FML Assignment 5

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Loading relevant libraries

```r
library(cluster)
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```r
library(dendextend)
```

```
##
## ---------------------
## Welcome to dendextend version 1.17.1
## 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
```

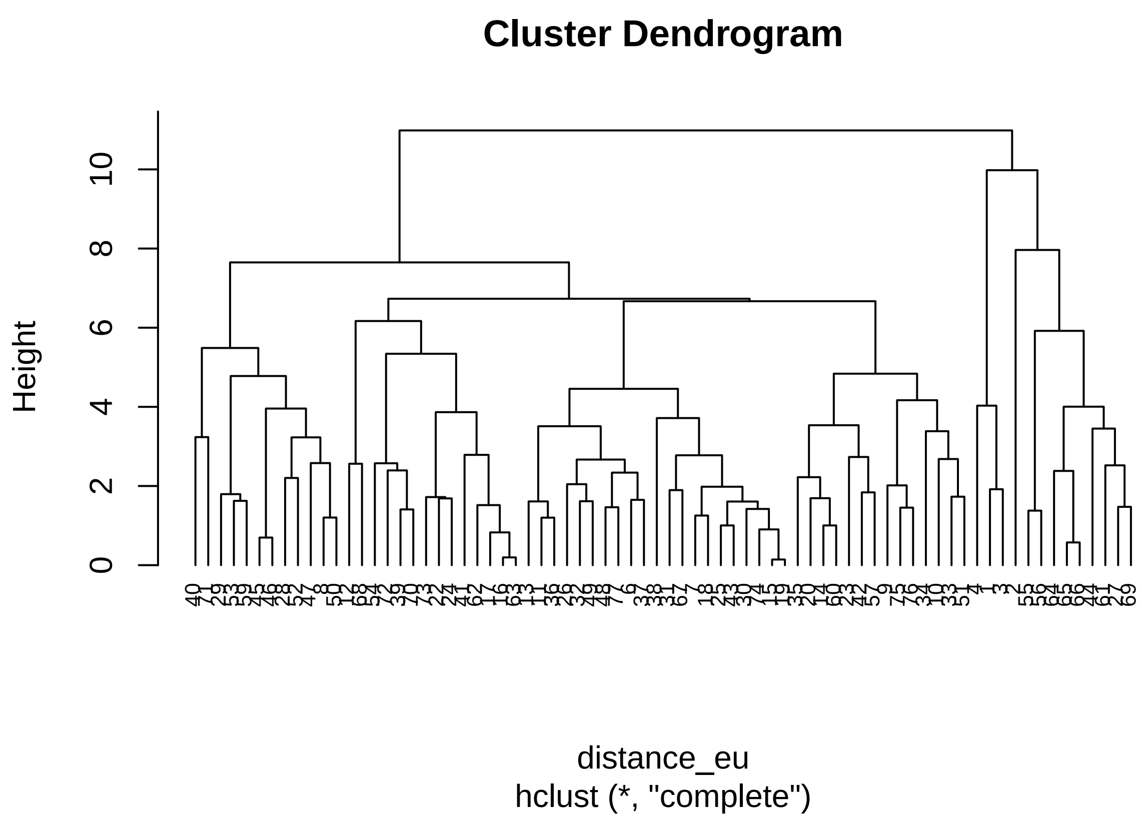
```r
library(readr)
```

Creating a dataset that includes numbers and omiting all the NA values in the dataset. This is stored in `cereals.df`. The function `scale()` is used to normalize the data. Ecucliedean distance is used to apply hirarchial clustering and is stored in `distance_eu`. Plotting the dendrogram using the plot() function.

```r
library(readr)
Cereals <- read_csv("~/Downloads/Cereals.csv")
```

```
## Rows: 77 Columns: 16
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (3): name, mfr, type
## dbl (13): calories, protein, fat, sodium, fiber, carbo, sugars, potass, vita...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
cereals.df<- data.frame(Cereals[,4:16])
cereals.df <- na.omit(cereals.df)
cereals.df_scaled <- scale(cereals.df)
distance_eu <- dist(cereals.df_scaled, method = "euclidean")
hierarchial_complete <- hclust(distance_eu, method = "complete")
plot(hierarchial_complete, cex = 0.7, hang = -1)
```



