Assignment 5

Rohith Desamseety

2022-11-30

```
#Importing the necessary packages and libraries
library(cluster)
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```
library(dendextend)
```

```
##
## ---------------------
## Welcome to dendextend version 1.16.0
## Type citation('dendextend') for how to cite the package.
##
## Type browseVignettes(package = 'dendextend') for the package vignette.
## The github page is: https://github.com/talgalili/dendextend/
##
## Suggestions and bug-reports can be submitted at: https://github.com/talgalili/dendextend/issues
## You may ask questions at stackoverflow, use the r and dendextend tags:
##   https://stackoverflow.com/questions/tagged/dendextend
##
##  To suppress this message use:  suppressPackageStartupMessages(library(dendextend))
## ---------------------

##
## Attaching package: 'dendextend'

## The following object is masked from 'package:stats':
##
##     cutree
```

```
library(knitr)
library(factoextra)
```

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

```
library(readr)
```

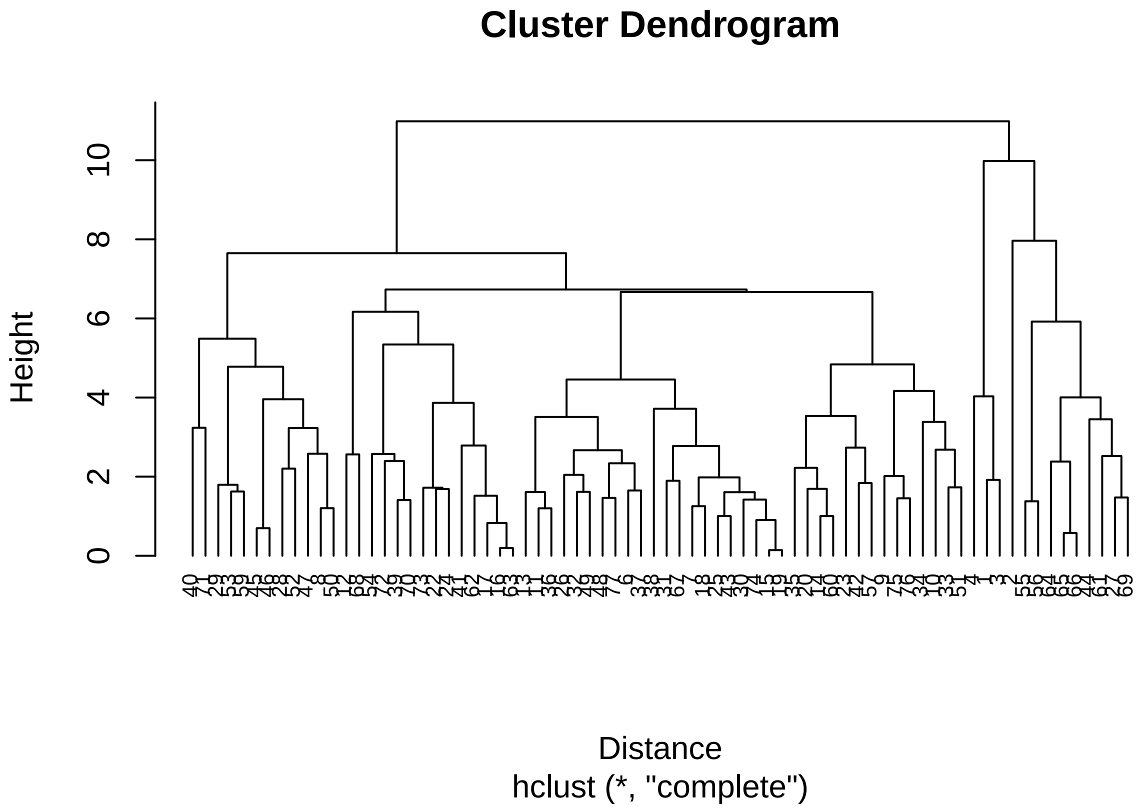
```
#Importing a dataset and producing a data set that only contains numerical information
library(readr)
Cereals <- read.csv("~/Downloads/Cereals.csv")
View(Cereals)
Numerical_data <- data.frame(Cereals[,4:16])
```

```
#Removing missing values from the data
Numerical_data <- na.omit(Numerical_data)
```

```
#Data normalization
Data_Cereals_normalise <- scale(Numerical_data)
```

```
#Using the Euclidean distance algorithm on the normalized data, apply hierarchical clustering to the da
Distance <- dist(Data_Cereals_normalise, method = "euclidean")
Hierarchial_Clustering <- hclust(Distance, method = "complete")
```

```
#Creating a dendogram plot.
plot(Hierarchial_Clustering, cex = 0.7, hang = -1)
```



```
#Using Agnes function to perform clustering with single linkage, complete linkage
#,average linkage and Ward.
HC_single <- agnes(Data_Cereals_normalise, method = "single")
HC_complete <- agnes(Data_Cereals_normalise, method = "complete")
HC_average <- agnes(Data_Cereals_normalise, method = "average")
HC_ward <- agnes(Data_Cereals_normalise, method = "ward")
```

```
#Choosing the most effective strategy
print(HC_single$ac)
```

