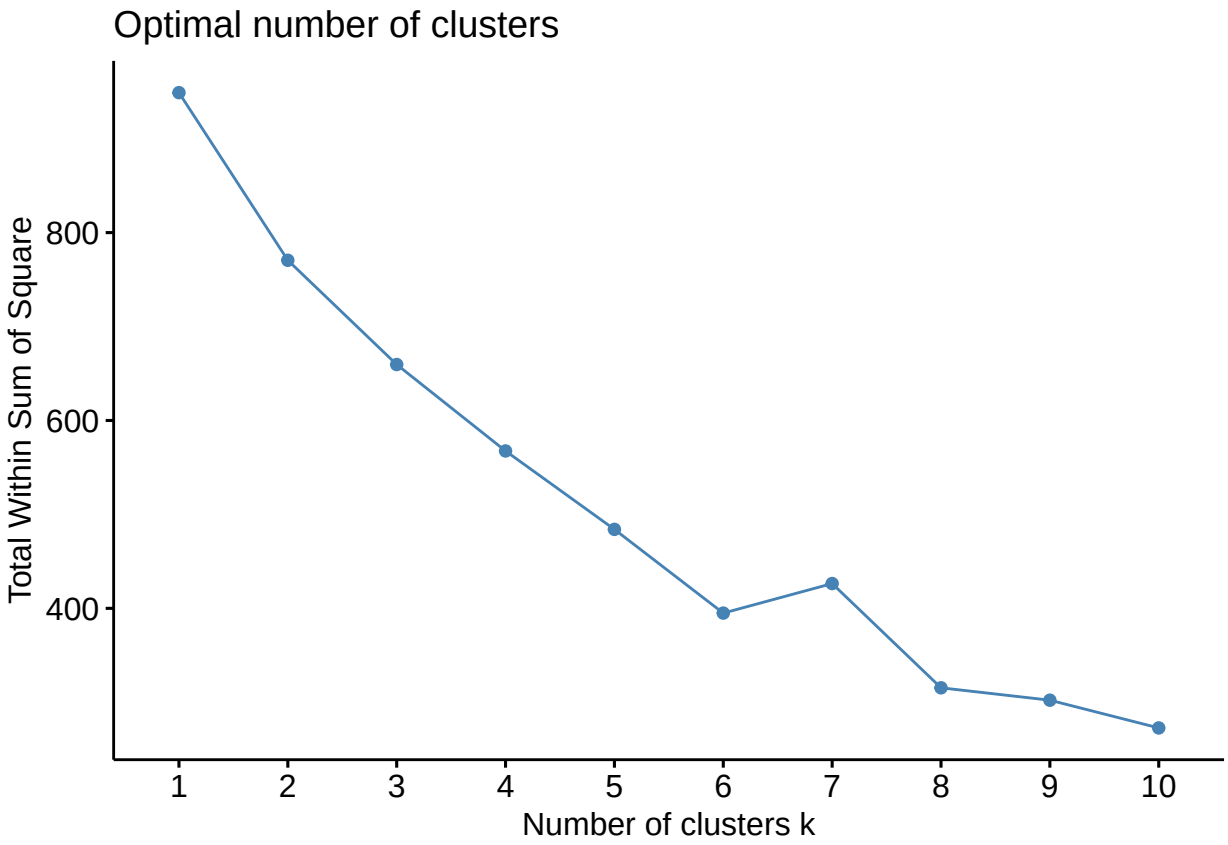
```
str(k3)
```

```
## List of 9
##  $ cluster     : Named int [1:74] 3 1 3 3 2 2 1 3 3 2 ...
##   ..- attr(*, "names")= chr [1:74] "100%_Bran" "100%_Natural_Bran" "All-Bran" "All-Bran_with_Extra_Fi
##  $ centers     : num [1:3, 1:13] 1.069 0.105 -0.946 0.562 -0.723 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:3] "1" "2" "3"
