FML ASSIGNMENT 5

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```
Cereals <- read.csv("C:/Users/srich/OneDrive/Desktop/Cereals.csv")
Cereals_1<-read.csv("C:/Users/srich/OneDrive/Desktop/Cereals.csv")
# Displays the structure of the dataset
str(Cereals)
```

```
## 'data.frame':    77 obs. of  16 variables:
##  $ name    : chr  "100%_Bran" "100%_Natural_Bran" "All-Bran" "All-Bran_with_Extra_Fiber" ...
##  $ mfr     : chr  "N" "Q" "K" "K" ...
##  $ type    : chr  "C" "C" "C" "C" ...
##  $ calories: int  70 120 70 50 110 110 110 130 90 90 ...
##  $ protein : int  4 3 4 4 2 2 2 3 2 3 ...
##  $ fat     : int  1 5 1 0 2 2 0 2 1 0 ...
##  $ sodium  : int  130 15 260 140 200 180 125 210 200 210 ...
##  $ fiber   : num  10 2 9 14 1 1.5 1 2 4 5 ...
##  $ carbo   : num  5 8 7 8 14 10.5 11 18 15 13 ...
##  $ sugars  : int  6 8 5 0 8 10 14 8 6 5 ...
##  $ potass  : int  280 135 320 330 NA 70 30 100 125 190 ...
##  $ vitamins: int  25 0 25 25 25 25 25 25 25 25 ...
##  $ shelf   : int  3 3 3 3 3 1 2 3 1 3 ...
##  $ weight  : num  1 1 1 1 1 1 1 1.33 1 1 ...
##  $ cups    : num  0.33 1 0.33 0.5 0.75 0.75 1 0.75 0.67 0.67 ...
##  $ rating  : num  68.4 34 59.4 93.7 34.4 ...
```

```
# Displays the first 6 rows of the "Cereals" dataset
head(Cereals)
```

```
##                          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
```

```r
# Calculates and returns the total count of missing values in the "Cereals" dataset
sum(is.na(Cereals))
```

```
## [1] 4
```

```r
# Removes rows with missing values from the "Cereals" dataset
Cereals <- na.omit(Cereals)
# Removes rows with missing values from the "Cereals_1" dataset
Cereals_1 <-na.omit(Cereals_1)
#  Calculates the sum of missing values in the "Cereals" data and print the result
sum(is.na(Cereals))
```

```
## [1] 0
```

```r
# Convert the names of the cereals to row names
rownames(Cereals) <- Cereals$name
rownames(Cereals_1) <- Cereals_1$name
```

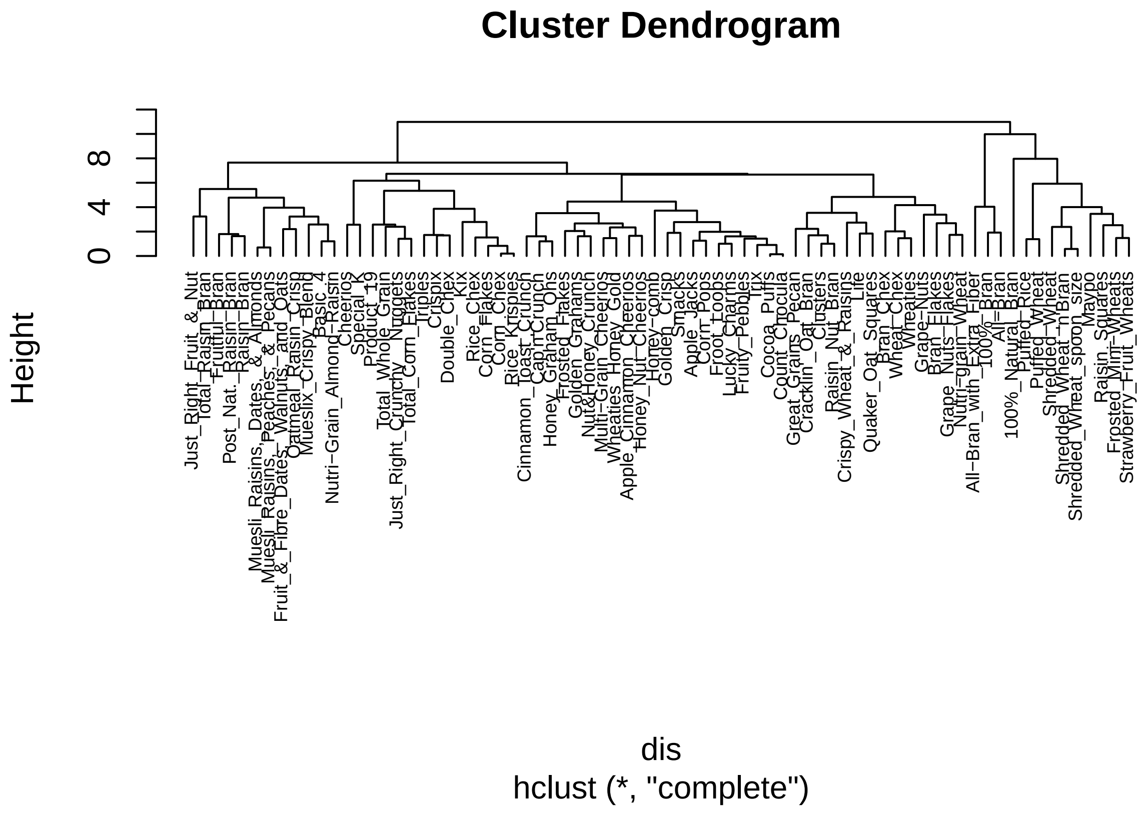
```r
# Sets the "name" variable in the "Cereals" dataset to NULL
# Sets the "name" variable in the "Cereals_1" dataset to NULL
Cereals$name = NULL
Cereals_1$name = NULL
```

