Assignment 5

RAJEEV VARMA

2022-12-01

```
#Importing required libraries and packages
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)
```

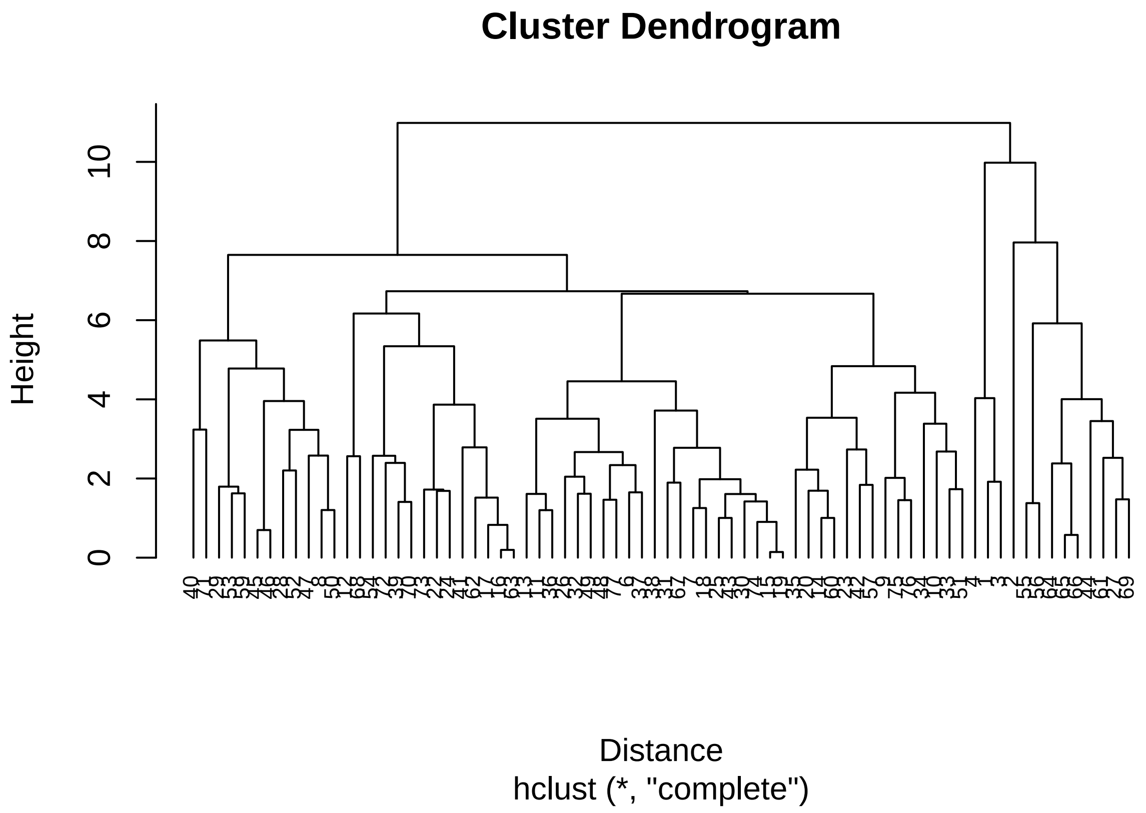
```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(readr)
```

```
#Importing dataset and creating data set with only numeric data
Cereals <- read.csv("C:/Users/RAJEEV VARMA/Downloads/Cereals.csv")
Num_data <- data.frame(Cereals[,4:16])

#Omitting missing values from the data
Num_data <- na.omit(Num_data)
```

```r
#Normalizing the data
Cereals_norm <- scale(Num_data)
```

```r
#Applying hierarchical clustering using Euclidean distance method.
Distance <- dist(Cereals_norm, method = "euclidean")
Hier_Clustering <- hclust(Distance, method = "complete")

#Plotting of the dendogram.
plot(Hier_Clustering, cex = 0.7, hang = -1)
```



```r
#Using Agnes function to perform clustering with single, complete, average and ward linkages

Hier_Clust_single <- agnes(Cereals_norm, method = "single")
Hier_Clust_complete <- agnes(Cereals_norm, method = "complete")
Hier_Clust_average <- agnes(Cereals_norm, method = "average")
Hier_Clust_ward <- agnes(Cereals_norm, method = "ward")

print(Hier_Clust_single$ac)
```