##   .. ..$ : chr [1:13] "calories" "protein" "fat" "sodium" ...
##  $ totss       : num 949
##  $ withinss    : num [1:3] 134 225 279
##  $ tot.withinss: num 638
##  $ betweenss   : num 311
##  $ size        : int [1:3] 17 34 23
##  $ iter        : int 3
##  $ ifault      : int 0
##  - attr(*, "class")= chr "kmeans"
```

```
fviz_cluster(k3, data = cereal)
```




```
set.seed(1)
fviz_nbclust(cereal, kmeans, method = "wss")
```



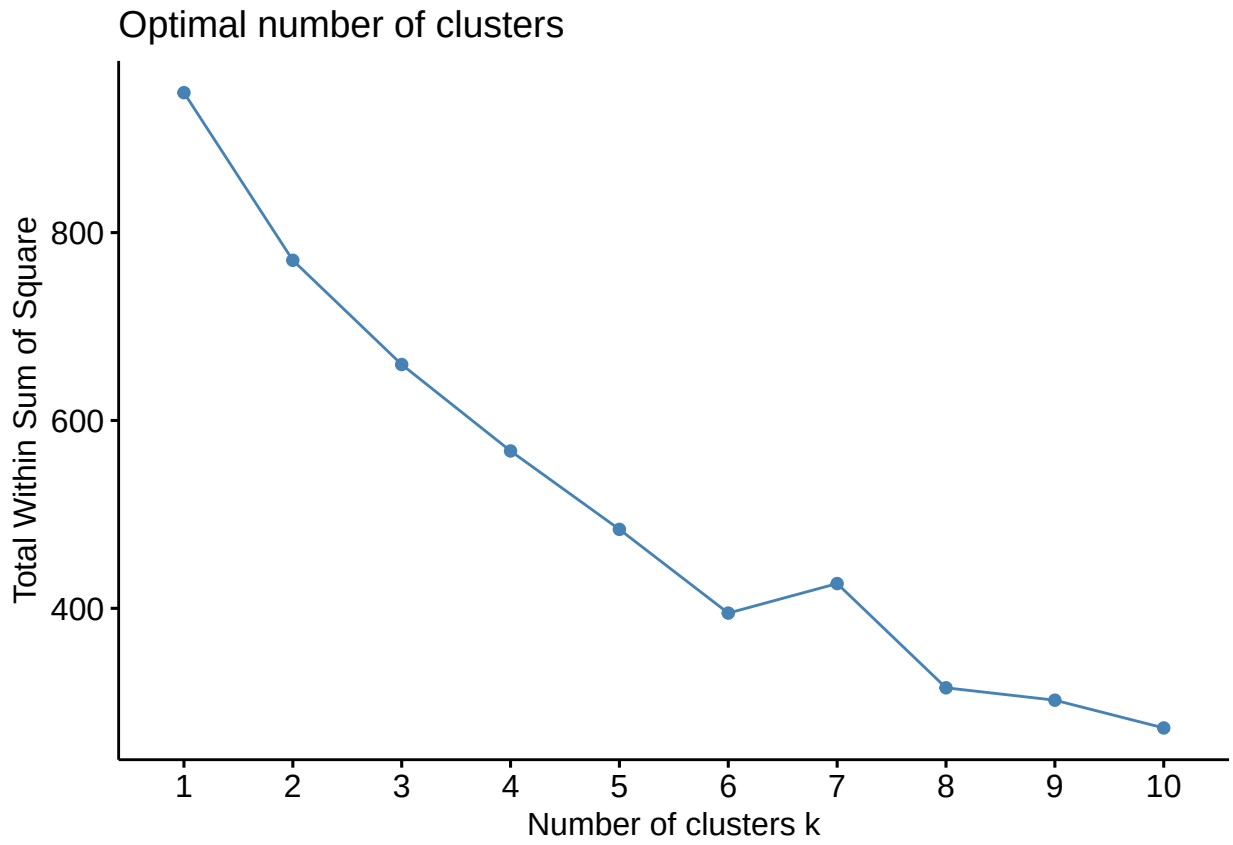

```
#we should have 6 clusters
```

```
wss <- 0
for(i in 1:15) wss[i] <- sum(kmeans(cereal, centers = i)$withinss)
wss
```

```
##  [1] 949.0000 770.5400 659.5665 567.5490 484.0579 394.9120 426.3782 315.4030
##  [9] 302.2273 272.6700 265.1042 230.5733 215.5769 187.5606 170.9735
```

```
plot(1:15, wss, type = "b", xlab="# of Clusters", ylab="Sum of squares")
```


```
fviz_nbclust(cereal, kmeans, method = "wss")
```




```
k6 <- kmeans(cereal, centers = 6)
k6clust <- k6$cluster
cereal_clust <- as.data.frame(cbind(k6$clust, cereal))
head(cereal_clust)
```

```
##                           V1   calories    protein        fat     sodium
## 100%_Bran                  2 -1.8659155  1.3817478  0.0000000 -0.3910227
## 100%_Natural_Bran          6  0.6537514  0.4522084  3.9728810 -1.7804186
## All-Bran                   2 -1.8659155  1.3817478  0.0000000  1.1795987
## All-Bran_with_Extra_Fiber  2 -2.8737823  1.3817478 -0.9932203 -0.2702057
## Apple_Cinnamon_Cheerios    3  0.1498180 -0.4773310  0.9932203  0.2130625
## Apple_Jacks                3  0.1498180 -0.4773310 -0.9932203 -0.4514312
##                                 fiber      carbo     sugars     potass
## 100%_Bran                  3.22866747 -2.5001396 -0.2542051  2.5605229
## 100%_Natural_Bran         -0.07249167 -1.7292632  0.2046041  0.5147738
## All-Bran                   2.81602258 -1.9862220 -0.4836096  3.1248675
## All-Bran_with_Extra_Fiber  4.87924705 -1.7292632 -1.6306324  3.2659536
## Apple_Cinnamon_Cheerios   -0.27881412 -1.0868662  0.6634132 -0.4022862
## Apple_Jacks               -0.48513656 -0.9583868  