```r
# Scales the variables in columns 3 to 15 of the "Cereals" dataset
Cereals <- scale(Cereals[,3:15])
```

```r
# Calculates Euclidean distance matrix for the "Cereals" dataset
dis <- dist(Cereals, method = "euclidean")
```

```r
#  Performs hierarchical clustering using complete linkage method
hc_comp <- hclust(dis, method = "complete" )
```

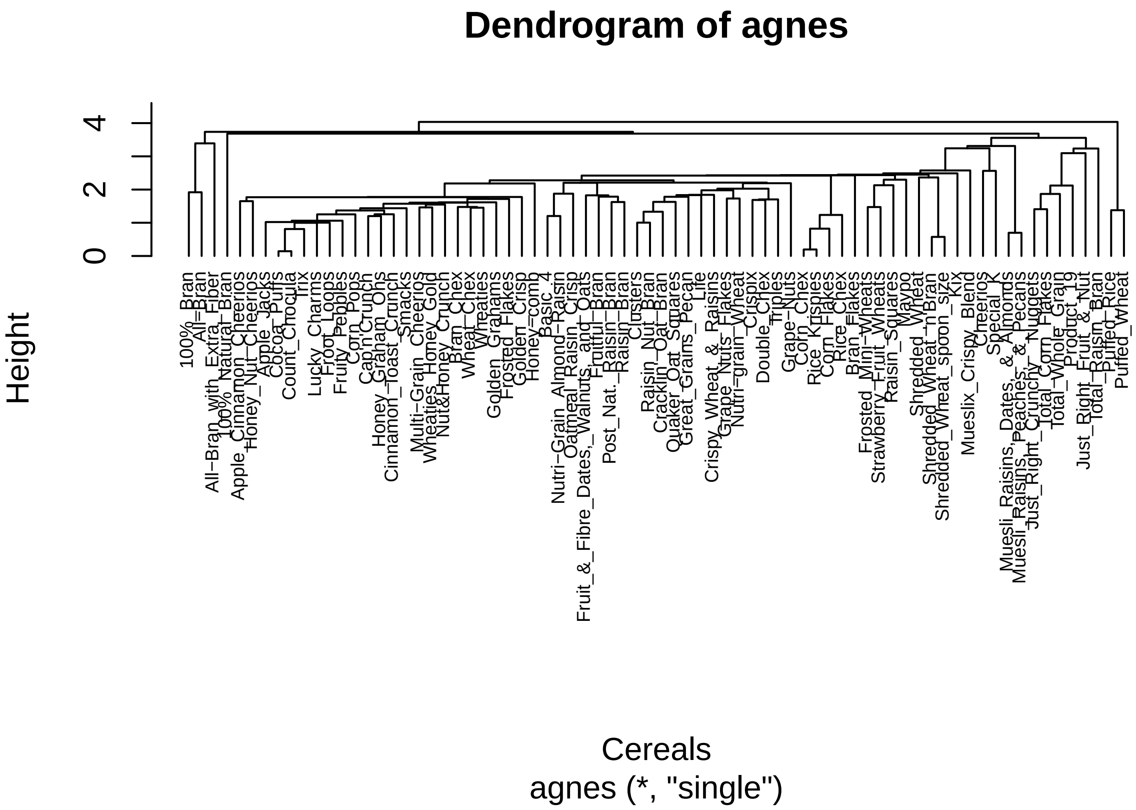
```r
# Plotting hierarchical clustering dendrogram
plot(hc_comp, cex = 0.6, hang = -1)
```



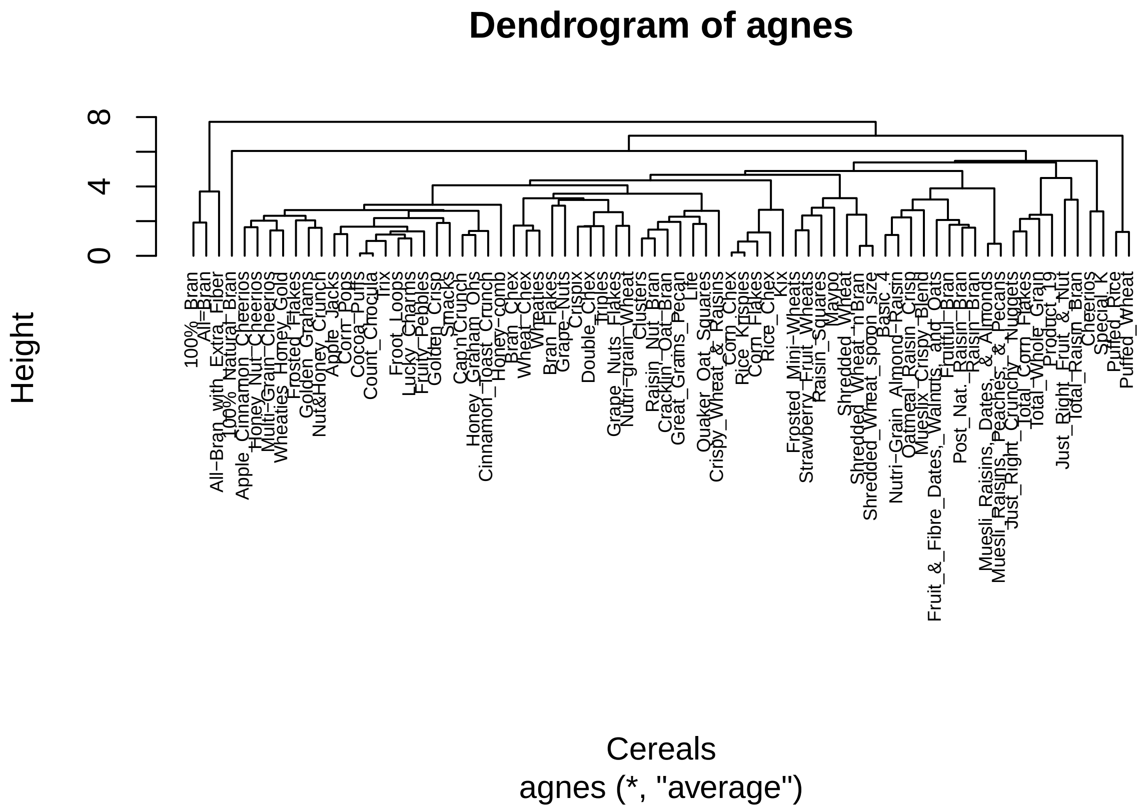
```r
# Loads the specified library
library(cluster)
```

