Assignment_5

Nawwaf Albahar

2022-11-30

Load the data set and convert it into a data frame

```
Cereals <- read_csv("/Users/nawwaf/Desktop/Kent/Kent Master_s/Machine
Learning/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.

df <- Cereals
df <- as.data.frame(df)
df <- na.omit(df) # Remove NA (missing) values

Cereals_clean <- na.omit(Cereals)


head(df)          # Examine the dataset

##                         name mfr type calories protein fat sodium fiber
carbo
## 1                  100%_Bran   N    C       70       4   1    130  10.0
5.0
## 2          100%_Natural_Bran   Q    C      120       3   5     15   2.0
8.0
## 3                   All-Bran   K    C       70       4   1    260   9.0
7.0
## 4 All-Bran_with_Extra_Fiber   K    C       50       4   0    140  14.0
8.0
## 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
##   sugars potass vitamins shelf weight cups   rating
## 1      6    280       25     3      1 0.33 68.40297
```

```
## 2      8    135         0     3      1 1.00 33.98368
## 3      5    320        25     3      1 0.33 59.42551
## 4      0    330        25     3      1 0.50 93.70491
## 6     10     70        25     1      1 0.75 29.50954
## 7     14     30        25     2      1 1.00 33.17409
```

Clean the dataframe and examine it

```
df <- na.omit(df) # Remove NA (missing) values

Cereals_clean <- na.omit(Cereals)

head(df)          # Examine the dataset
```

```
##                         name mfr type calories protein fat sodium fiber
carbo
## 1                 100%_Bran   N    C       70       4   1    130  10.0
5.0
## 2         100%_Natural_Bran   Q    C      120       3   5     15   2.0
8.0
## 3                  All-Bran   K    C       70       4   1    260   9.0
7.0
## 4 All-Bran_with_Extra_Fiber   K    C       50       4   0    140  14.0
8.0
## 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
##   sugars potass vitamins shelf weight cups   rating
## 1      6    280       25     3      1 0.33 68.40297
## 2      8    135        0     3      1 1.00 33.98368
## 3      5    320       25     3      1 0.33 59.42551
## 4      0    330       25     3      1 0.50 93.70491
## 6     10     70       25     1      1 0.75 29.50954
## 7     14     30       25     2      1 1.00 33.17409
```

Normalize the numrical columns

```
df <-- df[,4:16]

df <- scale(df)
```

Reassign the nonnumrical column to the dataframe after normalization

```
Normalized_df_Data <- cbind(df, name = Cereals_clean$name)
Normalized_df_Data <- cbind(df, mfr = Cereals_clean$mfr)
Normalized_df_Data <- cbind(df, type = Cereals_clean$type)

head(df) #re-examine the scaled data
```

