Assignment\_5

11/28/2022

**#First, load packages**

library(utils)  
library(base)  
library(stats)  
library(graphics)  
library(cluster)  
library(factoextra)

## Warning: package 'factoextra' was built under R version 4.2.2

## Loading required package: ggplot2

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

library(knitr)

**#Second, prep the data**

#Load dataset  
Cereal.Data<-read.csv("Cereals.csv")   
  
#Set row names to the Cereals column  
row.names(Cereal.Data) <- Cereal.Data[,1]  
  
#Remove Cereals column  
Cereal.Data <- Cereal.Data[,-1]

**#Normalize dataset**

Cereal.DF<-Cereal.Data[,3:15] #only numeric variables  
Cereal.DF.Norm1<-sapply(Cereal.DF, scale) # normalization  
  
row.names(Cereal.DF.Norm1) <- row.names(Cereal.Data)#set row names to cereal names

**#Remove all cereals with missing values**

Cereal.DF.Norm2<-na.omit(Cereal.DF.Norm1)  
head(Cereal.DF.Norm2)

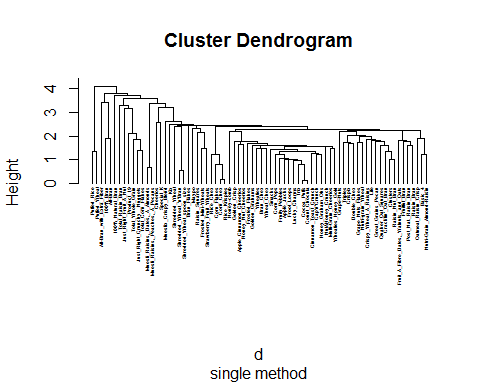
## calories protein fat sodium  
## 100%\_Bran -1.8929836 1.3286071 -0.01290349 -0.3539844  
## 100%\_Natural\_Bran 0.6732089 0.4151897 3.96137277 -1.7257708  
## All-Bran -1.8929836 1.3286071 -0.01290349 1.1967306  
## All-Bran\_with\_Extra\_Fiber -2.9194605 1.3286071 -1.00647256 -0.2346986  
## Apple\_Cinnamon\_Cheerios 0.1599704 -0.4982277 0.98066557 0.2424445  
## Apple\_Jacks 0.1599704 -0.4982277 -1.00647256 -0.4136273  
## fiber carbo sugars potass  
## 100%\_Bran 3.29284661 -2.5087829 -0.2343906 2.5753685  
## 100%\_Natural\_Bran -0.06375361 -1.7409943 0.2223705 0.5160205  
## All-Bran 2.87327158 -1.9969238 -0.4627711 3.1434645  
## All-Bran\_with\_Extra\_Fiber 4.97114672 -1.7409943 -1.6046739 3.2854885  
## Apple\_Cinnamon\_Cheerios -0.27354112 -1.1011705 0.6791317 -0.4071355  
## Apple\_Jacks -0.48332864 -0.9732057 1.5926539 -0.9752315  
## vitamins shelf weight cups  
## 100%\_Bran -0.1453172 0.9515734 -0.1967771 -2.1100340  
## 100%\_Natural\_Bran -1.2642598 0.9515734 -0.1967771 0.7690100  
## All-Bran -0.1453172 0.9515734 -0.1967771 -2.1100340  
## All-Bran\_with\_Extra\_Fiber -0.1453172 0.9515734 -0.1967771 -1.3795303  
## Apple\_Cinnamon\_Cheerios -0.1453172 -1.4507595 -0.1967771 -0.3052601  
## Apple\_Jacks -0.1453172 -0.2495930 -0.1967771 0.7690100  
## rating  
## 100%\_Bran 1.8321876  
## 100%\_Natural\_Bran -0.6180571  
## All-Bran 1.1930986  
## All-Bran\_with\_Extra\_Fiber 3.6333849  
## Apple\_Cinnamon\_Cheerios -0.9365625  
## Apple\_Jacks -0.6756899