```
## Warning: package 'cluster' was built under R version 4.3.2
```

```r
# Performs hierarchical clustering using the agnes function with the "single" method
hc_single1 <- agnes(Cereals, method = "single")
#  Visualizes the dendrogram using the pltree function
pltree(hc_single1, cex = 0.6, hang = -1, main = "Dendrogram of agnes")
```



```
# Performs hierarchical clustering
hc_avg <- agnes(Cereals, method = "average")
# Plots the dendrogram
pltree(hc_avg, cex = 0.6, hang = -1, main = "Dendrogram of agnes")
```



```
# Defines a vector "m" with clustering method names
m <- c( "average", "single", "complete", "ward")
# Assigns names to the vector elements
names(m) <- c( "average", "single", "complete", "ward")
# Defines a function "ac" that takes a clustering method as an argument and returns the agglomerative c
ac <- function(x) {
  agnes(Cereals, method = x)$ac
}
#install.packages("purrr")
library(purrr)
```

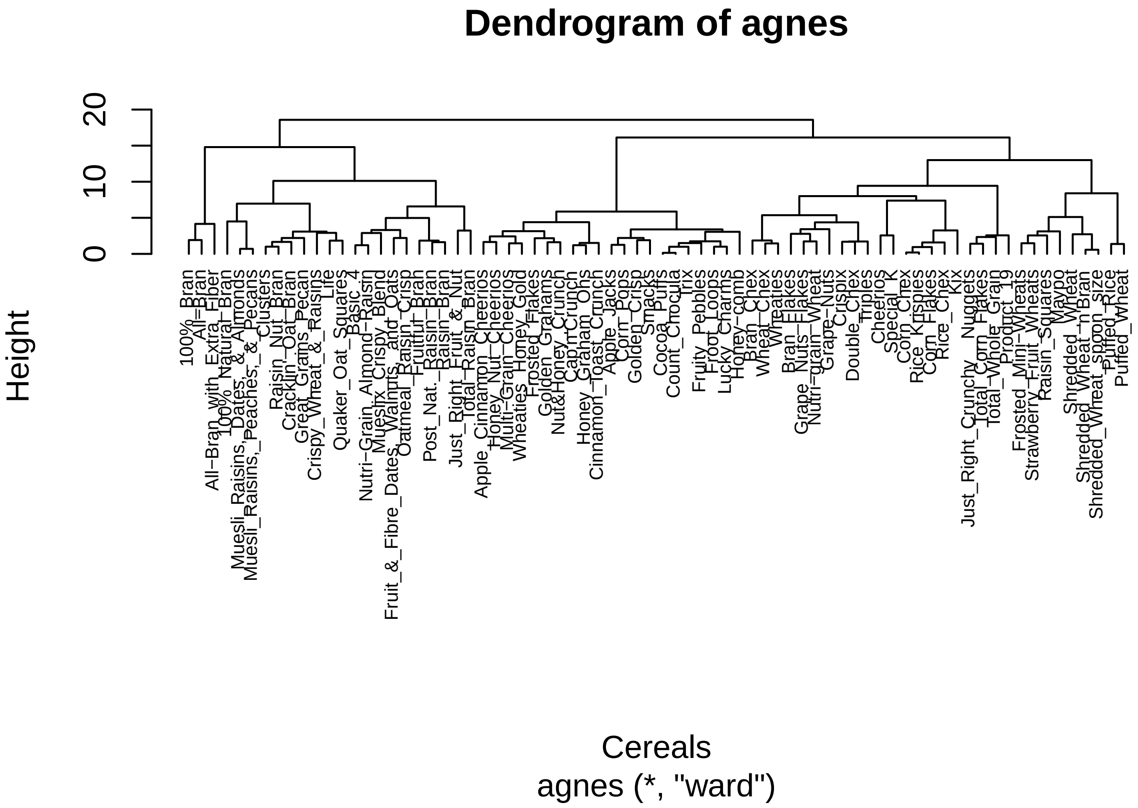
```
## Warning: package 'purrr' was built under R version 4.3.2
```