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

```
print(HC_complete$ac)
```

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

```
print(HC_average$ac)
```

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

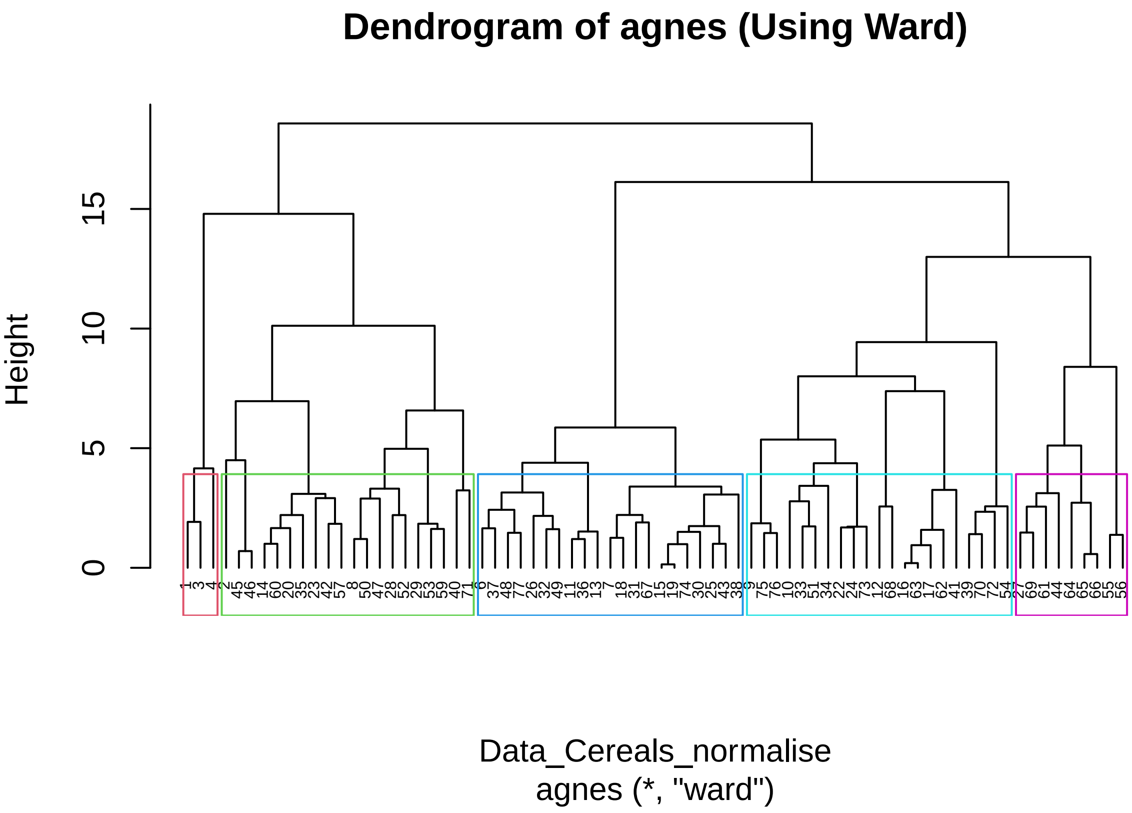
```
print(HC_ward$ac)
```

```
## [1] 0.9046042
```

#Given the information above, it is clear that the ward approach is the most effective because of its value of 0.9046042.