**#Dissimilarity matrix**

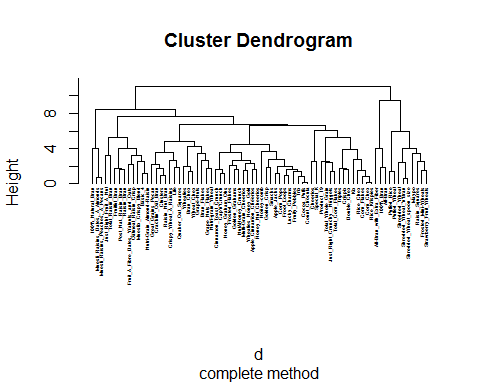
d<-dist(Cereal.DF.Norm2, method = "euclidean")

**#Hierarchical clustering using different methods**

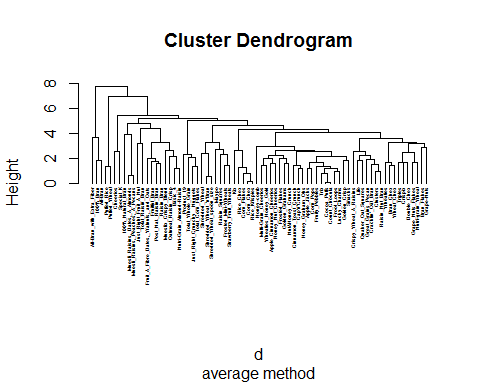
hclust.1<-hclust(d, method = "single")  
plot(hclust.1, cex=0.3, hang=-1, sub="single method")



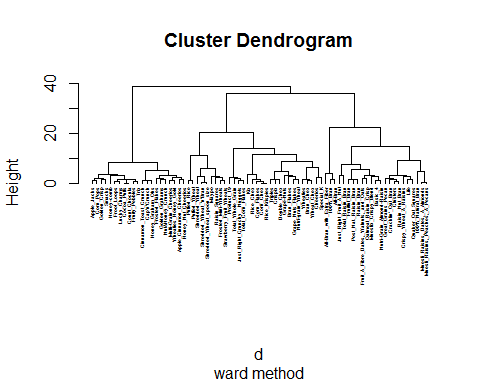
hclust.2<-hclust(d, method="complete")  
plot(hclust.2, cex=0.3, hang=-1, sub="complete method")



hclust.3<-hclust(d, method="average")  
plot(hclust.3, cex=0.3, hang=-1, sub="average method")



hclust.4<-hclust(d, method="ward.D")  
plot(hclust.4, cex=0.3, hang=-1, sub="ward method")



**#Computing AGNES with different methods of linkage**

hclust.single<-agnes(Cereal.DF.Norm2, method="single")  
hclust.complete<-agnes(Cereal.DF.Norm2, method="complete")  
hclust.average<-agnes(Cereal.DF.Norm2, method= "average")  
hclust.ward<-agnes(Cereal.DF.Norm2, method= "ward")

**#Compare AGNES coefficients with different linkage methods**

print(hclust.single$ac)

## [1] 0.6094447

print(hclust.complete$ac)

## [1] 0.8413498

print(hclust.average$ac)

## [1] 0.7814484

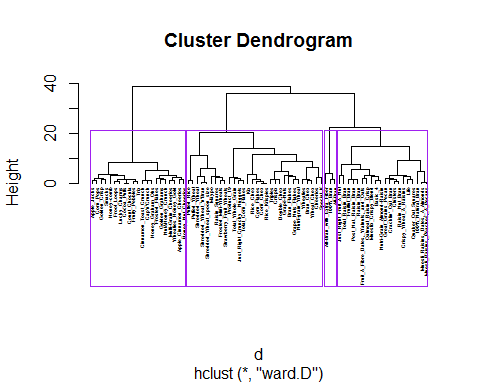
print(hclust.ward$ac) #Best method of linkage

## [1] 0.9049881

**#The best method of linkage is the ward method. This is because the AGNES coefficient is the highest; therefore, the ward method provides the strongest clustering structure.**