```
map_dbl(m, ac)
```

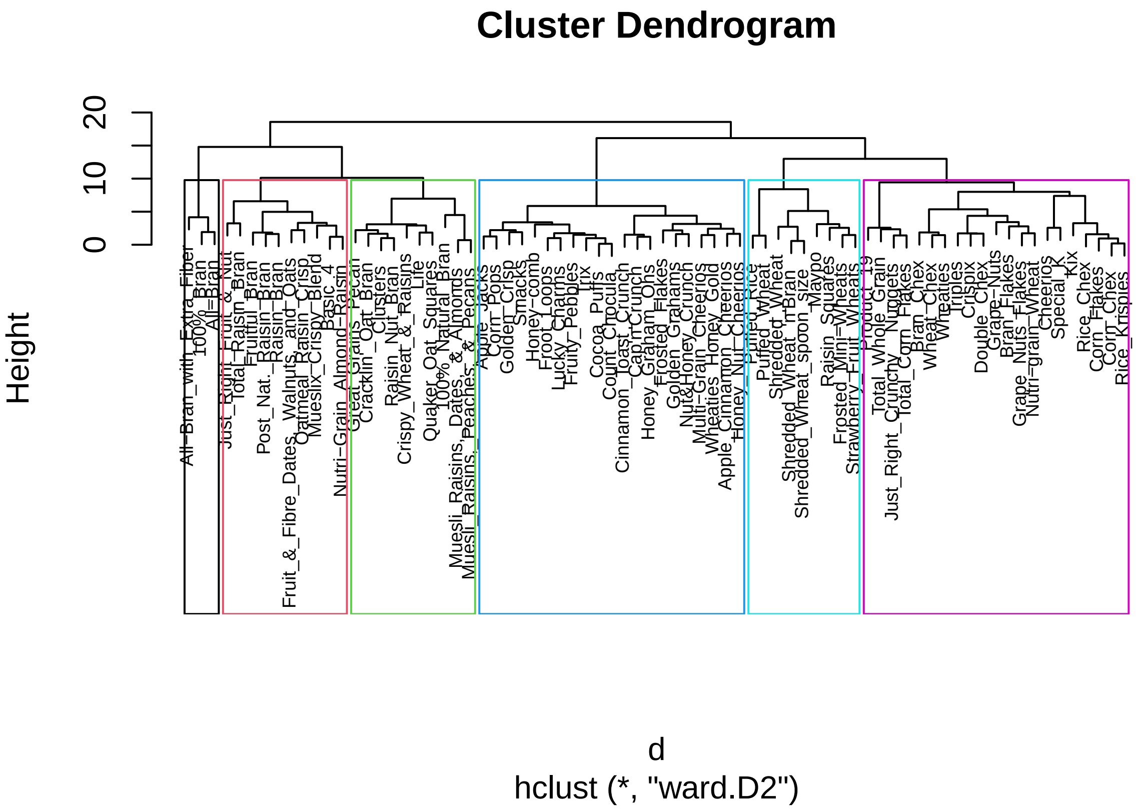
```
##   average    single  complete      ward
## 0.7766075 0.6067859 0.8353712 0.9046042
```

```
### Based on the obtained coefficients, we can see that the ward linkage method has the highest coeffic
### Ward linkage method is the best method for clustering the cereal data based on Euclidean distance t




# Performs hierarchical clustering on the "Cereals" dataset using the agnes function with the "ward" me
```

```
hc_wards <- agnes(Cereals, method = "ward")
# Plots the dendrogram based on the hierarchical clustering results
# Adjusting the text size (cex), hang distance, and adding title to the plot.
pltree(hc_wards, cex = 0.6, hang = -1, main = "Dendrogram of agnes")
```



```
# Calculates the Euclidean distance matrix for the "Cereals" dataset and store it in "d"
d <- dist(Cereals, method = "euclidean")
# Performs hierarchical clustering using the Ward's method on the distance matrix "d"
hc_ward_clust <- hclust(d, method = "ward.D2" )
# Plots the hierarchical clustering dendrogram with reduced text size
plot(hc_ward_clust, cex=0.6 )
# Highlights clusters by drawing rectangles around them where "k=6" specifies 6 clusters
rect.hclust(hc_ward_clust,k=6,border = 1:6)
```



```
### 6 Clusters appear to be a good number to group the data using the Ward linkage
```

```
# Using hierarchical clustering with the Ward's method (hc_ward_clust) to create clusters, and then ass
# Displays the table of counts for each subgroup.
sub_group <- cutree(hc_ward_clust, k = 6)
table(sub_group)
```