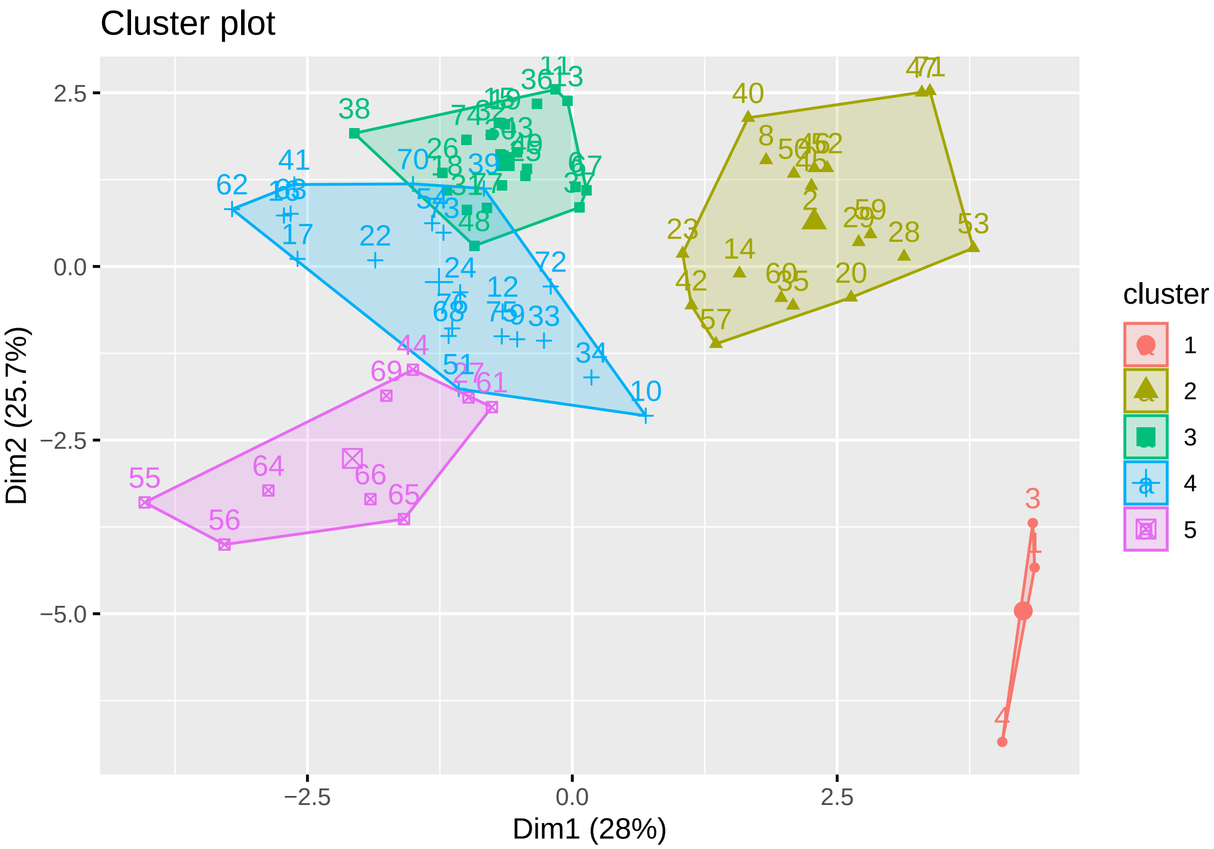
#Task 2- Choosing the clusters:

```
pltree(HC_ward, cex = 0.5, hang = -1, main = "Dendrogram of agnes (Using Ward)")
rect.hclust(HC_ward, k = 5, border = 2:7)
```



```
Group <- cutree(HC_ward, k=5)
dataframe2 <- as.data.frame(cbind(Data_Cereals_normalise,Group))
```

```
fviz_cluster(list(data = dataframe2, cluster = Group))
```