**#How many clusters would you choose? 4 clusters**

plot(hclust.4,cex=0.3, hang=-1)  
rect.hclust(hclust.4, k=4, border="purple")



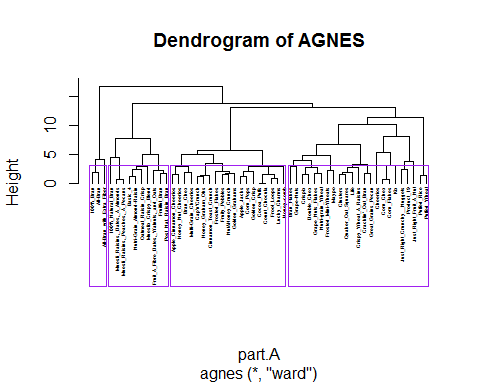
clust.1<-cutree(hclust.4, k=4)  
c.1<-as.data.frame(cbind(Cereal.DF.Norm2,clust.1))

**#Comment on the structure of the clusters and on their stability.**

#normalized data with missing values omitted  
part.data<-Cereal.DF.Norm2  
  
#partition the cereal data  
part.A<-part.data[1:55,]  
part.B<-part.data[56:74,]  
  
#Computing AGNES with different methods of linkage  
hclust.5<- agnes(part.A,method = "ward")  
hclust.6<-agnes(part.A,method="average")  
hclust.7<-agnes(part.A,method="complete")  
hclust.8<-agnes(part.A,method="single")  
  
#create a table of AGNES coefficients  
kable(cbind(ward=hclust.5$ac,average=hclust.6$ac,complete=hclust.7$ac,single=hclust.8$ac))

| ward | average | complete | single |
| --- | --- | --- | --- |
| 0.8841008 | 0.7524187 | 0.8218118 | 0.6611225 |

#Ward method is the best because it has the highest AGNES coefficient.   
  
#plot dendrogram of AGNES using best method (ward method)  
pltree(hclust.5,cex=0.3,hang=-1,main="Dendrogram of AGNES")  
  
#create clusters in dendrogram of AGNES  
rect.hclust(hclust.5, k = 4, border = "purple")



#identify cereals in the 4 clusters  
clust.2<-cutree(hclust.5, k=4)  
result<-as.data.frame(cbind(part.A,clust.2))  
  
#finding cluster centers of part.A data  
result[result$clust.2==1,]

## calories protein fat sodium fiber  
## 100%\_Bran -1.892984 1.328607 -0.01290349 -0.3539844 3.292847  
## All-Bran -1.892984 1.328607 -0.01290349 1.1967306 2.873272  
## All-Bran\_with\_Extra\_Fiber -2.919461 1.328607 -1.00647256 -0.2346986 4.971147  
## carbo sugars potass vitamins shelf  
## 100%\_Bran -2.508783 -0.2343906 2.575368 -0.1453172 0.9515734  
## All-Bran -1.996924 -0.4627711 3.143464 -0.1453172 0.9515734  
## All-Bran\_with\_Extra\_Fiber -1.740994 -1.6046739 3.285488 -0.1453172 0.9515734  
## weight cups rating clust.2  
## 100%\_Bran -0.1967771 -2.110034 1.832188 1  
## All-Bran -0.1967771 -2.110034 1.193099 1  
## All-Bran\_with\_Extra\_Fiber -0.1967771 -1.379530 3.633385 1

center.1<-colMeans(result[result$clust.2==1,])  
result[result$clust.2==2,]

