Assignment 5

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```r
#Displaying the required libraries
library(cluster)
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```r
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
```

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

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

```r
library(readr)
```

```r
#Creating a data set with only numerical data by importing a dataset
library(readr)
sl_Cereals <- read.csv("~/Downloads/Cereals.csv")
Num_data <- data.frame(sl_Cereals[,4:16])
```

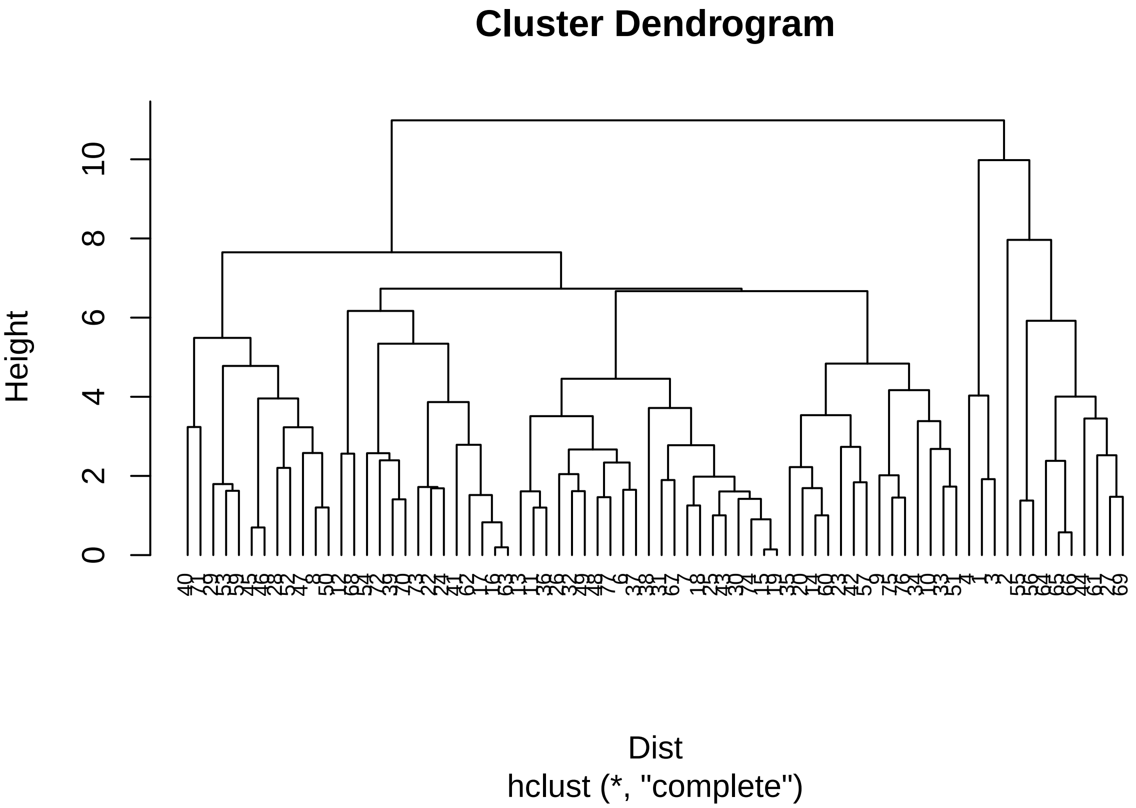
```r
#Deleting all cereals with missing values
Num_data <- na.omit(Num_data)
```

```
#Normalizing data
sl_Cereals_normalise <- scale(Num_data)
```

Apply hierarchical clustering to the adjusted data using the Euclidean distance technique

```
Dist <- dist(sl_Cereals_normalise, method = "euclidean")
H_clust <- hclust(Dist, method = "complete")
```

```
#the dendogram plotting process.
plot(H_clust, cex = 0.7, hang = -1)
```



Comparing the Clustering with single linkage, complete linkage, average linkage and Ward using the Agnes function/

```
single_Hclust <- agnes(sl_Cereals_normalise, method = "single")
complete_Hclust <- agnes(sl_Cereals_normalise, method = "complete")
average_Hclust <- agnes(sl_Cereals_normalise, method = "average")
ward_Hclust <- agnes(sl_Cereals_normalise, method = "ward")
```

Choosing the best method

```
#Choosing the best method
print(single_Hclust$ac)
```

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

```
print(complete_Hclust$ac)
```

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