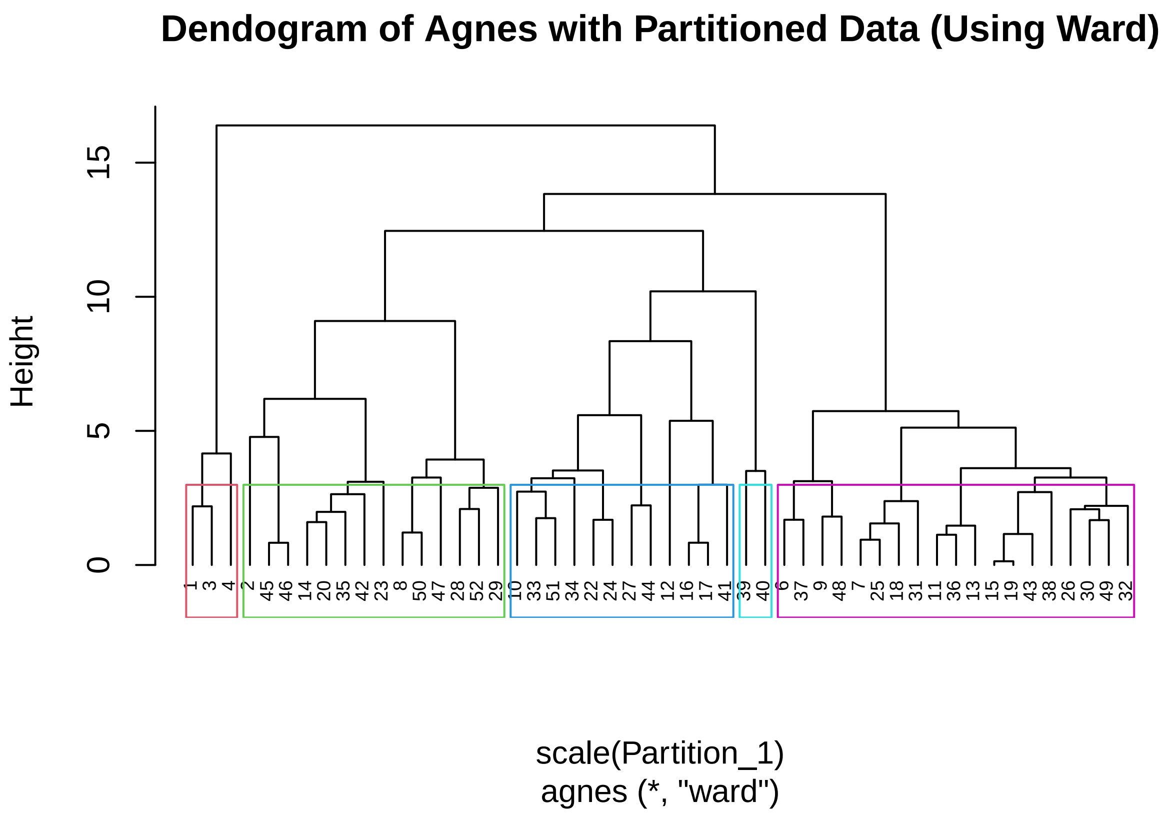
#5
clusters can be chosen from the observation above.. #figuring out the clusters stability and structure.

```r
#Constructing Partitions
set.seed(123)
Partition_1 <- Numerical_data[1:50,]
Partition_2 <- Numerical_data[51:74,]
```

```r
#Performing Hierarchical Clustering, taking into account k = 5.
RD_single <- agnes(scale(Partition_1), method = "single")
RD_complete <- agnes(scale(Partition_1), method = "complete")
RD_average <- agnes(scale(Partition_1), method = "average")
RD_ward <- agnes(scale(Partition_1), method = "ward")
cbind(single=RD_single$ac , complete=RD_complete$ac , average= RD_average$ac , ward= RD_ward$ac)
```

```
##         single  complete   average      ward
## [1,] 0.6393338 0.8138238 0.7408904 0.8764323
```

```r
pltree(RD_ward, cex = 0.6, hang = -1, main = "Dendogram of Agnes with Partitioned Data (Using Ward)")
rect.hclust(RD_ward, k = 5, border = 2:7)
```



```
cut_2 <- cutree(RD_ward, k = 5)
```

```
#Calculating the centroids.
result <- as.data.frame(cbind(Partition_1, cut_2))
result[result$cut_2==1,]
```

```
##   calories protein fat sodium fiber carbo sugars potass vitamins shelf weight
## 1       70       4   1    130    10     5      6    280       25     3      1
## 3       70       4   1    260     9     7      5    320       25     3      1
## 4       50       4   0    140    14     8      0    330       25     3      1
##   cups   rating cut_2
## 1 0.33 68.40297     1
## 3 0.33 59.42551     1
## 4 0.50 93.70491     1
```

```
centroid_1 <- colMeans(result[result$cut_2==1,])
result[result$cut_2==2,]
```

```
##    calories protein fat sodium fiber carbo sugars potass vitamins shelf weight
## 2       120       3   5     15   2.0   8.0      8    135        0     3   1.00
## 8       130       3   2    210   2.0  18.0      8    100       25     3   1.33
## 14      110       3   2    140   2.0  13.0      7    105       25     3   1.00
## 20      110       3   3    140   4.0  10.0      7    160       25     3   1.00
## 23      100       2   1    140   2.0  11.0     10    120       25     3   1.00
## 28      120       3   2    160   5.0  12.0     10    200       25     3   1.25
## 29      120       3   0    240   5.0  14.0     12    190       25     3   1.33
## 35      120       3   3     75   3.0  13.0      4    100       25     3   1.00
## 42      100       4   2    150   2.0  12.0      6     95       25     2   1.00
## 45      150       4   3     95   3.0  16.0     11    170       25     3   1.00
## 46      150       4   3    150   3.0  16.0     11    170       25     3   1.00
## 47      160       3   2    150   3.0  17.0     13    160       25     3   1.50
## 50      140       3   2    220   3.0  21.0      7    130       25     3   1.33
## 52      130       3   2    170   1.5  13.5     10    120       25     3   1.25
##    cups   rating cut_2
## 2  1.00 33.98368     2
## 8  0.75 37.03856     2
## 14 0.50 40.40021     2
## 20 0.50 40.44877     2
## 23 0.75 36.17620     2
## 28 0.67 40.91705     2
## 29 0.67 41.01549     2
## 35 0.33 45.81172     2
## 42 0.67 45.32807     2
## 45 1.00 37.13686     2
## 46 1.00 34.13976     2
## 47 0.67 30.31335     2
## 50 0.67 40.69232     2
## 52 0.50 30.45084     2
```

```
centroid_2 <- colMeans(result[result$cut_2==2,])
result[result$cut_2==3,]
```

```