`agnes()` function is used to implement clustering with single, complete, average and ward linkage. The single linkage is printed using the `print()` function.

```
hierarchial_single <- agnes(cereals.df_scaled, method = "single")
hierarchial_complete <- agnes(cereals.df_scaled, method = "complete")
hierarchial_avg <- agnes(cereals.df_scaled, method = "average")
hierarchial_ward <- agnes(cereals.df_scaled, method = "ward")
print(hierarchial_single$ac)
```

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

Complete linkage is printed below.

```
print(hierarchial_complete$ac)
```

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

Average linkage is printed below.

```
print(hierarchial_avg$ac)
```

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

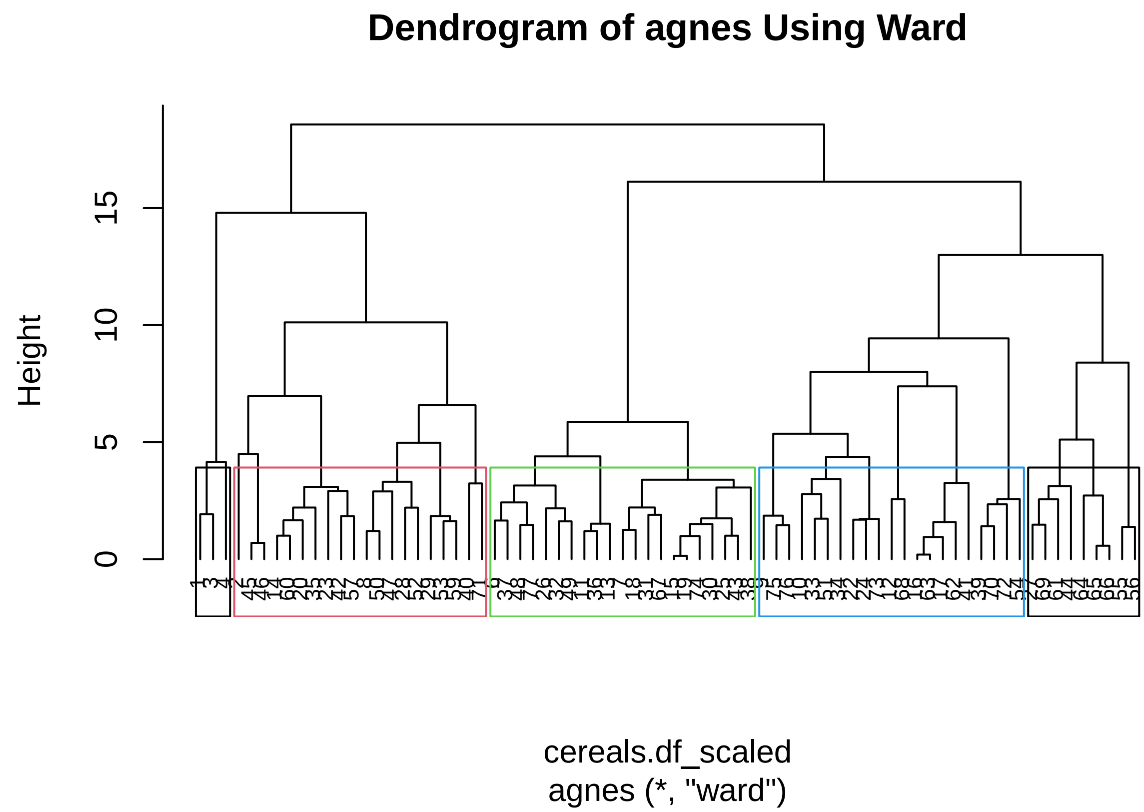
Ward hierarchial linkage is printed below. The ward method is chosen given the fact that it has the highest value of 0.9046042 in comparison to other linkages.

```
print(hierarchial_ward$ac)
```