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

```r
print(Hier_Clust_complete$ac)
```

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

```r
print(Hier_Clust_average$ac)
```

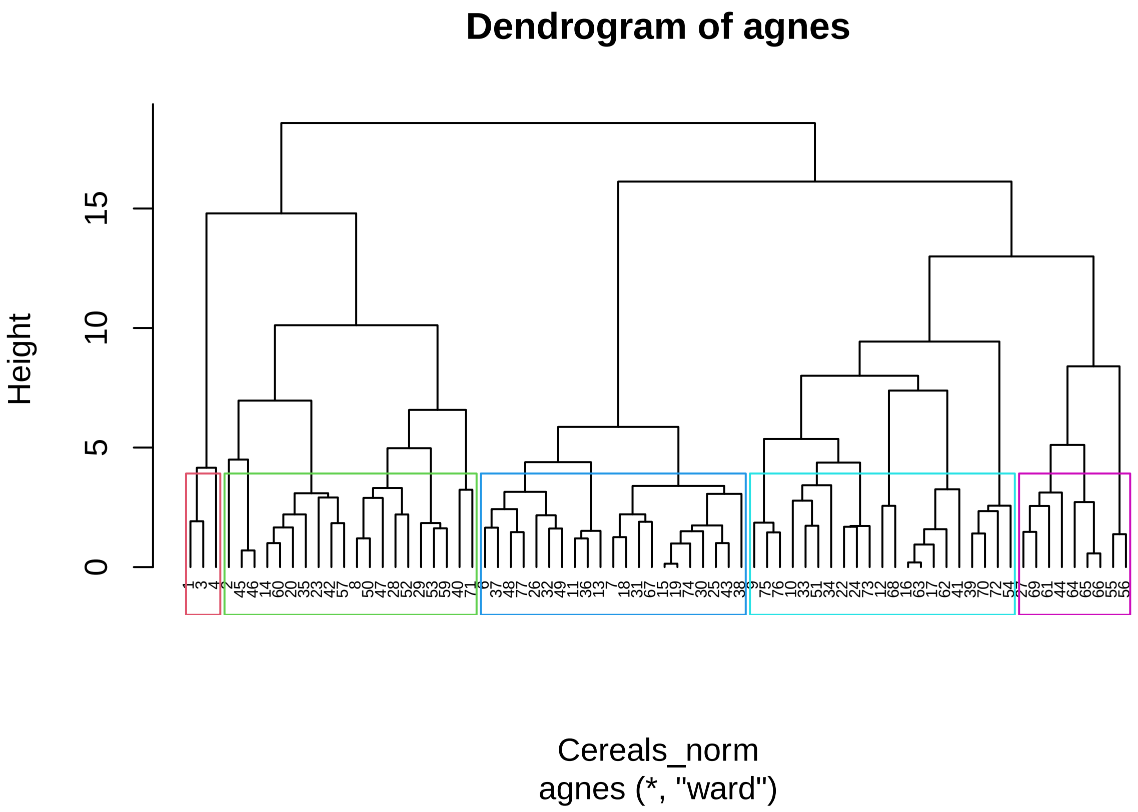
```
## [1] 0.7766075
```

```r
print(Hier_Clust_ward$ac)
```