```
print(average_Hclust$ac)
```

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

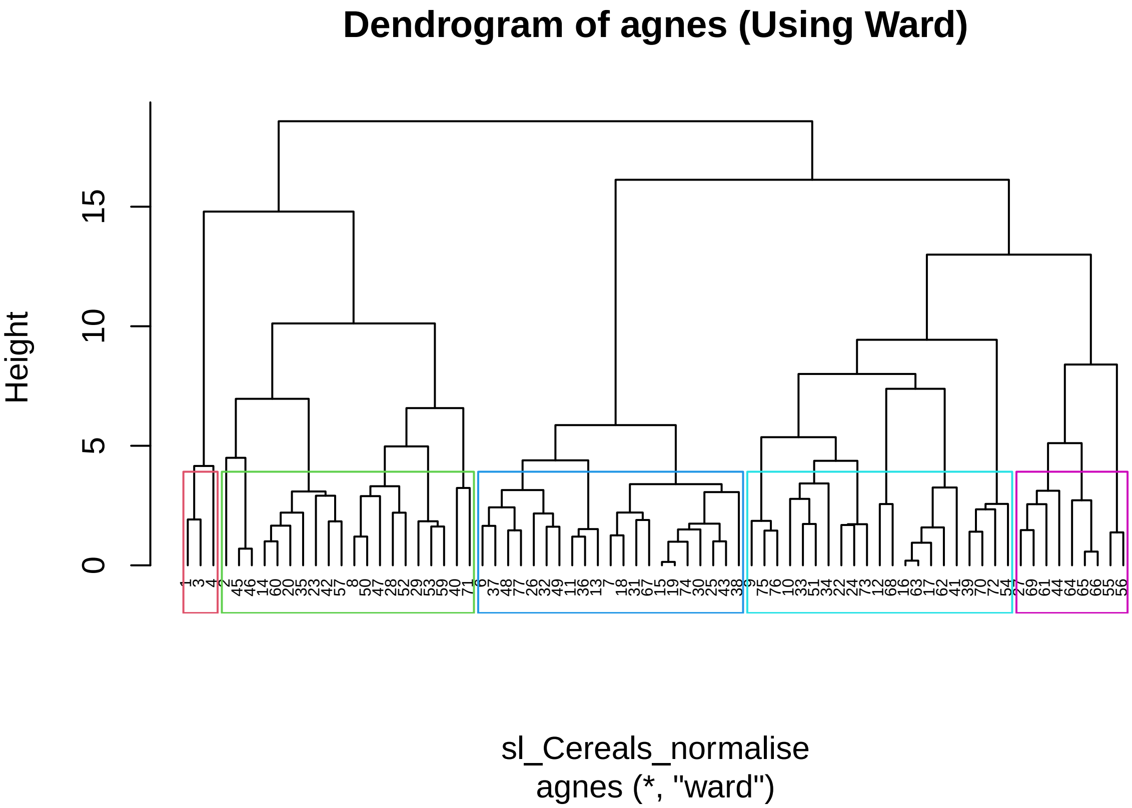
```
print(ward_Hclust$ac)
```

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

#The ward strategy is the most successful one, as shown by its value of 0.9046042, which is evident given the facts provided.

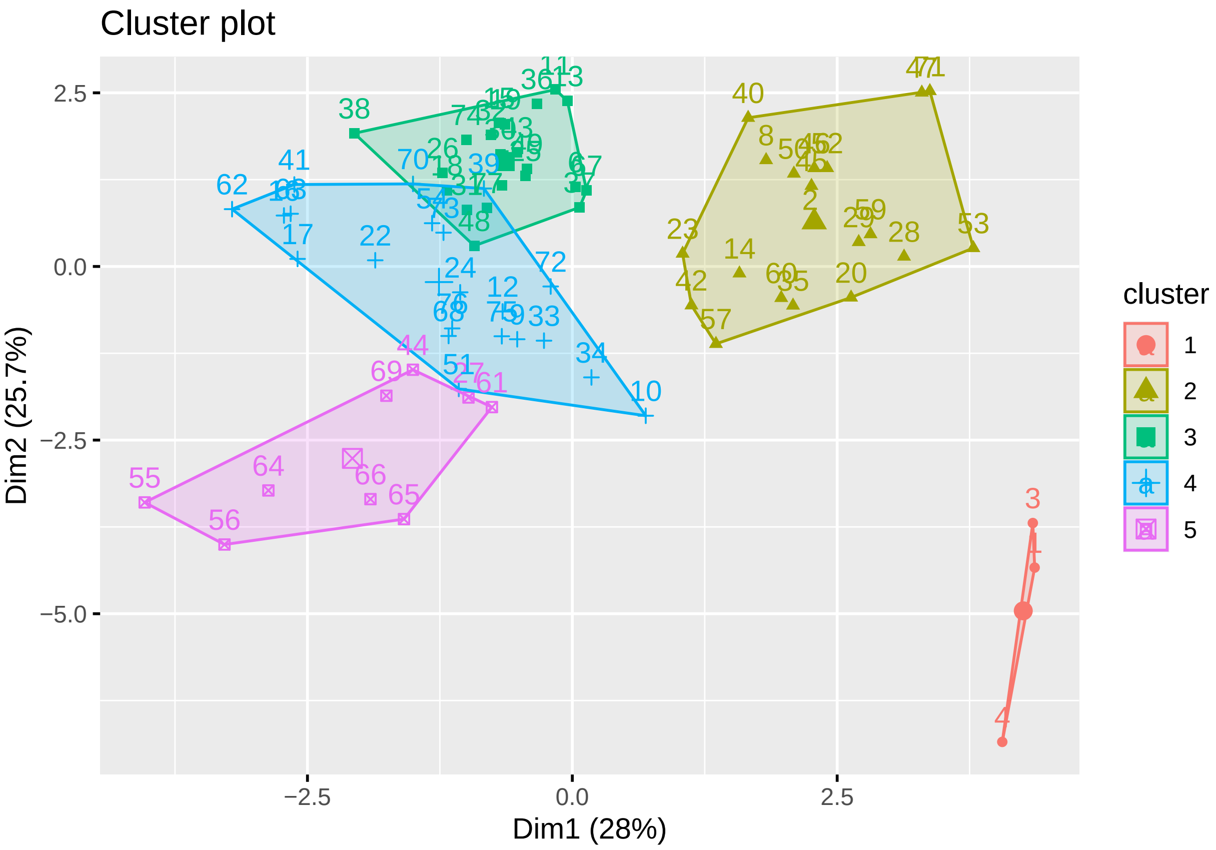
Choosing the clusters

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