##    calories protein fat sodium fiber carbo sugars potass vitamins shelf weight
## 6       110       2   2    180   1.5  10.5     10     70       25     1      1
## 7       110       2   0    125   1.0  11.0     14     30       25     2      1
## 9        90       2   1    200   4.0  15.0      6    125       25     1      1
## 11      120       1   2    220   0.0  12.0     12     35       25     2      1
## 13      120       1   3    210   0.0  13.0      9     45       25     2      1
## 15      110       1   1    180   0.0  12.0     13     55       25     2      1
## 18      110       1   0     90   1.0  13.0     12     20       25     2      1
## 19      110       1   1    180   0.0  12.0     13     65       25     2      1
## 25      110       2   1    125   1.0  11.0     13     30       25     2      1
## 26      110       1   0    200   1.0  14.0     11     25       25     1      1
## 30      110       1   1    135   0.0  13.0     12     25       25     2      1
## 31      100       2   0     45   0.0  11.0     15     40       25     1      1
## 32      110       1   1    280   0.0  15.0      9     45       25     2      1
## 36      120       1   2    220   1.0  12.0     11     45       25     2      1
## 37      110       3   1    250   1.5  11.5     10     90       25     1      1
## 38      110       1   0    180   0.0  14.0     11     35       25     1      1
## 43      110       2   1    180   0.0  12.0     12     55       25     2      1
## 48      100       2   1    220   2.0  15.0      6     90       25     1      1
## 49      120       2   1    190   0.0  15.0      9     40       25     2      1
##    cups   rating cut_2
## 6  0.75 29.50954     3
## 7  1.00 33.17409     3
## 9  0.67 49.12025     3
## 11 0.75 18.04285     3
## 13 0.75 19.82357     3
## 15 1.00 22.73645     3
## 18 1.00 35.78279     3
## 19 1.00 22.39651     3
## 25 1.00 32.20758     3
## 26 0.75 31.43597     3
## 30 0.75 28.02576     3
## 31 0.88 35.25244     3
## 32 0.75 23.80404     3
## 36 1.00 21.87129     3
## 37 0.75 31.07222     3
## 38 1.33 28.74241     3
## 43 1.00 26.73451     3
## 48 1.00 40.10596     3
## 49 0.67 29.92429     3
```

```
centroid_3 <- colMeans(result[result$cut_2==3,])
result[result$cut_2==4,]
```

```
##    calories protein fat sodium fiber carbo sugars potass vitamins shelf weight
## 10       90       3   0    210     5    13      5    190       25     3      1
## 12      110       6   2    290     2    17      1    105       25     1      1
## 16      110       2   0    280     0    22      3     25       25     1      1
## 17      100       2   0    290     1    21      2     35       25     1      1
## 22      110       2   0    220     1    21      3     30       25     3      1
## 24      100       2   0    190     1    18      5     80       25     3      1
## 27      100       3   0      0     3    14      7    100       25     2      1
## 33      100       3   1    140     3    15      5     85       25     3      1
## 34      110       3   0    170     3    17      3     90       25     3      1
## 41      110       2   1    260     0    21      3     40       25     2      1
## 44      100       4   1      0     0    16      3     95       25     2      1
## 51       90       3   0    170     3    18      2     90       25     3      1
##    cups   rating cut_2
## 10 0.67 53.31381     4
## 12 1.25 50.76500     4
## 16 1.00 41.44502     4
## 17 1.00 45.86332     4
## 22 1.00 46.89564     4
## 24 0.75 44.33086     4
## 27 0.80 58.34514     4
## 33 0.88 52.07690     4
## 34 0.25 53.37101     4
## 41 1.50 39.24111     4
## 44 1.00 54.85092     4
## 51 1.00 59.64284     4
```

```
centroid_4 <- colMeans(result[result$cut_2==4,])
centroids <- rbind(centroid_1, centroid_2, centroid_3, centroid_4)
x2 <- as.data.frame(rbind(centroids[,-14], Partition_2))
```

```
#Calculating the Distance.
Distance_1 <- get_dist(x2)
Matrix_1 <- as.matrix(Distance_1)
dataframe1 <- data.frame(data=seq(1,nrow(Partition_2),1), Clusters = rep(0,nrow(Partition_2)))
for(i in 1:nrow(Partition_2))
  {dataframe1[i,2] <- which.min(Matrix_1[i+4, 1:4])}
dataframe1
```