1.5810314 -0.9666308
##                             vitamins      shelf     weight       cups
## 100%_Bran                 -0.1818422  0.9419715 -0.2008324 -2.0856582
## 100%_Natural_Bran         -1.3032024  0.9419715 -0.2008324  0.7567534
## All-Bran                  -0.1818422  0.9419715 -0.2008324 -2.0856582
## All-Bran_with_Extra_Fiber -0.1818422  0.9419715 -0.2008324 -1.3644493
## Apple_Cinnamon_Cheerios   -0.1818422 -1.4616799 -0.2008324 -0.3038480
```

```
## Apple_Jacks               -0.1818422 -0.2598542 -0.2008324  0.7567534
##                               rating
## 100%_Bran                  1.8549038
## 100%_Natural_Bran         -0.5977113
## All-Bran                   1.2151965
## All-Bran_with_Extra_Fiber  3.6578436
## Apple_Cinnamon_Cheerios   -0.9165248
## Apple_Jacks               -0.6553998
```

```
hclust_stability <- clusterboot(cereal, clustermethod = hclustCBI, method = "ward.D", k=6)
```

```
## boot 1
## boot 2
## boot 3
## boot 4
## boot 5
## boot 6
## boot 7
## boot 8
## boot 9
## boot 10
## boot 11
## boot 12
## boot 13
## boot 14
## boot 15
## boot 16
## boot 17
## boot 18
## boot 19
## boot 20
## boot 21
## boot 22
## boot 23
## boot 24
## boot 25
## boot 26
## boot 27
## boot 28
## boot 29
## boot 30
## boot 31
## boot 32
## boot 33
## boot 34
## boot 35
## boot 36
## boot 37
## boot 38
## boot 39
## boot 40
## boot 41
## boot 42
## boot 43
```

```
## boot 44
## boot 45
## boot 46
## boot 47
## boot 48
## boot 49
## boot 50
## boot 51
## boot 52
## boot 53
## boot 54
## boot 55
## boot 56
## boot 57
## boot 58
## boot 59
## boot 60
## boot 61
## boot 62
## boot 63
## boot 64
## boot 65
## boot 66
## boot 67
## boot 68
## boot 69
## boot 70
## boot 71
## boot 72
## boot 73
## boot 74
## boot 75
## boot 76
## boot 77
## boot 78
## boot 79
## boot 80
## boot 81
## boot 82
## boot 83
## boot 84
## boot 85
## boot 86
## boot 87
## boot 88
## boot 89
## boot 90
## boot 91
## boot 92
## boot 93
## boot 94
## boot 95
## boot 96
## boot 97
```

```
## boot 98
## boot 99
## boot 100
```

```
hclust_stability
```