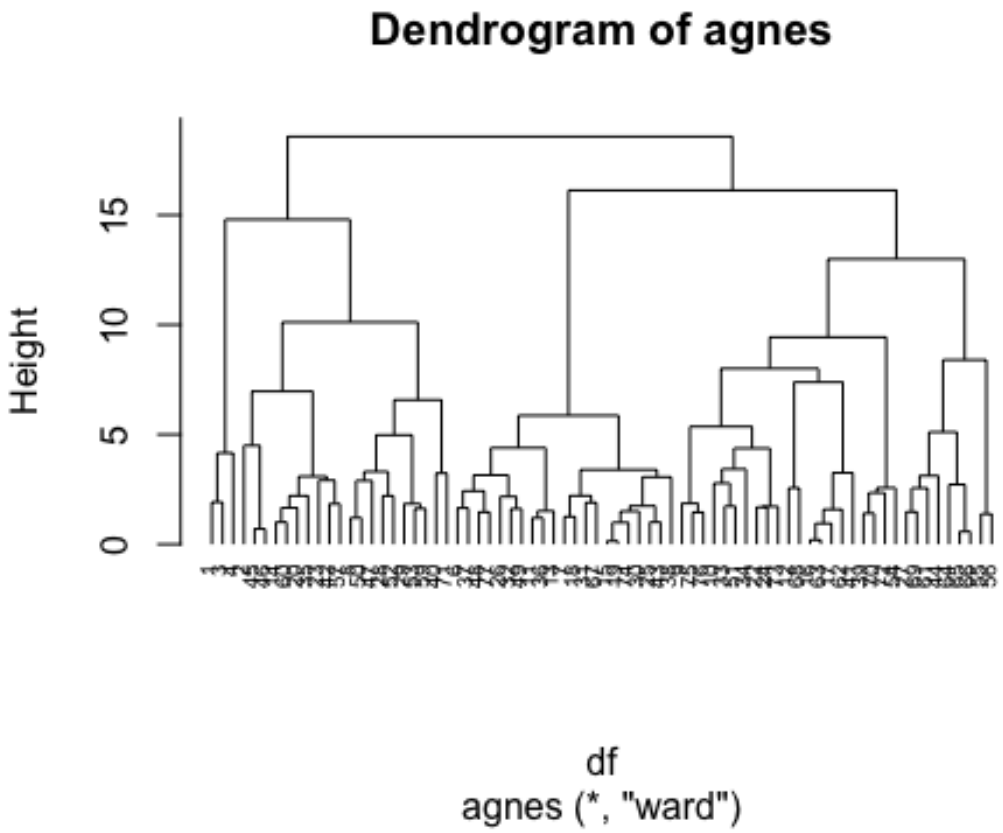
```
##     calories    protein        fat     sodium       fiber     carbo
sugars
## 1  1.8659155 -1.3817478  0.0000000  0.3910227 -3.22866747 2.5001396
0.2542051
## 2 -0.6537514 -0.4522084 -3.9728810  1.7804186  0.07249167 1.7292632 -
0.2046041
## 3  1.8659155 -1.3817478  0.0000000 -1.1795987 -2.81602258 1.9862220
0.4836096
## 4  2.8737823 -1.3817478  0.9932203  0.2702057 -4.87924705 1.7292632
1.6306324
## 6 -0.1498180  0.4773310 -0.9932203 -0.2130625  0.27881412 1.0868662 -
0.6634132
## 7 -0.1498180  0.4773310  0.9932203  0.4514312  0.48513656 0.9583868 -
1.5810314
##       potass  vitamins      shelf    weight       cups     rating
## 1 -2.5605229 0.1818422 -0.9419715 0.2008324  2.0856582 -1.8549038
## 2 -0.5147738 1.3032024 -0.9419715 0.2008324 -0.7567534  0.5977113
## 3 -3.1248675 0.1818422 -0.9419715 0.2008324  2.0856582 -1.2151965
## 4 -3.2659536 0.1818422 -0.9419715 0.2008324  1.3644493 -3.6578436
## 6  0.4022862 0.1818422  1.4616799 0.2008324  0.3038480  0.9165248
## 7  0.9666308 0.1818422  0.2598542 0.2008324 -0.7567534  0.6553998
```

Compute with agnes and with different linkage methods

```
hc_single <- agnes(df, method = "single")
hc_complete <- agnes(df, method = "complete")
hc_average <- agnes(df, method = "average")
hc_ward.D <- agnes(df, method = "ward")

# Compare Agglomerative coefficients
print(hc_single$ac)

## [1] 0.6067859

print(hc_complete$ac)

## [1] 0.8353712

print(hc_average$ac)

## [1] 0.7766075

print(hc_ward.D$ac) # is the best method as it classify 0.9046042 into their
actual cluster and the closer to 1 is best.

## [1] 0.9046042
```

Plot with the bes method in this case ward is the best

```
pltree(hc_ward.D, cex = 0.6, hang = -1, main = "Dendrogram of agnes")
```