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

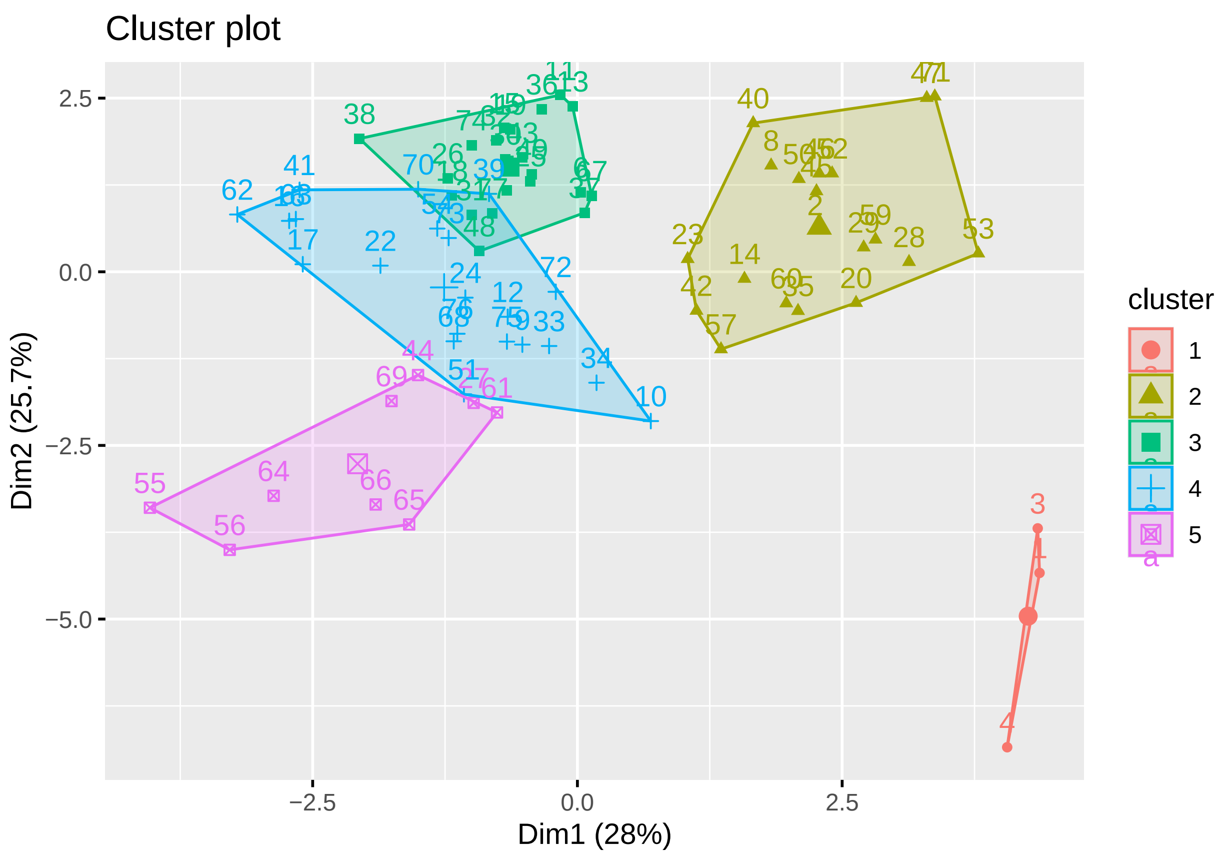
The `pltree()` and the `rect.hclust()` function is used to represent the dendrogram of agnes using the ward linkage.

```
pltree(hierarchial_ward, cex = 0.7, hang = -1, main = "Dendrogram of agnes Using Ward")
rect.hclust(hierarchial_ward, k = 5, border = 1:4)
```