```
## * Cluster stability assessment *
## Cluster method:  hclust/cutree
## Full clustering results are given as parameter result
## of the clusterboot object, which also provides further statistics
## of the resampling results.
## Number of resampling runs:  100
##
## Number of clusters found in data:  6
##
##  Clusterwise Jaccard bootstrap (omitting multiple points) mean:
## [1] 0.7710694 0.7073521 0.8933913 0.5651417 0.6253780 0.6745214
## dissolved:
## [1] 26 24  0 44 41 37
## recovered:
## [1] 74 42 83 12 31 48
```

```
clusters = hclust_stability$results$partition
```

```
cboot.hclust <- clusterboot(cereal, clustermethod = hclustCBI, method = "ward.D", k=6)
```

```
## boot 1
## boot 2
## boot 3
## boot 4
## boot 5
## boot 6
## boot 7
## boot 8
## boot 9
## boot 10
## boot 11
## boot 12
## boot 13
## boot 14
## boot 15
## boot 16
## boot 17
## boot 18
## boot 19
## boot 20
## boot 21
## boot 22
## boot 23
## boot 24
## boot 25
## boot 26
```

```
## boot 27
## boot 28
## boot 29
## boot 30
## boot 31
## boot 32
## boot 33
## boot 34
## boot 35
## boot 36
## boot 37
## boot 38
## boot 39
## boot 40
## boot 41
## boot 42
## boot 43
## boot 44
## boot 45
## boot 46
## boot 47
## boot 48
## boot 49
## boot 50
## boot 51
## boot 52
## boot 53
## boot 54
## boot 55
## boot 56
## boot 57
## boot 58
## boot 59
## boot 60
## boot 61
## boot 62
## boot 63
## boot 64
## boot 65
## boot 66
## boot 67
## boot 68
## boot 69
## boot 70
## boot 71
## boot 72
## boot 73
## boot 74
## boot 75
## boot 76
## boot 77
## boot 78
## boot 79
## boot 80
```

```
## boot 81
## boot 82
## boot 83
## boot 84
## boot 85
## boot 86
## boot 87
## boot 88
## boot 89
## boot 90
## boot 91
## boot 92
## boot 93
## boot 94
## boot 95
## boot 96
## boot 97
## boot 98
## boot 99
## boot 100
```

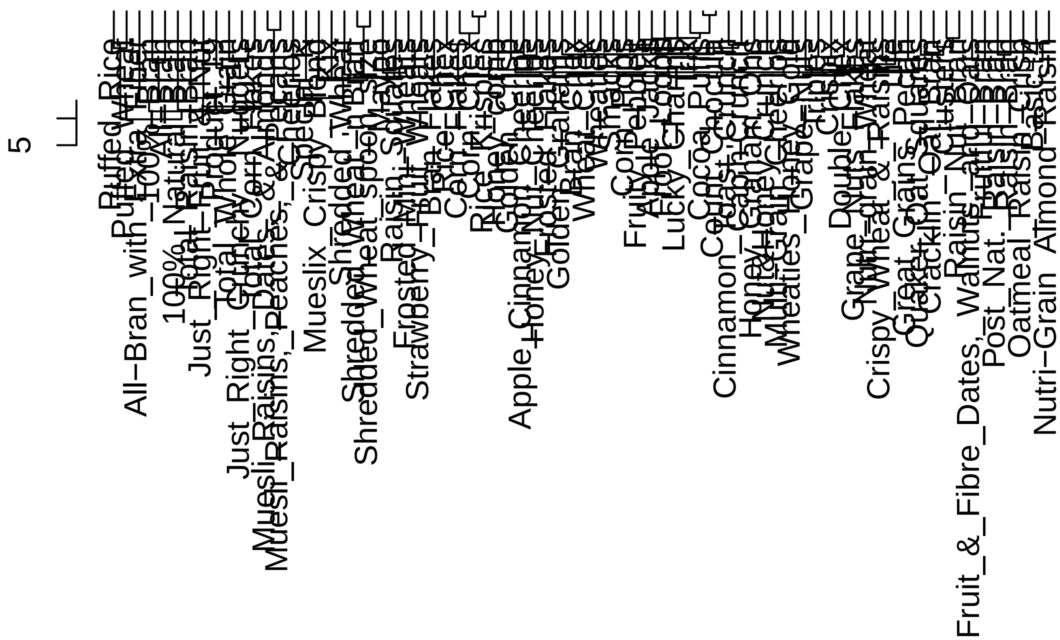
```
groups <- cboot.hclust$result$partition
cboot.hclust$bootmean
```

```
## [1] 0.8130602 0.6558469 0.9128397 0.5807440 0.6409682 0.6834519
```

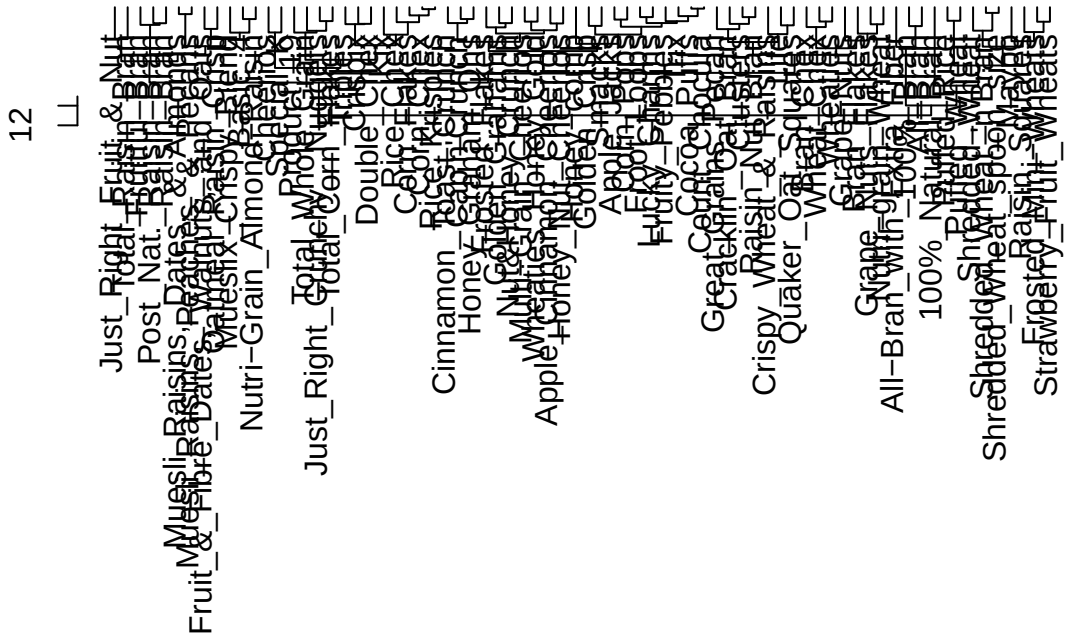
```
cboot.hclust$bootbrd
```

```
## [1] 21 32  0 38 46 38
```

```
d <- dist(cereal, method = "euclidean")
hc_single <- hclust(d, method = "single")
plot(hc_single, hang = -1, ann = FALSE)
```



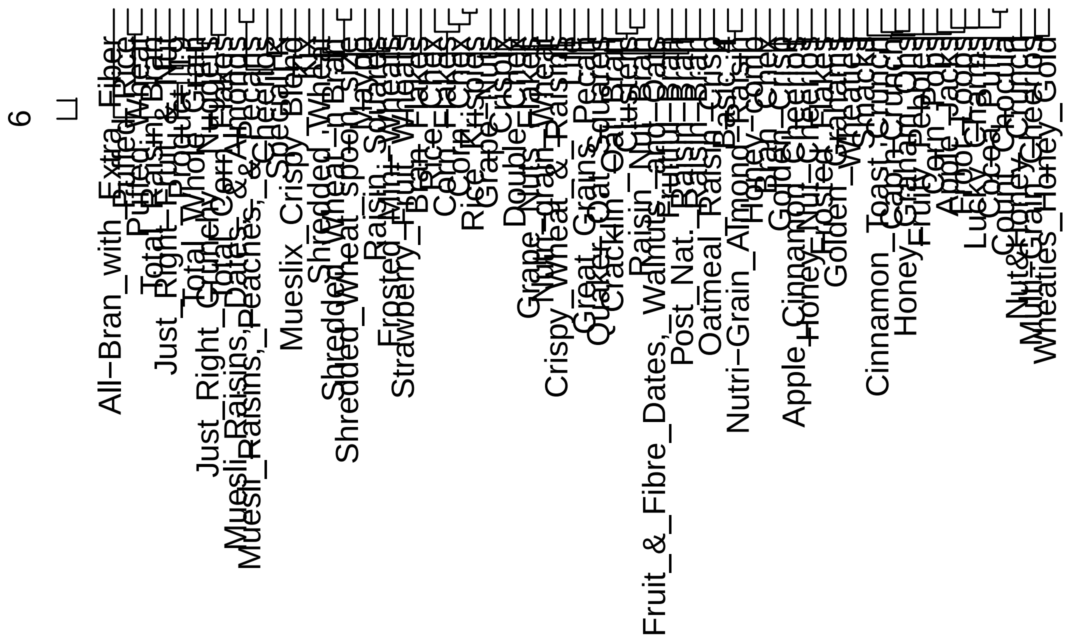
```r
hc_complete <- hclust(d, method = "complete")
plot(hc_complete, hang = -1, ann = FALSE)
```



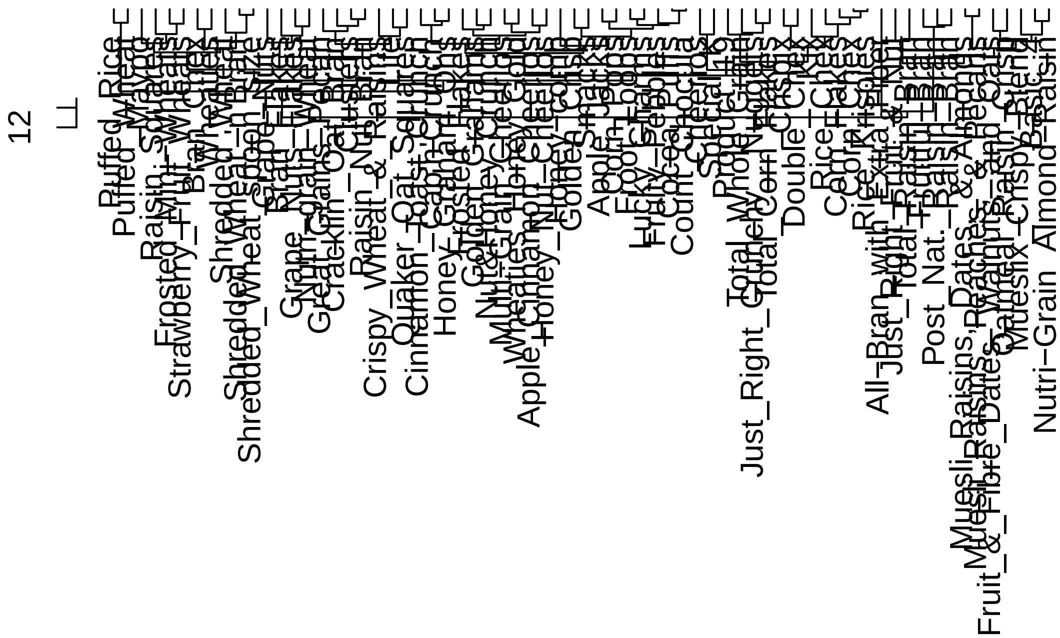

```
dim(cereal)
```

```
## [1] 74 13
```

```
d <- dist(cereal[-c(1:3, 70:72),], method = "euclidean")
hc_single <- hclust(d, method = "single")
plot(hc_single, hang = -1, ann = FALSE)
```



```r
hc_complete <- hclust(d, method = "complete")
plot(hc_complete, hang = -1, ann = FALSE)
```



```r
single <- cutree(hc_single, k = 6)
single
```

```