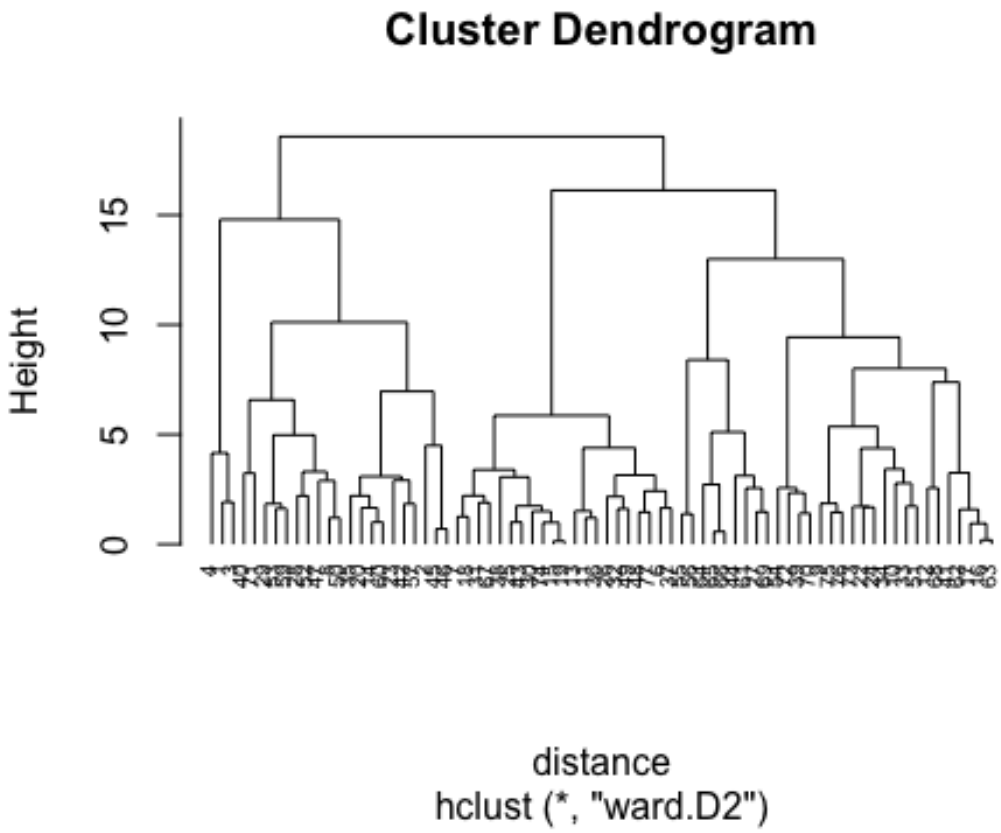


Calculate the euclidean to use in the clustering using ward since it is the best method

```
distance <- dist(df, method = "euclidean")
# Hierarchical clustering using ward method
hc1 <- hclust(distance, method = "ward.D2" )
```

Now plot using the euclidean distance and ward method

```
# Plot the obtained dendrogram
plot(hc1, cex = 0.6, hang = -1)
```



Cut the tree into four group and show how many member is in each group

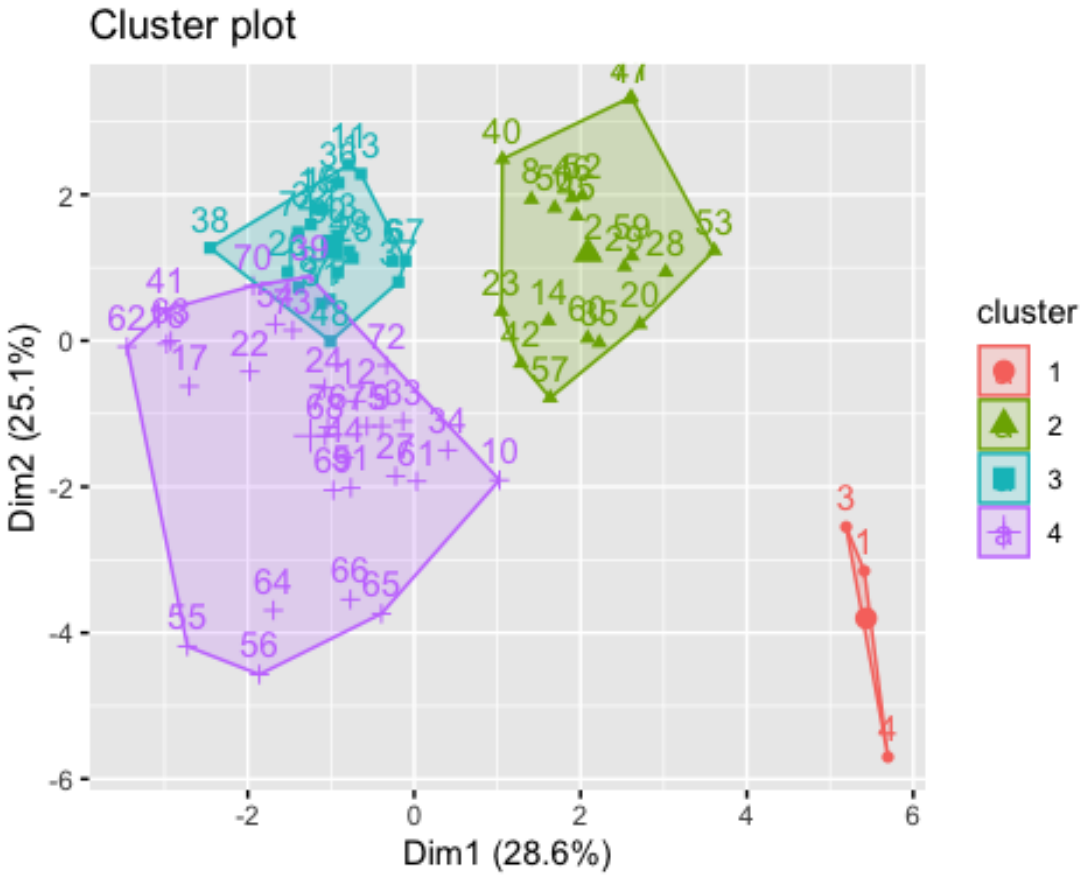
```
grp <- cutree(hc1, k = 4)
# Number of members in each cluster
table(grp)

## grp
##  1  2  3  4
##  3 20 21 30
```

now bind the group membership to each record

```
df <- as.data.frame(cbind(df,grp))
```

visulaize the cereals and their cluster membership

```
fviz_cluster(list(data = df, cluster = grp))
```