```
## sub_group
##  1  2  3  4  5  6
##  3 10 21 10 21  9
```

```
#install.packages("GGally")
# Load the required library
library(GGally)
```

```
## Warning: package 'GGally' was built under R version 4.3.2
```

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

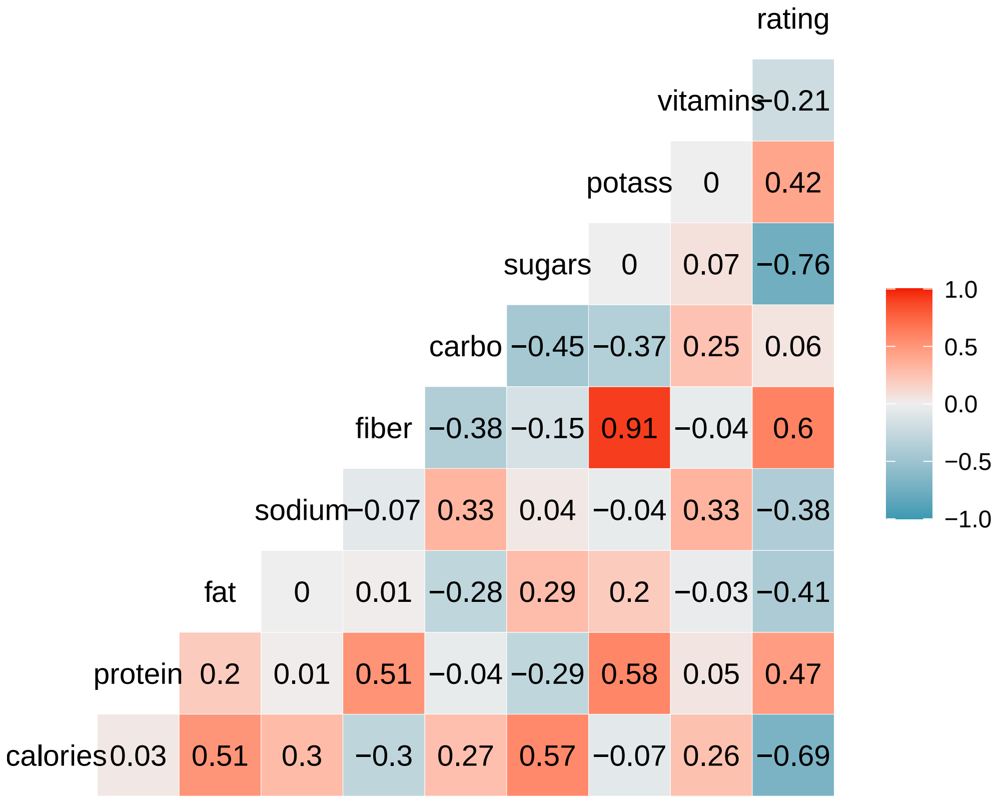
```
## Warning: package 'ggplot2' was built under R version 4.3.2
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.3.2

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
# Using the Cereals_1 data frame and selecting specific columns related to nutrition and rating
# Adjusting the data frame name and column names based on actual data
Cereals_1 %>%
 select(calories, protein, fat, sodium, fiber, carbo, sugars, potass,vitamins,rating) %>%
# Create a correlation matrix plot using ggcorr function from GGally
 ggcorr(palette = "RdBu", label = TRUE, label_round =  2)
```



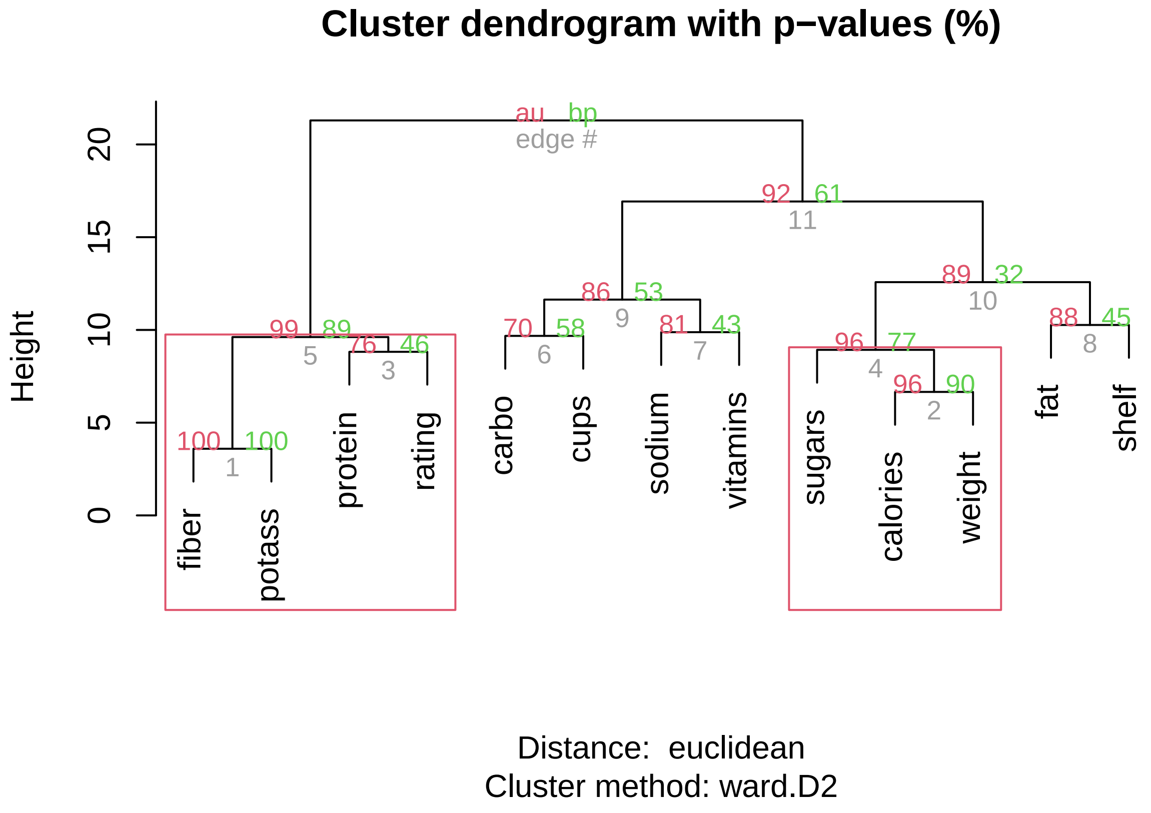
```
#install.packages("pvclust")
# Load the required library
library(pvclust)
```