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

```
cbind(dataframe2$Group[51:74], dataframe1$Clusters)
```

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

```
table(dataframe2$Group[51:74] == dataframe1$Clusters)
```

```
## 
## FALSE  TRUE 
##    12    12
```

#Our results from the observation above are 12 False and 12 True. As a result, we may say that the model is just partly unstable.

#TASK 3- The elementary public schools would like to choose a set of cereals to include in their daily cafeterias. Every day a different cereal is offered, but all cereals should support a healthy diet. For this goal, you are requested to find a cluster of "healthy cereals."

```
#Clustering Healthy Cereals.
Healthy_Cereals <- Cereals
Healthy_Cereals_RD <- na.omit(Healthy_Cereals)
clust <- cbind(Healthy_Cereals_RD, Group)
clust[clust$Group==1,]
```

```
##                        name mfr type calories protein fat sodium fiber carbo
## 1                 100%_Bran   N    C       70       4   1    130    10     5
## 3                  All-Bran   K    C       70       4   1    260     9     7
## 4 All-Bran_with_Extra_Fiber   K    C       50       4   0    140    14     8
##   sugars potass vitamins shelf weight cups   rating Group
## 1      6    280       25     3      1 0.33 68.40297     1
## 3      5    320       25     3      1 0.33 59.42551     1
## 4      0    330       25     3      1 0.50 93.70491     1
```

```
clust[clust$Group==2,]
```

```
##                                      name mfr type calories protein fat sodium
## 2                       100%_Natural_Bran   Q    C      120       3   5     15
## 8                                 Basic_4   G    C      130       3   2    210
## 14                               Clusters   G    C      110       3   2    140
## 20                     Cracklin'_Oat_Bran   K    C      110       3   3    140
## 23                 Crispy_Wheat_&_Raisins   G    C      100       2   1    140
## 28 Fruit_&_Fibre_Dates,_Walnuts,_and_Oats   P    C      120       3   2    160
## 29                          Fruitful_Bran   K    C      120       3   0    240
## 35                     Great_Grains_Pecan   P    C      120       3   3     75
## 40                 Just_Right_Fruit_&_Nut   K    C      140       3   1    170
## 42                                   Life   Q    C      100       4   2    150
## 45       Muesli_Raisins,_Dates,_&_Almonds   R    C      150       4   3     95
## 46      Muesli_Raisins,_Peaches,_&_Pecans   R    C      150       4   3    150
## 47                   Mueslix_Crispy_Blend   K    C      160       3   2    150
## 50              Nutri-Grain_Almond-Raisin   K    C      140       3   2    220
## 52                   Oatmeal_Raisin_Crisp   G    C      130       3   2    170
## 53                  Post_Nat._Raisin_Bran   P    C      120       3   1    200
## 57                     Quaker_Oat_Squares   Q    C      100       4   1    135
## 59                            Raisin_Bran   K    C      120       3   1    210
## 60                        Raisin_Nut_Bran   G    C      100       3   2    140
## 71                      Total_Raisin_Bran   G    C      140       3   1    190
##    fiber carbo sugars potass vitamins shelf weight cups   rating Group
## 2    2.0   8.0      8    135        0     3   1.00 1.00 33.98368     2
## 8    2.0  18.0      8    100       25     3   1.33 0.75 37.03856     2
## 14   2.0  13.0      7    105       25     3   1.00 0.50 40.40021     2
## 20   4.0  10.0      7    160       25     3   1.00 0.50 40.44877     2
## 23   2.0  11.0     10    120       25     3   1.00 0.75 36.17620     2
## 28   5.0  12.0     10    200       25     3   1.25 0.67 40.91705     2
## 29   5.0  14.0     12    190       25     3   1.33 0.67 41.01549     2
## 35   3.0  13.0      4    100       25     3   1.00 0.33 45.81172     2
## 40   2.0  20.0      