Now using the numrical and the group membership show each clusters members

```
Newdf = Cereals_clean[,4:16]
clust <- cbind(Newdf, grp)
clust[clust$grp==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 grp
## 1 0.33 68.40297   1
## 3 0.33 59.42551   1
## 4 0.50 93.70491   1

clust[clust$grp==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
## 40      140       3   1    170   2.0  20.0      9     95       100     3
1.30
## 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
## 59      120       3   1    210   5.0  14.0     12    240        25     2
1.33
## 60      100       3   2    140   2.5  10.5      8    140        25     3
1.00
## 71      140       3   1    190   4.0  15.0     14    230       100     3
1.50
##    cups   rating grp
## 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
## 40 0.75 36.47151   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
## 59 0.75 39.25920   2
## 60 0.50 39.70340   2
## 71 1.00 28.59278   2

clust[clust$grp==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
## 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
## 67      110       2   1     70   1.0   9.0     15     40       25     2
1
## 74      110       1   1    140   0.0  13.0     12     25       25     2
1
## 77      110       2   1    200   1.0  16.0      8     60       25     1
1
##    cups   rating grp
## 6  0.75 29.50954   3
## 7  1.00 33.17409   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
## 67 0.75 31.23005   3
## 74 1.00 27.75330   3
## 77 0.75 36.18756   3

clust[clust$grp==4,]

##    calories protein fat sodium fiber carbo sugars potass vitamins shelf
weight
## 9        90       2   1    200     4    15      6    125       25     1
1.00
## 10       90       3   0    210     5    13      5    190       25     3
1.00
## 12      110       6   2    290     2    17      1    105       25     1
1.00
## 16      110       2   0    280     0    22      3     25       25     1
1.00
## 17      100       2   0    290     1    21      2     35       25     1
1.00
## 22      110       2   0    220     1    21      3     30       25     3
1.00
## 24      100       2   0    190     1    18      5     80       25     3
1.00
## 27      100       3   0      0     3    14      7    100       25     2
1.00
```

```
## 33      100       3   1    140     3    15       5     85        25     3
1.00
## 34      110       3   0    170     3    17       3     90        25     3
1.00
## 39      110       2   1    170     1    17       6     60       100     3
1.00
## 41      110       2   1    260     0    21       3     40        25     2
1.00
## 44      100       4   1      0     0    16       3     95        25     2
1.00
## 51       90       3   0    170     3    18       2     90        25     3
1.00
## 54      100       3   0    320     1    20       3     45       100     3
1.00
## 55       50       1   0      0     0    13       0     15         0     3
0.50
## 56       50       2   0      0     1    10       0     50         0     3
0.50
## 61       90       2   0      0     2    15       6    110        25     3
1.00
## 62      110       1   0    240     0    23       2     30        25     1
1.00
## 63      110       2   0    290     0    22       3     35        25     1
1.00
## 64       80       2   0      0     3    16       0     95         0     1
0.83
## 65       90       3   0      0     4    19       0    140         0     1
1.00
## 66       90       3   0      0     3    20       0    120         0     1
1.00
## 68      110       6   0    230     1    16       3     55        25     1
1.00
## 69       90       2   0     15     3    15       5     90        25     2
1.00
## 70      110       2   1    200     0    21       3     35       100     3
1.00
## 72      100       3   1    200     3    16       3    110       100     3
1.00
## 73      110       2   1    250     0    21       3     60        25     3
1.00
## 75      100       3   1    230     3    17       3    115        25     1
1.00
## 76      100       3   1    200     3    17       3    110        25     1
1.00
##    cups   rating grp
## 9  0.67 49.12025   4
## 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
## 39 1.00 36.52368   4
## 41 1.50 39.24111   4
## 44 1.00 54.85092   4
## 51 1.00 59.64284   4
## 54 1.00 41.50354   4
## 55 1.00 60.75611   4
## 56 1.00 63.00565   4
## 61 0.50 55.33314   4
## 62 1.13 41.99893   4
## 63 1.00 40.56016   4
## 64 1.00 68.23588   4
## 65 0.67 74.47295   4
## 66 0.67 72.80179   4
## 68 1.00 53.13132   4
## 69 1.00 59.36399   4
## 70 1.00 38.83975   4
## 72 1.00 46.65884   4
## 73 0.75 39.10617   4
## 75 0.67 49.78744   4
## 76 1.00 51.59219   4
```

now based on the rating columns show the mean rating of each cluster to determine which cluster have the highes rating

```
mean(clust[clust$grp==1,"rating"])

## [1] 73.84446

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

## [1] 38.26161

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

## [1] 28.84825

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

## [1] 51.43111
```

from the rating we could tell that cluster one has the highest rating therefore it is the cluster with the best breakfast cereals