## calories protein fat  
## 100%\_Natural\_Bran 0.6732089 0.4151897 3.96137277  
## Basic\_4 1.1864474 0.4151897 0.98066557  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 0.6732089 0.4151897 0.98066557  
## Fruitful\_Bran 0.6732089 0.4151897 -1.00647256  
## Muesli\_Raisins,\_Dates,\_&\_Almonds 2.2129244 1.3286071 1.97423464  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans 2.2129244 1.3286071 1.97423464  
## Mueslix\_Crispy\_Blend 2.7261629 0.4151897 0.98066557  
## Nutri-Grain\_Almond-Raisin 1.6996859 0.4151897 0.98066557  
## Oatmeal\_Raisin\_Crisp 1.1864474 0.4151897 0.98066557  
## Post\_Nat.\_Raisin\_Bran 0.6732089 0.4151897 -0.01290349  
## sodium fiber carbo  
## 100%\_Natural\_Bran -1.725770770 -0.06375361 -1.7409943  
## Basic\_4 0.600301771 -0.06375361 0.8183010  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 0.003872915 1.19497147 -0.7172762  
## Fruitful\_Bran 0.958159085 1.19497147 -0.2054171  
## Muesli\_Raisins,\_Dates,\_&\_Almonds -0.771484599 0.35582142 0.3064419  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans -0.115412857 0.35582142 0.3064419  
## Mueslix\_Crispy\_Blend -0.115412857 0.35582142 0.5623715  
## Nutri-Grain\_Almond-Raisin 0.719587543 0.35582142 1.5860896  
## Oatmeal\_Raisin\_Crisp 0.123158686 -0.27354112 -0.3333819  
## Post\_Nat.\_Raisin\_Bran 0.481016000 1.61454650 -0.9732057  
## sugars potass vitamins  
## 100%\_Natural\_Bran 0.222370547 0.51602052 -1.2642598  
## Basic\_4 0.222370547 0.01893653 -0.1453172  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 0.679131670 1.43917651 -0.1453172  
## Fruitful\_Bran 1.135892793 1.29715251 -0.1453172  
## Muesli\_Raisins,\_Dates,\_&\_Almonds 0.907512232 1.01310452 -0.1453172  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans 0.907512232 1.01310452 -0.1453172  
## Mueslix\_Crispy\_Blend 1.364273355 0.87108052 -0.1453172  
## Nutri-Grain\_Almond-Raisin -0.006010015 0.44500853 -0.1453172  
## Oatmeal\_Raisin\_Crisp 0.679131670 0.30298453 -0.1453172  
## Post\_Nat.\_Raisin\_Bran 1.592653916 2.29132050 -0.1453172  
## shelf weight cups  
## 100%\_Natural\_Bran 0.9515734 -0.1967771 0.7690100  
## Basic\_4 0.9515734 1.9962520 -0.3052601  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 0.9515734 1.4646086 -0.6490266  
## Fruitful\_Bran 0.9515734 1.9962520 -0.6490266  
## Muesli\_Raisins,\_Dates,\_&\_Almonds 0.9515734 -0.1967771 0.7690100  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans 0.9515734 -0.1967771 0.7690100  
## Mueslix\_Crispy\_Blend 0.9515734 3.1259942 -0.6490266  
## Nutri-Grain\_Almond-Raisin 0.9515734 1.9962520 -0.6490266  
## Oatmeal\_Raisin\_Crisp 0.9515734 1.4646086 -1.3795303  
## Post\_Nat.\_Raisin\_Bran 0.9515734 1.9962520 -0.6490266  
## rating clust.2  
## 100%\_Natural\_Bran -0.6180571 2  
## Basic\_4 -0.4005857 2  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats -0.1244837 2  
## Fruitful\_Bran -0.1174756 2  
## Muesli\_Raisins,\_Dates,\_&\_Almonds -0.3935878 2  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans -0.6069456 2  
## Mueslix\_Crispy\_Blend -0.8793408 2  
## Nutri-Grain\_Almond-Raisin -0.1404816 2  
## Oatmeal\_Raisin\_Crisp -0.8695530 2  
## Post\_Nat.\_Raisin\_Bran -0.3434906 2

center.2<-colMeans(result[result$clust.2==2,])  
result[result$clust.2==3,]