9     95      100     3   1.30 0.75 36.47151     2
## 42   2.0  12.0      6     95       25     2   1.00 0.67 45.32807     2
## 45   3.0  16.0     11    170       25     3   1.00 1.00 37.13686     2
## 46   3.0  16.0     11    170       25     3   1.00 1.00 34.13976     2
## 47   3.0  17.0      13    160        25     3   1.50 0.67 30.31335     2
## 50   3.0  21.0       7    130        25     3   1.33 0.67 40.69232     2
## 52   1.5  13.5      10    120        25     3   1.25 0.50 30.45084     2
## 53   6.0  11.0      14    260        25     3   1.33 0.67 37.84059     2
## 57   2.0  14.0       6    110        25     3   1.00 0.50 49.51187     2
## 59   5.0  14.0      12    240        25     2   1.33 0.75 39.25920     2
## 60   2.5  10.5       8    140        25     3   1.00 0.50 39.70340     2
## 71   4.0  15.0      14    230       100     3   1.50 1.00 28.59278     2
```

```
clust[clust$Group==3,]
```

```
##                         name mfr type calories protein fat sodium fiber carbo
## 6  Apple_Cinnamon_Cheerios   G    C      110       2   2    180   1.5  10.5
## 7              Apple_Jacks   K    C      110       2   0    125   1.0  11.0
## 11            Cap'n'Crunch   Q    C      120       1   2    220   0.0  12.0
## 13   Cinnamon_Toast_Crunch   G    C      120       1   3    210   0.0  13.0
## 15             Cocoa_Puffs   G    C      110       1   1    180   0.0  12.0
## 18               Corn_Pops   K    C      110       1   0     90   1.0  13.0
## 19           Count_Chocula   G    C      110       1   1    180   0.0  12.0
## 25             Froot_Loops   K    C      110       2   1    125   1.0  11.0
## 26          Frosted_Flakes   K    C      110       1   0    200   1.0  14.0
## 30          Fruity_Pebbles   P    C      110       1   1    135   0.0  13.0
## 31            Golden_Crisp   P    C      100       2   0     45   0.0  11.0
## 32          Golden_Grahams   G    C      110       1   1    280   0.0  15.0
## 36        Honey_Graham_Ohs   Q    C      120       1   2    220   1.0  12.0
## 37      Honey_Nut_Cheerios   G    C      110       3   1    250   1.5  11.5
## 38              Honey-comb   P    C      110       1   0    180   0.0  14.0
## 43            Lucky_Charms   G    C      110       2   1    180   0.0  12.0
## 48    Multi-Grain_Cheerios   G    C      100       2   1    220   2.0  15.0
## 49        Nut&Honey_Crunch   K    C      120       2   1    190   0.0  15.0
## 67                  Smacks   K    C      110       2   1     70   1.0   9.0
## 74                    Trix   G    C      110       1   1    140   0.0  13.0
## 77     Wheaties_Honey_Gold   G    C      110       2   1    200   1.0  16.0
##    sugars potass vitamins shelf weight cups   rating Group
## 6      10     70       25     1      1 0.75 29.50954     3
## 7      14     30       25     2      1 1.00 33.17409     3
## 11     12     35       25     2      1 0.75 18.04285     3
## 13      9     45       25     2      1 0.75 19.82357     3
## 15     13     55       25     2      1 1.00 22.73645     3
## 18     12     20       25     2      1 1.00 35.78279     3
## 19     13     65       25     2      1 1.00 22.39651     3
## 25     13     30       25     2      1 1.00 32.20758     3
## 26     11     25       25     1      1 0.75 31.43597     3
## 30     12     25       25     2      1 0.75 28.02576     3
## 31     15     40       25     1      1 0.88 35.25244     3
## 32      9     45       25     2      1 0.75 23.80404     3
## 36     11     45       25     2      1 1.00 21.87129     3
## 37     10     90       25     1      1 0.75 31.07222     3
## 38     11     35       25     1      1 1.33 28.74241     3
## 43     12     55       25     2      1 1.00 26.73451     3
## 48      6     90       25     1      1 1.00 40.10596     3
## 49      9     40       25     2      1 0.67 29.92429     3
## 67     15     40       25     2      1 0.75 31.23005     3
## 74     12     25       25     2      1 1.00 27.75330     3
## 77      8     60       25     1      1 0.75 36.18756     3
```