```
## Warning: package 'pvclust' was built under R version 4.3.2
```

```
# Performs hierarchical clustering on the "Cereals" data using the Ward.D2 method with Euclidean distan
fit.pv <- pvclust(Cereals, method.hclust="ward.D2",
               method.dist="euclidean")
```

```
## Bootstrap (r = 0.5)... Done.
## Bootstrap (r = 0.59)... Done.
## Bootstrap (r = 0.69)... Done.
## Bootstrap (r = 0.8)... Done.
## Bootstrap (r = 0.89)... Done.
## Bootstrap (r = 1.0)... Done.
## Bootstrap (r = 1.09)... Done.
## Bootstrap (r = 1.19)... Done.
## Bootstrap (r = 1.3)... Done.
## Bootstrap (r = 1.39)... Done.
```

```
# Plots the results of the fit.pv model using the plot function
plot(fit.pv)
pvrect(fit.pv, alpha=.95)
```



```
### The effectiveness of the initial clustering is evaluated through the cluster stability, represented
### Stability rating between 0.6 and 0.75 suggests that a cluster identifies a pattern in the data,but t
### The goal is to maximize the Jaccard bootstrap for each cluster.Where efforts should be made to minim
```

```
#install.packages("fpc")
# Load the required library
library(fpc)
```

```
## Warning: package 'fpc' was built under R version 4.3.2
```

```
# Set the number of clusters to 6
Kbest_p<-6
# Perform hierarchical clustering using the Ward.D2 method and the hclustCBI function on the "Cereals"
cboot_hclust <- clusterboot(Cereals,clustermethod=hclustCBI,method="ward.D2", k=Kbest_p)
```

```
## 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
```

```
# Summarizing the results of hierarchical clustering using cboot_hclust
summary(cboot_hclust$result)
```

```
##               Length Class  Mode
## result         7     hclust list
## noise          1     -none- logical
## nc             1     -none- numeric
## clusterlist    6     -none- list
## partition     74     -none- numeric
## clustermethod  1     -none- character
## nccl           1     -none- numeric
```

```
# Extracting the cluster assignments from the hierarchical clustering results stored in cboot_hclust$re
groups<-cboot_hclust$result$partition
head(data.frame(groups))
```

```
##                           groups
## 100%_Bran                      1
## 100%_Natural_Bran              2
## All-Bran                       1
## All-Bran_with_Extra_Fiber      1
## Apple_Cinnamon_Cheerios        3
## Apple_Jacks                    3
```

```
# Extracting the bootstrap means from the "cboot_hclust" object
cboot_hclust$bootmean
```

```
## [1] 0.8965202 0.5363575 0.9115696 0.6582853 0.6315921 0.7054986
```

```
# Count of how many times each cluster was dissolved and by default clusterboot() runs 100 bootstrap it
# Accessing the "bootbrd" column in the "cboot_hclust" data frame
cboot_hclust$bootbrd
```

```
## [1] 11 58  0 37 25 34
```

```
### The results suggest that clusters 1 and 3 exhibit a high degree of stability. While clusters 4 and


# Assign cluster labels using cutree() based on hierarchical clustering (hc_ward_clust) with k=6
groups <- cutree(hc_ward_clust, k = 6)
# Define a function to print details of each cluster
```

```
print_clusters <- function(labels, k) {
for(i in 1:k) {
print(paste("cluster", i))
print(Cereals_1[labels==i,c("mfr","calories","protein","fat","sodium","fiber","carbo","sugars","potass"
                "vitamins","rating")])
}
}
# Call the function to print cluster details for the assigned labels
print_clusters(groups, 6)
```