## calories protein fat sodium  
## Apple\_Cinnamon\_Cheerios 0.1599704 -0.4982277 0.98066557 0.2424445  
## Apple\_Jacks 0.1599704 -0.4982277 -1.00647256 -0.4136273  
## Bran\_Chex -0.8665066 -0.4982277 -0.01290349 0.4810160  
## Cap'n'Crunch 0.6732089 -1.4116451 0.98066557 0.7195875  
## Cinnamon\_Toast\_Crunch 0.6732089 -1.4116451 1.97423464 0.6003018  
## Cocoa\_Puffs 0.1599704 -1.4116451 -0.01290349 0.2424445  
## Corn\_Pops 0.1599704 -1.4116451 -1.00647256 -0.8311275  
## Count\_Chocula 0.1599704 -1.4116451 -0.01290349 0.2424445  
## Froot\_Loops 0.1599704 -0.4982277 -0.01290349 -0.4136273  
## Frosted\_Flakes 0.1599704 -1.4116451 -1.00647256 0.4810160  
## Fruity\_Pebbles 0.1599704 -1.4116451 -0.01290349 -0.2943415  
## Golden\_Crisp -0.3532681 -0.4982277 -1.00647256 -1.3679135  
## Golden\_Grahams 0.1599704 -1.4116451 -0.01290349 1.4353022  
## Honey\_Graham\_Ohs 0.6732089 -1.4116451 0.98066557 0.7195875  
## Honey\_Nut\_Cheerios 0.1599704 0.4151897 -0.01290349 1.0774449  
## Honey-comb 0.1599704 -1.4116451 -1.00647256 0.2424445  
## Lucky\_Charms 0.1599704 -0.4982277 -0.01290349 0.2424445  
## Multi-Grain\_Cheerios -0.3532681 -0.4982277 -0.01290349 0.7195875  
## Nut&Honey\_Crunch 0.6732089 -0.4982277 -0.01290349 0.3617302  
## fiber carbo sugars potass  
## Apple\_Cinnamon\_Cheerios -0.27354112 -1.10117049 0.6791317 -0.4071355  
## Apple\_Jacks -0.48332864 -0.97320572 1.5926539 -0.9752315  
## Bran\_Chex 0.77539645 0.05051241 -0.2343906 0.3739965  
## Cap'n'Crunch -0.90290366 -0.71727619 1.1358928 -0.9042195  
## Cinnamon\_Toast\_Crunch -0.90290366 -0.46134666 0.4507511 -0.7621955  
## Cocoa\_Puffs -0.90290366 -0.71727619 1.3642734 -0.6201715  
## Corn\_Pops -0.48332864 -0.46134666 1.1358928 -1.1172554  
## Count\_Chocula -0.90290366 -0.71727619 1.3642734 -0.4781475  
## Froot\_Loops -0.48332864 -0.97320572 1.3642734 -0.9752315  
## Frosted\_Flakes -0.48332864 -0.20541712 0.9075122 -1.0462434  
## Fruity\_Pebbles -0.90290366 -0.46134666 1.1358928 -1.0462434  
## Golden\_Crisp -0.90290366 -0.97320572 1.8210345 -0.8332075  
## Golden\_Grahams -0.90290366 0.05051241 0.4507511 -0.7621955  
## Honey\_Graham\_Ohs -0.48332864 -0.71727619 0.9075122 -0.7621955  
## Honey\_Nut\_Cheerios -0.27354112 -0.84524095 0.6791317 -0.1230875  
## Honey-comb -0.90290366 -0.20541712 0.9075122 -0.9042195  
## Lucky\_Charms -0.90290366 -0.71727619 1.1358928 -0.6201715  
## Multi-Grain\_Cheerios -0.06375361 0.05051241 -0.2343906 -0.1230875  
## Nut&Honey\_Crunch -0.90290366 0.05051241 0.4507511 -0.8332075  
## vitamins shelf weight cups rating  
## Apple\_Cinnamon\_Cheerios -0.1453172 -1.450759 -0.1967771 -0.3052601 -0.9365625  
## Apple\_Jacks -0.1453172 -0.249593 -0.1967771 0.7690100 -0.6756899  
## Bran\_Chex -0.1453172 -1.450759 -0.1967771 -0.6490266 0.4594871  
## Cap'n'Crunch -0.1453172 -0.249593 -0.1967771 -0.3052601 -1.7528545  
## Cinnamon\_Toast\_Crunch -0.1453172 -0.249593 -0.1967771 -0.3052601 -1.6260883  
## Cocoa\_Puffs -0.1453172 -0.249593 -0.1967771 0.7690100 -1.4187264  
## Corn\_Pops -0.1453172 -0.249593 -0.1967771 0.7690100 -0.4899817  
## Count\_Chocula -0.1453172 -0.249593 -0.1967771 0.7690100 -1.4429256  
## Froot\_Loops -0.1453172 -0.249593 -0.1967771 0.7690100 -0.7444941  
## Frosted\_Flakes -0.1453172 -1.450759 -0.1967771 -0.3052601 -0.7994234  
## Fruity\_Pebbles -0.1453172 -0.249593 -0.1967771 -0.3052601 -1.0421897  
## Golden\_Crisp -0.1453172 -1.450759 -0.1967771 0.2533603 -0.5277361  
## Golden\_Grahams -0.1453172 -0.249593 -0.1967771 -0.3052601 -1.3427262  
## Honey\_Graham\_Ohs -0.1453172 -0.249593 -0.1967771 0.7690100 -1.4803151  
## Honey\_Nut\_Cheerios -0.1453172 -1.450759 -0.1967771 -0.3052601 -0.8253186  
## Honey-comb -0.1453172 -1.450759 -0.1967771 2.1870466 -0.9911728  
## Lucky\_Charms -0.1453172 -0.249593 -0.1967771 0.7690100 -1.1341114  
## Multi-Grain\_Cheerios -0.1453172 -1.450759 -0.1967771 0.7690100 -0.1822231  
## Nut&Honey\_Crunch -0.1453172 -0.249593 -0.1967771 -0.6490266 -0.9070377  
## clust.2  
## Apple\_Cinnamon\_Cheerios 3  
## Apple\_Jacks 3  
## Bran\_Chex 3  
## Cap'n'Crunch 3  
## Cinnamon\_Toast\_Crunch 3  
## Cocoa\_Puffs 3  
## Corn\_Pops 3  
## Count\_Chocula 3  
## Froot\_Loops 3  
## Frosted\_Flakes 3  
## Fruity\_Pebbles 3  
## Golden\_Crisp 3  
## Golden\_Grahams 3  
## Honey\_Graham\_Ohs 3  
## Honey\_Nut\_Cheerios 3  
## Honey-comb 3  
## Lucky\_Charms 3  
## Multi-Grain\_Cheerios 3  
## Nut&Honey\_Crunch 3