##                 All-Bran_with_Extra_Fiber                 Apple_Cinnamon_Cheerios
##                                         1                                       2
##                               Apple_Jacks                                 Basic_4
##                                         2                                       2
##                                 Bran_Chex                             Bran_Flakes
##                                         2                                       2
##                              Cap'n'Crunch                                Cheerios
##                                         2                                       3
##                     Cinnamon_Toast_Crunch                                Clusters
##                                         2                                       2
##                               Cocoa_Puffs                               Corn_Chex
##                                         2                                       2
##                               Corn_Flakes                               Corn_Pops
##                                         2                                       2
##                             Count_Chocula                      Cracklin'_Oat_Bran
##                                         2                                       2
##                                   Crispix                 Crispy_Wheat_&_Raisins
##                                         2                                       2
##                               Double_Chex                             Froot_Loops
##                                         2                                       2
##                            Frosted_Flakes                    Frosted_Mini-Wheats
##                                         2                                       2
```

```
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats                    Fruitful_Bran
##                                      2                                2
##                           Fruity_Pebbles                     Golden_Crisp
##                                      2                                2
##                           Golden_Grahams                 Grape_Nuts_Flakes
##                                      2                                2
##                               Grape-Nuts                 Great_Grains_Pecan
##                                      2                                2
##                         Honey_Graham_Ohs                 Honey_Nut_Cheerios
##                                      2                                2
##                               Honey-comb          Just_Right_Crunchy__Nuggets
##                                      2                                4
##                    Just_Right_Fruit_&_Nut                              Kix
##                                      4                                2
##                                     Life                     Lucky_Charms
##                                      2                                2
##                                    Maypo      Muesli_Raisins,_Dates,_&_Almonds
##                                      2                                5
##      Muesli_Raisins,_Peaches,_&_Pecans                 Mueslix_Crispy_Blend
##                                      5                                2
##                     Multi-Grain_Cheerios                   Nut&Honey_Crunch
##                                      