The `fviz_cluster()` function is used to form clusters as represented below.

```
Cluster_1 <- cutree(hierarchial_ward, k=5)
df_2 <- as.data.frame(cbind(cereals.df_scaled,Cluster_1))
fviz_cluster(list(data = df_2 , cluster = Cluster_1))
```



Five clusters are chosen after observing the distance. Creating partitions and determining the stability and structure of the clusters. By considering k=5, hierarchial clustering is performed.

```
set.seed(123)
Partition_1 <- cereals.df[1:50,]
Partition_2 <- cereals.df[51:74,]
single_agnes <- agnes(scale(Partition_1), method = "single")
single_agnes
```

```
## Call:     agnes(x = scale(Partition_1), method = "single")
## Agglomerative coefficient:  0.6393338
## Order of objects:
##  [1] 1  3  4  6  37 7  25 15 19 43 18 30 11 36 13 49 32 26 31 9  48 38 14 20 35
## [26] 42 23 22 24 33 51 10 16 17 34 41 8  50 52 28 29 27 44 47 45 46 2  12 39 40
## Height (summary):
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.1395  1.5998  1.9818  2.1040  2.5164  5.0678
##
## Available components:
## [1] "order"     "height"    "ac"        "merge"     "diss"      "call"
## [7] "method"    "order.lab" "data"
```

```
Complete_agnes <- agnes(scale(Partition_1), method = "complete")
Complete_agnes
```

```
## Call:     agnes(x = scale(Partition_1), method = "complete")
```

```
## Agglomerative coefficient:  0.8138238
## Order of objects:
##  [1] 1  3  4  2  14 20 35 42 45 46 6  37 26 32 49 11 36 13 7  25 18 15 19 43 30
## [26] 23 9  48 31 38 8  50 47 28 52 29 10 33 51 34 27 44 12 16 17 41 22 24 39 40
## Height (summary):
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.1395  1.6874  2.7335  3.2009  4.1021 10.8673
##
## Available components:
## [1] "order"     "height"    "ac"        "merge"     "diss"      "call"
## [7] "method"    "order.lab" "data"
```

```
Avg_agnes <- agnes(scale(Partition_1), method = "average")
Avg_agnes
```

```
## Call:     agnes(x = scale(Partition_1), method = "average")
## Agglomerative coefficient:  0.7408904
## Order of objects:
##  [1] 1  3  4  2  6  37 9  48 7  25 18 15 19 43 30 26 11 36 13 32 49 38 31 10 34
## [26] 22 24 33 51 14 20 35 42 23 27 44 8  50 28 52 29 47 45 46 12 16 17 41 39 40
## Height (summary):
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.1395  1.6874  2.3623  2.6778  3.2878  7.7084
##
## Available components:
## [1] "order"     "height"    "ac"        "merge"     "diss"      "call"
## [7] "method"    "order.lab" "data"
```