center.3<-colMeans(result[result$clust.2==3,])  
result[result$clust.2==4,]

## calories protein fat sodium  
## Bran\_Flakes -0.8665066 0.4151897 -1.00647256 0.6003018  
## Cheerios 0.1599704 3.1554419 0.98066557 1.5545879  
## Clusters 0.1599704 0.4151897 0.98066557 -0.2346986  
## Corn\_Chex 0.1599704 -0.4982277 -1.00647256 1.4353022  
## Corn\_Flakes -0.3532681 -0.4982277 -1.00647256 1.5545879  
## Cracklin'\_Oat\_Bran 0.1599704 0.4151897 1.97423464 -0.2346986  
## Crispix 0.1599704 -0.4982277 -1.00647256 0.7195875  
## Crispy\_Wheat\_&\_Raisins -0.3532681 -0.4982277 -0.01290349 -0.2346986  
## Double\_Chex -0.3532681 -0.4982277 -1.00647256 0.3617302  
## Frosted\_Mini-Wheats -0.3532681 0.4151897 -1.00647256 -1.9046994  
## Grape\_Nuts\_Flakes -0.3532681 0.4151897 -0.01290349 -0.2346986  
## Grape-Nuts 0.1599704 0.4151897 -1.00647256 0.1231587  
## Great\_Grains\_Pecan 0.6732089 0.4151897 1.97423464 -1.0100561  
## Just\_Right\_Crunchy\_\_Nuggets 0.1599704 -0.4982277 -0.01290349 0.1231587  
## Just\_Right\_Fruit\_&\_Nut 1.6996859 0.4151897 -0.01290349 0.1231587  
## Kix 0.1599704 -0.4982277 -0.01290349 1.1967306  
## Life -0.3532681 1.3286071 0.98066557 -0.1154129  
## Maypo -0.3532681 1.3286071 -0.01290349 -1.9046994  
## Nutri-grain\_Wheat -0.8665066 0.4151897 -1.00647256 0.1231587  
## Product\_19 -0.3532681 0.4151897 -1.00647256 1.9124453  
## Puffed\_Rice -2.9194605 -1.4116451 -1.00647256 -1.9046994  
## Puffed\_Wheat -2.9194605 -0.4982277 -1.00647256 -1.9046994  
## Quaker\_Oat\_Squares -0.3532681 1.3286071 -0.01290349 -0.2943415  
## fiber carbo sugars potass  
## Bran\_Flakes 1.19497147 -0.46134666 -0.462771138 1.29715251  
## Cheerios -0.06375361 0.56237147 -1.376293384 0.08994853  
## Clusters -0.06375361 -0.46134666 -0.006010015 0.08994853  
## Corn\_Chex -0.90290366 1.84201913 -0.919532261 -1.04624345  
## Corn\_Flakes -0.48332864 1.58608960 -1.147912823 -0.90421945  
## Cracklin'\_Oat\_Bran 0.77539645 -1.22913525 -0.006010015 0.87108052  
## Crispix -0.48332864 1.58608960 -0.919532261 -0.97523145  
## Crispy\_Wheat\_&\_Raisins -0.06375361 -0.97320572 0.679131670 0.30298453  
## Double\_Chex -0.48332864 0.81830100 -0.462771138 -0.26511146  
## Frosted\_Mini-Wheats 0.35582142 -0.20541712 -0.006010015 0.01893653  
## Grape\_Nuts\_Flakes 0.35582142 0.05051241 -0.462771138 -0.19409946  
## Grape-Nuts 0.35582142 0.56237147 -0.919532261 -0.12308746  
## Great\_Grains\_Pecan 0.35582142 -0.46134666 -0.691151699 0.01893653  
## Just\_Right\_Crunchy\_\_Nuggets -0.48332864 0.56237147 -0.234390576 -0.54915946  
## Just\_Right\_Fruit\_&\_Nut -0.06375361 1.33016007 0.450751108 -0.05207547  
## Kix -0.90290366 1.58608960 -0.919532261 -0.83320745  
## Life -0.06375361 -0.71727619 -0.234390576 -0.05207547  
## Maypo -0.90290366 0.30644194 -0.919532261 -0.05207547  
## Nutri-grain\_Wheat 0.35582142 0.81830100 -1.147912823 -0.12308746  
## Product\_19 -0.48332864 1.33016007 -0.919532261 -0.76219545  
## Puffed\_Rice -0.90290366 -0.46134666 -1.604673946 -1.18826745  
## Puffed\_Wheat -0.48332864 -1.22913525 -1.604673946 -0.69118346  
## Quaker\_Oat\_Squares -0.06375361 -0.20541712 -0.234390576 0.16096053  
## vitamins shelf weight cups  
## Bran\_Flakes -0.1453172 