```
## [1] "cluster 1"
##                          mfr calories protein fat sodium fiber carbo sugars
## 100%_Bran                   N       70       4   1    130    10     5      6
## All-Bran                    K       70       4   1    260     9     7      5
## All-Bran_with_Extra_Fiber   K       50       4   0    140    14     8      0
##                          potass vitamins   rating
## 100%_Bran                   280       25 68.40297
## All-Bran                    320       25 59.42551
## All-Bran_with_Extra_Fiber   330       25 93.70491
## [1] "cluster 2"
##                                  mfr calories protein fat sodium fiber carbo
## 100%_Natural_Bran                   Q      120       3   5     15   2.0   8.0
## Clusters                            G      110       3   2    140   2.0  13.0
## Cracklin’_Oat_Bran                  K      110       3   3    140   4.0  10.0
## Crispy_Wheat_&_Raisins              G      100       2   1    140   2.0  11.0
## Great_Grains_Pecan                  P      120       3   3     75   3.0  13.0
## Life                                Q      100       4   2    150   2.0  12.0
## Muesli_Raisins,_Dates,_&_Almonds    R      150       4   3     95   3.0  16.0
## Muesli_Raisins,_Peaches,_&_Pecans   R      150       4   3    150   3.0  16.0
## Quaker_Oat_Squares                  Q      100       4   1    135   2.0  14.0
## Raisin_Nut_Bran                     G      100       3   2    140   2.5  10.5
##                                  sugars potass vitamins   rating
## 100%_Natural_Bran                     8    135        0 33.98368
## Clusters                              7    105       25 40.40021
## Cracklin’_Oat_Bran                    7    160       25 40.44877
## Crispy_Wheat_&_Raisins               10    120       25 36.17620
## Great_Grains_Pecan                    4    100       25 45.81172
## Life                                  6     95       25 45.32807
## Muesli_Raisins,_Dates,_&_Almonds     11    170       25 37.13686
## Muesli_Raisins,_Peaches,_&_Pecans    11    170       25 34.13976
## Quaker_Oat_Squares                    6    110       25 49.51187
## Raisin_Nut_Bran                       8    140       25 39.70340
## [1] "cluster 3"
##                        mfr calories protein fat sodium fiber carbo sugars
## Apple_Cinnamon_Cheerios   G      110       2   2    180   1.5  10.5     10
## Apple_Jacks               K      110       2   0    125   1.0  11.0     14
## Cap’n’Crunch              Q      120       1   2    220   0.0  12.0     12
## Cinnamon_Toast_Crunch     G      120       1   3    210   0.0  13.0      9
## Cocoa_Puffs               G      110       1   1    180   0.0  12.0     13
## Corn_Pops                 K      110       1   0     90   1.0  13.0     12
## Count_Chocula             G      110       1   1    180   0.0  12.0     13
## Froot_Loops               K      110       2   1    125   1.0  11.0     13
## Frosted_Flakes            K      110       1   0    200   1.0  14.0     11
## Fruity_Pebbles            P      110       1   1    135   0.0  13.0      12
## Golden_Crisp              P      100       2   0     45   0.0  11.0      15
## Golden_Grahams            G      110       1   1    280   0.0  15.0       9
## Honey_Graham_Ohs          Q      120       1   2    220   1.0  12.0      11
## Honey_Nut_Cheerios        G      110       3   1    250   1.5  11.5      10
## Honey-comb                P      110       1   0    180   0.0  14.0      11
## Lucky_Charms              G      110       2   1    180   0.0  12.0      12
## Multi-Grain_Cheerios      G      100       2   1    220   2.0  15.0       6
## Nut&Honey_Crunch          K      120       2   1    190   0.0  15.0       9
## Smacks                    K      110       2   1     70   1.0   9.0      15
## Trix                      G      110       1   1    140   0.0  13.0      12
## Wheaties_Honey_Gold       G      110       2   1    200   1.0  16.0       8
##                         potass vitamins   rating
## Apple_Cinnamon_Cheerios     70       25 29.50954
## Apple_Jacks                 30       25 33.17409
## Cap’n’Crunch                35       25 18.04285
## Cinnamon_Toast_Crunch       45       25 19.82357
## Cocoa_Puffs                 55       25 22.73645
## Corn_Pops                   20       25 35.78279
## Count_Chocula               65       25 22.39651
## Froot_Loops                 30       25 32.20758
## Frosted_Flakes              25       25 31.43597
## Fruity_Pebbles              25       25 28.02576
## Golden_Crisp                40       25 35.25244
## Golden_Grahams              45       25 23.80404
## Honey_Graham_Ohs            45       25 21.87129
## Honey_Nut_Cheerios          90       25 31.07222
## Honey-comb                  35       25 28.74241
## Lucky_Charms                55       25 26.73451
## Multi-Grain_Cheerios        90       25 40.10596
## Nut&Honey_Crunch            40       25 29.92429
## Smacks                      40       25 31.23005
## Trix                        25       25 27.75330
## Wheaties_Honey_Gold         60       25 36.18756
## [1] "cluster 4"
##                                        mfr calories protein fat sodium fiber
## Basic_4                                  G      130       3   2    210   2.0
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats   P      120       3   2    160   5.0