2                                2
##                Nutri-Grain_Almond-Raisin                   Nutri-grain_Wheat
##                                      2                                2
##                     Oatmeal_Raisin_Crisp                Post_Nat._Raisin_Bran
##                                      2                                2
##                                Product_19                      Puffed_Rice
##                                      4                                6
##                               Puffed_Wheat                 Quaker_Oat_Squares
##                                      6                                2
##                               Raisin_Bran                    Raisin_Nut_Bran
##                                      2                                2
##                             Raisin_Squares                        Rice_Chex
##                                      2                                2
##                              Rice_Krispies                    Shredded_Wheat
##                                      2                                2
##                   Shredded_Wheat_'n'Bran             Shredded_Wheat_spoon_size
##                                      2                                2
##                                   Smacks                          Special_K
##                                      2                                3
##                  Strawberry_Fruit_Wheats                  Total_Corn_Flakes
##                                      2                                4
##                        Total_Raisin_Bran                  Total_Whole_Grain
##                                      4                                4
##                                 Wheaties                 Wheaties_Honey_Gold
##                                      2                                2
```

```
complete <- cutree(hc_complete, k = 6)
complete
```

```
##                All-Bran_with_Extra_Fiber                Apple_Cinnamon_Cheerios
##                                        1                                      2
##                              Apple_Jacks                              Basic_4
##                                        2                                      3
```

```
##                              Bran_Chex                             Bran_Flakes
##                                      4                                       4
##                           Cap'n'Crunch                               Cheerios
##                                      2                                       5
##                    Cinnamon_Toast_Crunch                                Clusters
##                                      2                                       4
##                             Cocoa_Puffs                              Corn_Chex
##                                      2                                       5
##                             Corn_Flakes                              Corn_Pops
##                                      5                                       2
##                           