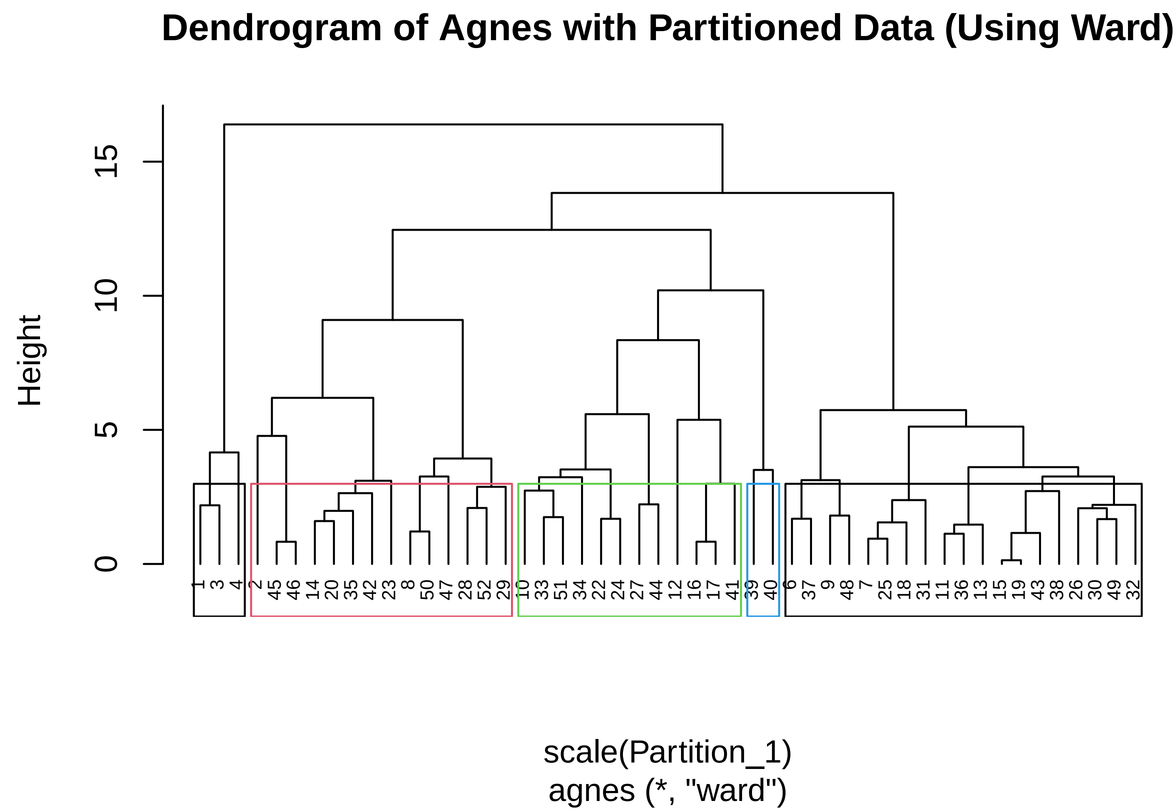
```
Ward_agnes <- agnes(scale(Partition_1), method = "ward")
Ward_agnes
```

```
## Call:     agnes(x = scale(Partition_1), method = "ward")
## Agglomerative coefficient:  0.8764323
## Order of objects:
##  [1] 1  3  4  2  45 46 14 20 35 42 23 8  50 47 28 52 29 10 33 51 34 22 24 27 44
## [26] 12 16 17 41 39 40 6  37 9  48 7  25 18 31 11 36 13 15 19 43 38 26 30 49 32
## Height (summary):
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.1395  1.6874  2.7356  3.8040  4.1584 16.3888
##
## Available components:
## [1] "order"     "height"    "ac"        "merge"     "diss"      "call"
## [7] "method"    "order.lab" "data"
```

```
cbind(single=single_agnes$ac , complete=Complete_agnes$ac , average= Avg_agnes$ac , ward= Ward_agnes$ac)
```

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

```
pltree(Ward_agnes, cex = 0.6, hang = -1, main = "Dendrogram of Agnes with Partitioned Data (Using Ward)
rect.hclust(Ward_agnes, k = 5, border = 1:4)
```



The centroids are calculated as seen below.

```r
cutree_2 <- cutree(Ward_agnes, k = 5)
result <- as.data.frame(cbind(Partition_1, cutree_2))
result[result$cutree_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 cutree_2
## 1 0.33 68.40297        1
## 3 0.33 59.42551        1
## 4 0.50 93.70491        1
```

`centroid.1` stores the centroid 1.

```r
centroid.1 <- colMeans(result[result$cutree_2==1,])
result[result$cutree_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 cutree_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`stores the centroid 2.