```
S_Group <- cutree(ward_Hclust, k=5)
D_frame_2 <- as.data.frame(cbind(sl_Cereals_normalise,S_Group))
```

```
fviz_cluster(list(data = D_frame_2, cluster = S_Group))
```



#From the observation mentioned above, clusters can be selected.

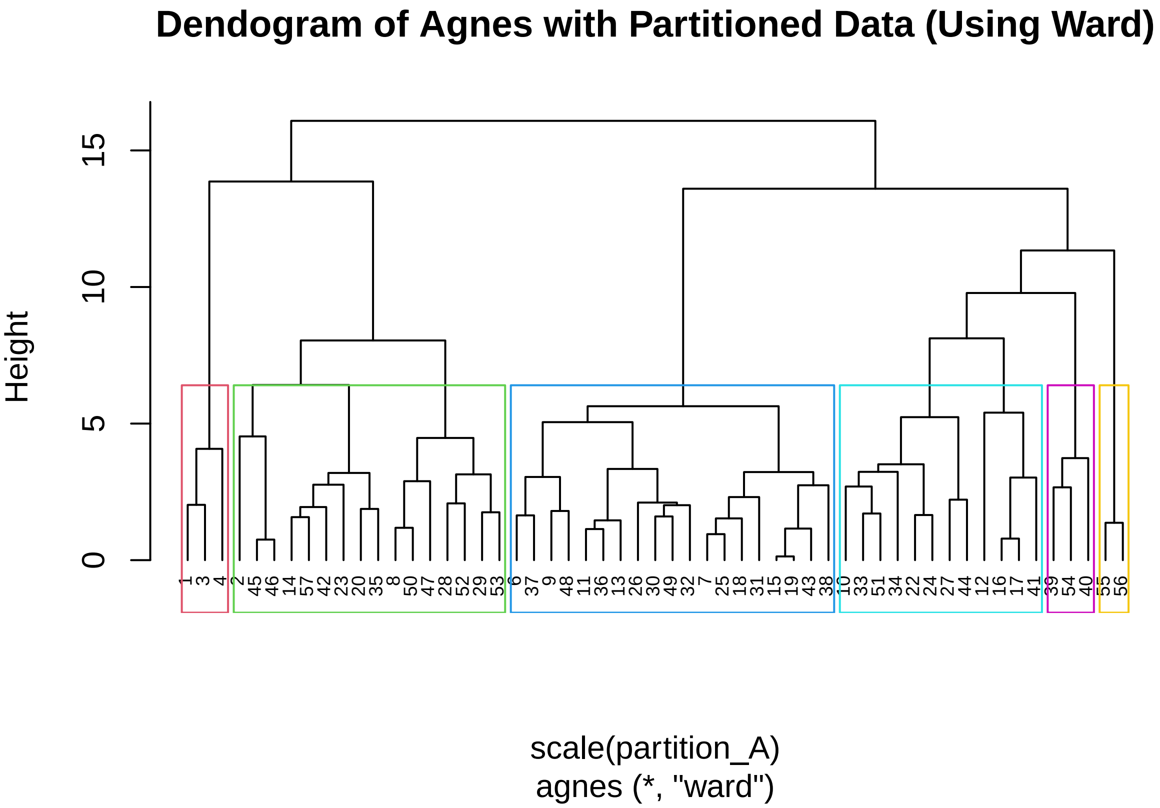
Determining the stability and structure of the clusters