Count_Chocula                    Cracklin'_Oat_Bran
##                                      2                                       4
##                                 Crispix                  Crispy_Wheat_&_Raisins
##                                      5                                       4
##                             Double_Chex                             Froot_Loops
##                                      5                                       2
##                           Frosted_Flakes                     Frosted_Mini-Wheats
##                                      2                                       4
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats                          Fruitful_Bran
##                                      3                                       3
##                           Fruity_Pebbles                           Golden_Crisp
##                                      2                                       2
##                           Golden_Grahams                      Grape_Nuts_Flakes
##                                      2                                       4
##                                Grape-Nuts                     Great_Grains_Pecan
##                                      4                                       4
##                          Honey_Graham_Ohs                     Honey_Nut_Cheerios
##                                      2                                       2
##                                Honey-comb               Just_Right_Crunchy__Nuggets
##                                      2                                       5
##                    Just_Right_Fruit_&_Nut                                   Kix
##                                      3                                       5
##                                    Life                            Lucky_Charms
##                                      4                                       2
##                                   Maypo           Muesli_Raisins,_Dates,_&_Almonds
##                                      4                                       3
##         Muesli_Raisins,_Peaches,_&_Pecans                    Mueslix_Crispy_Blend
##                                      3                                       3
##                     Multi-Grain_Cheerios                        Nut&Honey_Crunch
##                                      2                                       2
##                 Nutri-Grain_Almond-Raisin                     Nutri-grain_Wheat
##                                      3                                       4
##                     Oatmeal_Raisin_Crisp                  Post_Nat._Raisin_Bran
##                                      3                                       3
##                                Product_19                             Puffed_Rice
##                                      5                                       6
##                              Puffed_Wheat                     Quaker_Oat_Squares
##                                      6                                       4
##                               