```
clust[clust$Group==4,]
```

```
##                            name mfr type calories protein fat sodium fiber carbo
## 9                     Bran_Chex   R    C       90       2   1    200     4    15
## 10                  Bran_Flakes   P    C       90       3   0    210     5    13
## 12                     Cheerios   G    C      110       6   2    290     2    17
## 16                    Corn_Chex   R    C      110       2   0    280     0    22
## 17                  Corn_Flakes   K    C      100       2   0    290     1    21
## 22                      Crispix   K    C      110       2   0    220     1    21
## 24                  Double_Chex   R    C      100       2   0    190     1    18
## 33            Grape_Nuts_Flakes   P    C      100       3   1    140     3    15
## 34                   Grape-Nuts   P    C      110       3   0    170     3    17
## 39  Just_Right_Crunchy__Nuggets   K    C      110       2   1    170     1    17
## 41                          Kix   G    C      110       2   1    260     0    21
## 51            Nutri-grain_Wheat   K    C       90       3   0    170     3    18
## 54                   Product_19   K    C      100       3   0    320     1    20
## 62                    Rice_Chex   R    C      110       1   0    240     0    23
## 63                Rice_Krispies   K    C      110       2   0    290     0    22
## 68                    Special_K   K    C      110       6   0    230     1    16
## 70            Total_Corn_Flakes   G    C      110       2   1    200     0    21
## 72            Total_Whole_Grain   G    C      100       3   1    200     3    16
## 73                      Triples   G    C      110       2   1    250     0    21
## 75                   Wheat_Chex   R    C      100       3   1    230     3    17
## 76                     Wheaties   G    C      100       3   1    200     3    17
##    sugars potass vitamins shelf weight cups   rating Group
## 9       6    125       25     1      1 0.67 49.12025     4
## 10      5    190       25     3      1 0.67 53.31381     4
## 12      1    105       25     1      1 1.25 50.76500     4
## 16      3     25       25     1      1 1.00 41.44502     4
## 17      2     35       25     1      1 1.00 45.86332     4
## 22      3     30       25     3      1 1.00 46.89564     4
## 24      5     80       25     3      1 0.75 44.33086     4
## 33      5     85       25     3      1 0.88 52.07690     4
## 34      3     90       25     3      1 0.25 53.37101     4
## 39      6     60      100     3      1 1.00 36.52368     4
## 41      3     40       25     2      1 1.50 39.24111     4
## 51      2     90       25     3      1 1.00 59.64284     4
## 54      3     45      100     3      1 1.00 41.50354     4
## 62      2     30       25     1      1 1.13 41.99893     4
## 63      3     35       25     1      1 1.00 40.56016     4
## 68      3     55       25     1      1 1.00 53.13132     4
## 70      3     35      100     3      1 1.00 38.83975     4
## 72      3    110      100     3      1 1.00 46.65884     4
## 73      3     60       25     3      1 0.75 39.10617     4
## 75      3    115       25     1      1 0.67 49.78744     4
## 76      3    110       25     1      1 1.00 51.59219     4
```

```
#The best cluster is chosen using mean ratings.
mean(clust[clust$Group==1,"rating"])
```

```
## [1] 73.84446
```

```
mean(clust[clust$Group==2,"rating"])
```

```
## [1] 38.26161
```

```
mean(clust[clust$Group==3,"rating"])
```

```
## [1] 28.84825
```

```
mean(clust[clust$Group==4,"rating"])
```

```
## [1] 46.46513
```

#According to the results above, cluster 1 may be selected as it is the highest. #Hence, Group 1 can be considered as the healthy diet cluster.