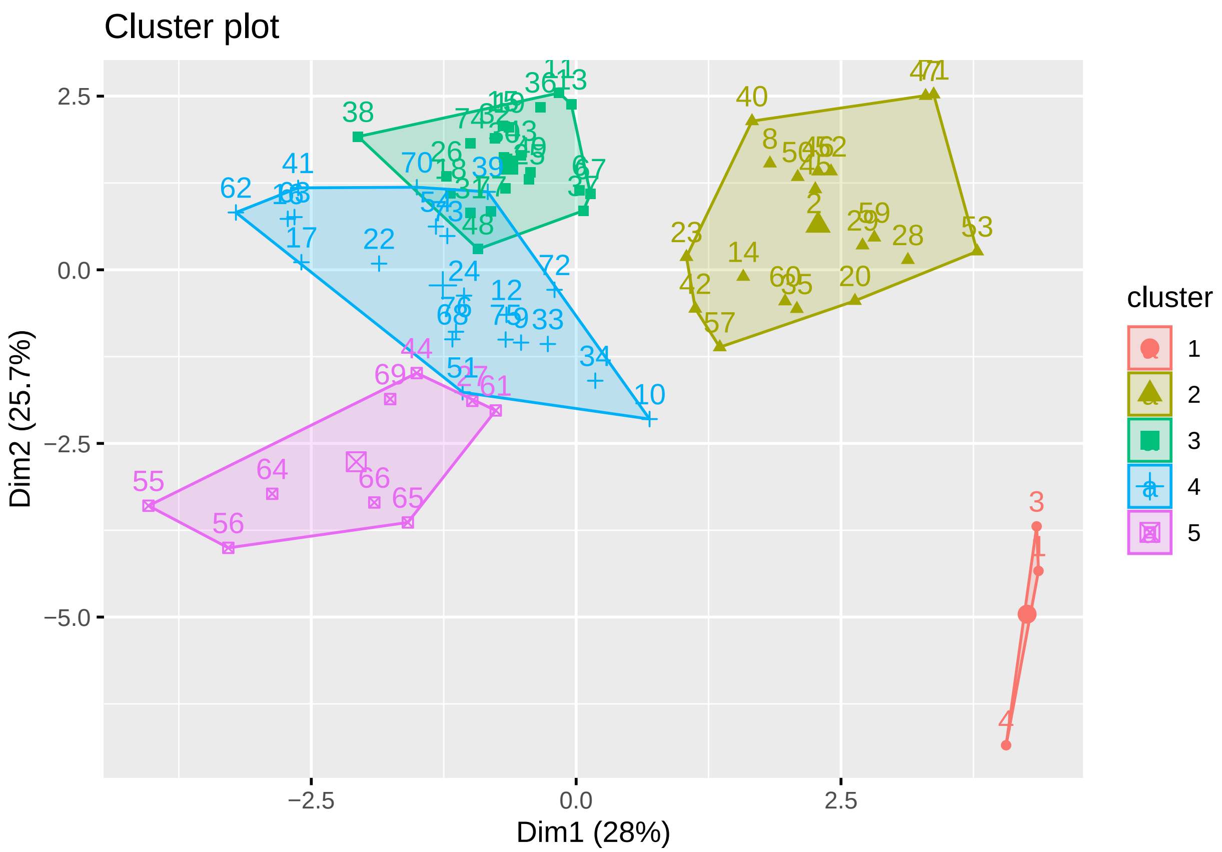
```
## [1] 0.9046042
```

```r
#From the data it is shown that the ward method is best as it has the value of 0.9046042.
```

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



```r
SubGrp <- cutree(Hier_Clust_ward, k=5)
df <- as.data.frame(cbind(Cereals_norm,SubGrp))
fviz_cluster(list(data = df, cluster = SubGrp))
```



```
#From the above results, 5 clusters can be selected.
```