Raisin_Bran                        Raisin_Nut_Bran
##                                      3                                       4
##                             Raisin_Squares                             Rice_Chex
##                                      4                                       5
##                              Rice_Krispies                          Shredded_Wheat
##                                      5                                       4
```

```
##                  Shredded_Wheat_'n'Bran              Shredded_Wheat_spoon_size
##                                       4                                      4
##                                  Smacks                                Special_K
##                                       2                                      5
##                 Strawberry_Fruit_Wheats                    Total_Corn_Flakes
##                                       4                                      5
##                       Total_Raisin_Bran                    Total_Whole_Grain
##                                       3                                      5
##                                Wheaties                  Wheaties_Honey_Gold
##                                       4                                      2
```

```
healthy_cereal <- read.csv("Cereals.csv", header=TRUE)
healthy_cereal <- na.omit(healthy_cereal)
rownames(healthy_cereal) <- healthy_cereal$name
healthy_cereal$name  = NULL
healthy_cereal <- subset(healthy_cereal, select = -c(1:3))
healthy_cereal <- scale(healthy_cereal)

fit <- kmeans(healthy_cereal, 6)
aggregate(healthy_cereal, by=list(fit$cluster), FUN=mean)
```

```
##   Group.1     protein        fat      sodium       fiber      carbo     sugars
## 1       1  0.14236189 -0.1655367  0.55537739 -0.14126582  0.8831512 -0.1777369
## 2       2 -0.06420242 -0.8828625 -1.94150793 -0.02664224  0.1551013 -1.0953551
## 3       3  0.14236189 -0.4635028  0.90574678 -0.32007861  1.0801529 -0.8965378
## 4       4  0.58499970  0.8040354 -0.08610352  0.41875225 -0.2486911  0.3029203
## 5       5  1.38174776 -0.3310734  0.17279012  3.64131237 -2.0718749 -0.7894824
## 6       6 -0.94210075  0.0000000  0.09224544 -0.69145901 -0.5729487  1.0189902
##        potass   vitamins      shelf     weight       cups     rating
## 1 -0.03781363  3.1822385  0.9419715  0.6682670  0.5799865 -0.3045121
## 2 -0.11227576 -0.8048201 -0.2598542 -1.0482044  0.1156788  1.4712151
## 3 -0.42580053 -0.1818422 -0.7405845 -0.2008324  0.6775618  0.2755718
## 4  0.67265589 -0.2352403  0.8275119  0.6217081 -0.6775837 -0.1047744
## 5  2.98378133 -0.1818422  0.9419715 -0.2008324 -1.8452553  2.2426479
## 6 -0.77263731 -0.1818422 -0.6204019 -0.2008324  0.2540284 -1.0037561
```

```
#Cluster 5 has the highest protein
#Cluster 6 has the lowest fat
#Cluster 5 has the lowest sodium
#Cluster 5 has the highest fiber
#Cluster 2 has the lowest carbohydrates
#Cluster 4 has the lowest sugar
#Cluster 5 has the highest potassium
#Cluster 1 has the most vitamins

#Based on the above, I would choose cluster 5. I disregarded negative numbers as you cannot have negati
```