```
centroid.2 <- colMeans(result[result$cutree_2==2,])
result[result$cutree_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 cutree_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` stores the centroid 3.

```r
centroid.3 <- colMeans(result[result$cutree_2==3,])
result[result$cutree_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 cutree_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` stores the centroid 4.

```r
centroid.4 <- colMeans(result[result$cutree_2==4,])
all_centroids <- rbind(centroid.1, centroid.2, centroid.3, centroid.4)
all_centroids
```

```
##             calories  protein       fat   sodium      fiber     carbo    sugars
## centroid.1  63.33333 4.000000 0.6666667 176.6667 11.0000000  6.666667  3.666667
## centroid.2 125.71429 3.142857 2.2857143 146.7857  2.8928571 13.892857  8.857143
## centroid.3 110.00000 1.526316 1.0000000 179.4737  0.7368421 12.736842 10.947368
## centroid.4 102.50000 2.916667 0.4166667 185.0000  1.8333333 17.750000  3.500000
##               potass vitamins    shelf   weight      cups   rating cutree_2
## centroid.1 310.00000 25.00000 3.000000 1.000000 0.3866667 73.84446        1
## centroid.2 139.64286 23.21429 2.928571 1.142143 0.6914286 38.13235        2
## centroid.3  50.78947 25.00000 1.631579 1.000000 0.8842105 29.46119        3
## centroid.4  80.41667 25.00000 2.250000 1.000000 0.9250000 50.01180        4
```

The distance is calculated and stored in `Distance_1`.

```r
z <- as.data.frame(rbind(all_centroids[,-14], Partition_2))
Distance_1 <- get_dist(z)
Matrix.1 <- as.matrix(Distance_1)
dataf_1 <- data.frame(data=seq(1,nrow(Partition_2),1), Clusters = rep(0,nrow(Partition_2)))
for(i in 1:nrow(Partition_2))
{dataf_1[i,2] <- which.min(Matrix.1[i+4, 1:4])}
dataf_1
```

```
##    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
```

```r
cbind(df_2$Cluster_1[51:74], dataf_1$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
```

```r
table(df_2$Cluster_1[51:74] == dataf_1$Clusters)
```

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

The data is partially stable as there are 12 TRUE and FALSE in count respectively.

```r
#Since we are getting 12 FALSE and 12 TRUE, we can conclude that the model is partially stable by looki
Health.Cereals <- Cereals
Health.Cereals_na <- na.omit(Health.Cereals)
Healthy.Cluster <- cbind(Health.Cereals_na, Cluster_1)
Healthy.Cluster[Healthy.Cluster$Cluster_1==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 Cluster_1
## 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
Healthy.Cluster[Healthy.Cluster$Cluster_1==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 Cluster_1
## 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
```

```r
Healthy.Cluster[Healthy.Cluster$Cluster_1==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 Cluster_1
## 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
```

```
Healthy.Cluster[Healthy.Cluster$Cluster_1==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 Cluster_1
## 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 to determine the best cluster.
mean(Healthy.Cluster[Healthy.Cluster$Cluster_1==1,"rating"])
```

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

```r
mean(Healthy.Cluster[Healthy.Cluster$Cluster_1==2,"rating"])
```

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

```r
mean(Healthy.Cluster[Healthy.Cluster$Cluster_1==3,"rating"])
```

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

The mean of `Cluster_1` is 73.84446 which is the highest. Hence Cluster_1 is chosen for a healthier cereal to the menu. With respect to this dataset, normalization of numerical measurements is performed using the `scale()` function. This is due to the fact that Euclidean distance is used and this parameter calculates the distance. This is highly scale dependent, sensitive to outliers and change in units of one variable have high influence on the results.

```r
mean(Healthy.Cluster[Healthy.Cluster$Cluster_1==4,"rating"])
```

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