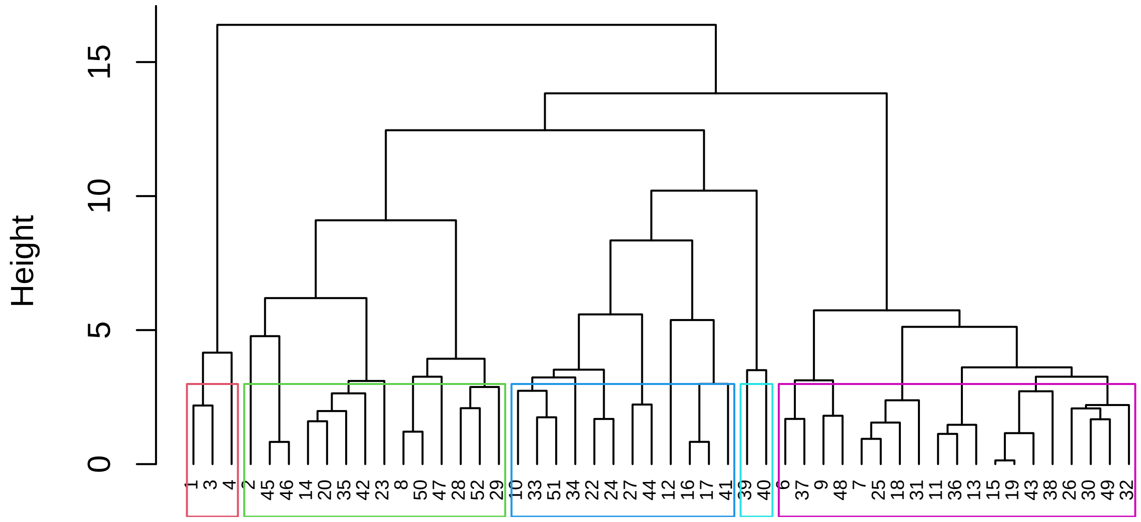
```
#Creating Partitions
set.seed(123)
Part1 <- Num_data[1:50,]
Part2 <- Num_data[51:74,]
```

```
#Performing Hierarchial Clustering,consedering k = 5.
AG_single <- agnes(scale(Part1), method = "single")
AG_complete <- agnes(scale(Part1), method = "complete")
AG_average <- agnes(scale(Part1), method = "average")
AG_ward <- agnes(scale(Part1), method = "ward")

cbind(single=AG_single$ac , complete=AG_complete$ac , average= AG_average$ac , ward= AG_ward$ac)
```

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

```
pltree(AG_ward, cex = 0.6, hang = -1, main = "Dendogram of Agnes with Partitioned Data")

rect.hclust(AG_ward, k = 5, border = 2:7)
```

Dendogram of Agnes with Partitioned Data



scale(Part1)
agnes (*, "ward")

```
cut <- cutree(AG_ward, k = 5)
```

```
#Calculating the centroids.
Res <- as.data.frame(cbind(Part1, cut))
Res[Res$cut==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
## 1 0.33 68.40297   1
## 3 0.33 59.42551   1
## 4 0.50 93.70491   1
```

```
cent_1 <- colMeans(Res[Res$cut==1,])
Res[Res$cut==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  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
```

```
cent_2 <- colMeans(Res[Res$cut==2,])
Res[Res$cut==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
## 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
```

```
cent_3 <- colMeans(Res[Res$cut==3,])
Res[Res$cut==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
## 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
```

```
cent_4 <- colMeans(Res[Res$cut==4,])
centroids <- rbind(cent_1, cent_2, cent_3, cent_4)
x2 <- as.data.frame(rbind(centroids[,-14], Part2))
```

```
#Calculating the Distance.

Dist1 <- get_dist(x2)
Matrix1 <- as.matrix(Dist1)
df1 <- data.frame(data=seq(1,nrow(Part2),1), Clusters = rep(0,nrow(Part2)))

for(i in 1:nrow(Part2))
  {df1[i,2] <- which.min(Matrix1[i+4, 1:4])}
df1
```

```
##    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(df$SubGrp[51:74], df1$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(df$SubGrp[51:74] == df1$Clusters)
```

```
##
```

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

```
#From the above results, we are getting 12 False and 12 True. So, we can tell that the model is partial
```

```
#Clustering Healthy Cereals.
Healthy.Cereals <- Cereals
Healthy.Cereals_na <- na.omit(Healthy.Cereals)
Clusthealthy <- cbind(Healthy.Cereals_na, SubGrp)
Clusthealthy[Clusthealthy$SubGrp==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 SubGrp
## 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
```

```
Clusthealthy[Clusthealthy$SubGrp==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 SubGrp
## 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
```

```
Clusthealthy[Clusthealthy$SubGrp==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 SubGrp
## 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
```

```
Clusthealthy[Clusthealthy$SubGrp==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 SubGrp
## 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
```

```
#Mean ratings to determine the best cluster.
mean(Clusthealthy[Clusthealthy$SubGrp==1,"rating"])
```

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

```
mean(Clusthealthy[Clusthealthy$SubGrp==2,"rating"])
```

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

```
mean(Clusthealthy[Clusthealthy$SubGrp==3,"rating"])
```

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

```
mean(Clusthealthy[Clusthealthy$SubGrp==4,"rating"])
```

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

```
#From the above results, the cluster 1 can choose as it is the highest.
#So, Cluster 1 can be considered as healthy cluster.
```