```
#Partitioning the data into A and B
set.seed(123)
partition_A <- Num_data[1:55,]
partition_B <- Num_data[56:74,]
```

```
#Performing the Hierarchical Clustering of each partition while considering k = 6.
single_sl <- agnes(scale(partition_A), method = "single")
complete_sl <- agnes(scale(partition_A), method = "complete")
average_sl <- agnes(scale(partition_A), method = "average")
ward_sl <- agnes(scale(partition_A), method = "ward")
cbind(single=single_sl$ac , complete=complete_sl$ac , average= average_sl$ac , ward= ward_sl$ac)
```

```
##         single  complete   average      ward
## [1,] 0.6564842 0.8120228 0.7449303 0.8808195
```

```
pltree(ward_sl, cex = 0.6, hang = -1, main = "Dendogram of Agnes with Partitioned Data (Using Ward)")
rect.hclust(ward_sl, k = 6, border = 2:7)
```



```
cut_2 <- cutree(ward_sl, k = 6)
```

```
#the centroids are calculated.
sl_result <- as.data.frame(cbind(partition_A, cut_2))
sl_result[sl_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
```

```
one_centroid <- colMeans(sl_result[sl_result$cut_2==1,])
sl_result[sl_result$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
## 53      120       3   1    200   6.0  11.0     14    260       25     3   1.33
## 57      100       4   1    135   2.0  14.0      6    110       25     3   1.00
##    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
## 53 0.67 37.84059     2
## 57 0.50 49.51187     2
```

```
two_centroid <- colMeans(sl_result[sl_result$cut_2==2,])
sl_result[sl_result$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
```

```
three_centroid <- colMeans(sl_result[sl_result$cut_2==3,])
sl_result[sl_result$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
```

```
four_centroid <- colMeans(sl_result[sl_result$cut_2==4,])
centroids <- rbind(one_centroid, two_centroid, three_centroid, four_centroid)
x2 <- as.data.frame(rbind(centroids[,-14], partition_B))
```

```
#finding the Distance
Dist_1 <- get_dist(x2)
Matrix_1 <- as.matrix(Dist_1)
dataframe1 <- data.frame(data=seq(1,nrow(partition_B),1), Clusters =rep(0,nrow(partition_B)))
for(i in 1:nrow(partition_B))
  {dataframe1[i,2] <- which.min(Matrix_1[i+4, 1:4])}
dataframe1
```

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

```
cbind(D_frame_2$S_Group[56:74], dataframe1$Clusters)
```

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

```
table(D_frame_2$S_Group[56:74] == dataframe1$Clusters)
```

```
##
## FALSE  TRUE
##     9    10
```

#Our findings from the observation mentioned above are 9 False and 10 True. As a result, we may say that the model is just partially unstable.

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

finding Clusters of Healthy Cereals

```r
#Clustering Healthy sl_Cereals
Healthy_sl_Cereals <- sl_Cereals
Healthy_sl_Cereals_RD <- na.omit(Healthy_sl_Cereals)
clust <- cbind(Healthy_sl_Cereals_RD, S_Group)
clust[clust$S_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 S_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
```

```r
clust[clust$S_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 S_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$S_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 S_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
```

```r
clust[clust$S_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 S_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
```

```r
#Mean ratings are used to select the best cluster.
mean(clust[clust$S_Group==1,"rating"])
```

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

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

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

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

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

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

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

#Cluster 1 may be chosen based on the data mentioned above because it is the highest. #Therefore, Group 1 may be considered of as the cluster for a healthy diet.