## Fruitful_Bran                            K      120       3   0    240   5.0
## Just_Right_Fruit_&_Nut                   K      140       3   1    170   2.0
## Mueslix_Crispy_Blend                     K      160       3   2    150   3.0
## Nutri-Grain_Almond-Raisin                K      140       3   2    220   3.0
## Oatmeal_Raisin_Crisp                     G      130       3   2    170   1.5
## Post_Nat._Raisin_Bran                    P      120       3   1    200   6.0
## Raisin_Bran                              K      120       3   1    210   5.0
## Total_Raisin_Bran                        G      140       3   1    190   4.0
##                                        carbo sugars potass vitamins   rating
## Basic_4                                 18.0      8    100       25 37.03856
## Fruit_&_Fibre_Dates,_Walnuts,_and_Oats  12.0     10    200       25 40.91705
## Fruitful_Bran                           14.0     12    190       25 41.01549
## Just_Right_Fruit_&_Nut                  20.0      9     95      100 36.47151
## Mueslix_Crispy_Blend                    17.0     13    160       25 30.31335
## Nutri-Grain_Almond-Raisin               21.0      7    130       25 40.69232
## Oatmeal_Raisin_Crisp                    13.5     10    120       25 30.45084
## Post_Nat._Raisin_Bran                    11.0     14    260       25 37.84059
## Raisin_Bran                              14.0     12    240       25 39.25920
## Total_Raisin_Bran                        15.0     14    230      100 28.59278
## [1] "cluster 5"
##                             mfr calories protein fat sodium fiber carbo sugars
## Bran_Chex                     R       90       2   1    200     4    15      6
## Bran_Flakes                   P       90       3   0    210     5    13      5
## Cheerios                      G      110       6   2    290     2    17      1
## Corn_Chex                     R      110       2   0    280     0    22      3
## Corn_Flakes                   K      100       2   0    290     1    21      2
## Crispix                       K      110       2   0    220     1    21      3
## Double_Chex                   R      100       2   0    190     1    18      5
## Grape_Nuts_Flakes             P      100       3   1    140     3    15      5
## Grape-Nuts                    P      110       3   0    170     3    17      3
## Just_Right_Crunchy__Nuggets   K      110       2   1    170     1    17      6
## Kix                           G      110       2   1    260     0    21      3
## Nutri-grain_Wheat             K       90       3   0    170     3    18      2
## Product_19                    K      100       3   0    320     1    20      3
## Rice_Chex                     R      110       1   0    240     0    23      2
## Rice_Krispies                 K      110       2   0    290     0    22      3
## Special_K                     K      110       6   0    230     1    16      3
## Total_Corn_Flakes             G      110       2   1    200     0    21      3
## Total_Whole_Grain             G      100       3   1    200     3    16      3
## Triples                       G      110       2   1    250     0    21      3
## Wheat_Chex                    R      100       3   1    230     3    17      3
## Wheaties                      G      100       3   1    200     3    17      3
##                             potass vitamins   rating
## Bran_Chex                      125       25 49.12025
## Bran_Flakes                    190       25 53.31381
## Cheerios                       105       25 50.76500
## Corn_Chex                       25       25 41.44502
## Corn_Flakes                     35       25 45.86332
## Crispix                         30       25 46.89564
## Double_Chex                     80       25 44.33086
## Grape_Nuts_Flakes               85       25 52.07690
## Grape-Nuts                      90       25 53.37101
## Just_Right_Crunchy__Nuggets     60      100 36.52368
## Kix                             40       25 39.24111
## Nutri-grain_Wheat               90       25 59.64284
## Product_19                      45      100 41.50354
## Rice_Chex                       30       25 41.99893
## Rice_Krispies                   35       25 40.56016
## Special_K                       55       25 53.13132
## Total_Corn_Flakes               35      100 38.83975
## Total_Whole_Grain              110      100 46.65884
## Triples                         60       25 39.10617
## Wheat_Chex                     115       25 49.78744
## Wheaties                       110       25 51.59219
## [1] "cluster 6"
##                           mfr calories protein fat sodium fiber carbo sugars
## Frosted_Mini-Wheats         K      100       3   0      0     3    14      7
## Maypo                       A      100       4   1      0     0    16      3
## Puffed_Rice                 Q       50       1   0      0     0    13      0
## Puffed_Wheat                Q       50       2   0      0     1    10      0
## Raisin_Squares              K       90       2   0      0     2    15      6
## Shredded_Wheat              N       80       2   0      0     3    16      0
## Shredded_Wheat_’n’Bran      N       90       3   0      0     4    19      0
## Shredded_Wheat_spoon_size   N       90       3   0      0     3    20      0
## Strawberry_Fruit_Wheats     N       90       2   0     15     3    15      5
##                           potass vitamins   rating
## Frosted_Mini-Wheats          100       25 58.34514
## Maypo                         95       25 54.85092
## Puffed_Rice                   15        0 60.75611
## Puffed_Wheat                  50        0 63.00565
## Raisin_Squares               110       25 55.33314
## Shredded_Wheat                95        0 68.23588
## Shredded_Wheat_’n’Bran       140        0 74.47295
## Shredded_Wheat_spoon_size    120        0 72.80179
## Strawberry_Fruit_Wheats       90       25 59.36399
```

```
### I opted to select clusters based on statistical values and nutritional richness with the goal of fo

### To determine whether normalization was necessary,I concluded that it was not.  Normalizing the data

### The cereal diet levels within the clusters exhibit variations in richness, adequacy, and deficienci

### While Cluster 1 provides nutritionally consistent guidelines for crafting a balanced diet, the optio

### Clusters 4 and 5 showcase well-balanced nutritional values and receive high ratings for consumer sa
```