0.9515734 -0.1967771 -0.64902659  
## Cheerios -0.1453172 -1.4507595 -0.1967771 1.84328015  
## Clusters -0.1453172 0.9515734 -0.1967771 -1.37953029  
## Corn\_Chex -0.1453172 -1.4507595 -0.1967771 0.76901001  
## Corn\_Flakes -0.1453172 -1.4507595 -0.1967771 0.76901001  
## Cracklin'\_Oat\_Bran -0.1453172 0.9515734 -0.1967771 -1.37953029  
## Crispix -0.1453172 0.9515734 -0.1967771 0.76901001  
## Crispy\_Wheat\_&\_Raisins -0.1453172 0.9515734 -0.1967771 -0.30526014  
## Double\_Chex -0.1453172 0.9515734 -0.1967771 -0.30526014  
## Frosted\_Mini-Wheats -0.1453172 -0.2495930 -0.1967771 -0.09040611  
## Grape\_Nuts\_Flakes -0.1453172 0.9515734 -0.1967771 0.25336034  
## Grape-Nuts -0.1453172 0.9515734 -0.1967771 -2.45380043  
## Great\_Grains\_Pecan -0.1453172 0.9515734 -0.1967771 -2.11003399  
## Just\_Right\_Crunchy\_\_Nuggets 3.2115106 0.9515734 -0.1967771 0.76901001  
## Just\_Right\_Fruit\_&\_Nut 3.2115106 0.9515734 1.7968857 -0.30526014  
## Kix -0.1453172 -0.2495930 -0.1967771 2.91755030  
## Life -0.1453172 -0.2495930 -0.1967771 -0.64902659  
## Maypo -0.1453172 -0.2495930 -0.1967771 0.76901001  
## Nutri-grain\_Wheat -0.1453172 0.9515734 -0.1967771 0.76901001  
## Product\_19 3.2115106 0.9515734 -0.1967771 0.76901001  
## Puffed\_Rice -1.2642598 0.9515734 -3.5195485 0.76901001  
## Puffed\_Wheat -1.2642598 0.9515734 -3.5195485 0.76901001  
## Quaker\_Oat\_Squares -0.1453172 0.9515734 -0.1967771 -1.37953029  
## rating clust.2  
## Bran\_Flakes 0.75801873 4  
## Cheerios 0.57657347 4  
## Clusters -0.16127646 4  
## Corn\_Chex -0.08689833 4  
## Corn\_Flakes 0.22763247 4  
## Cracklin'\_Oat\_Bran -0.15781928 4  
## Crispix 0.30112138 4  
## Crispy\_Wheat\_&\_Raisins -0.46197591 4  
## Double\_Chex 0.11853896 4  
## Frosted\_Mini-Wheats 1.11618949 4  
## Grape\_Nuts\_Flakes 0.66996501 4  
## Grape-Nuts 0.76209027 4  
## Great\_Grains\_Pecan 0.22395859 4  
## Just\_Right\_Crunchy\_\_Nuggets -0.43723896 4  
## Just\_Right\_Fruit\_&\_Nut -0.44095292 4  
## Kix -0.24379018 4  
## Life 0.18952903 4  
## Maypo 0.86744227 4  
## Nutri-grain\_Wheat 1.20857002 4  
## Product\_19 -0.08273233 4  
## Puffed\_Rice 1.28782197 4  
## Puffed\_Wheat 1.44796198 4  
## Quaker\_Oat\_Squares 0.48736586 4

center.4<-colMeans(result[result$clust.2==4,])  
all.centers<-rbind(center.1,center.2,center.3,center.4)  
  
#Assigning part.B data to clusters using cluster centroids from part.A data  
c.2<-as.data.frame(rbind(all.centers[,-14],part.B))  
  
dis<-get\_dist(c.2)  
matrix<-as.matrix(dis)  
  
data.1<-data.frame(data=seq(1,nrow(part.B),1),clusters=rep(0,nrow(part.B)))  
  
#Assessing how consistent the cluster assignments are compared to the assignments based on all data.  
for(i in 1:nrow(part.B))  
{  
 data.1[i,2]<-which.min(matrix[i+4,1:4])  
}  
data.1

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

cbind(c.1$clust.1[56:74],data.1$clusters)

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

table(c.1$clust.1[56:74]==data.1$clusters)

##   
## FALSE TRUE   
## 1 18

**#The stability of the clusters is 94.74% rounded. Out of the 19 variables in part.B, 18 were consistent with assignments based on all data and 1 was not consistent. Therefore, the stability is 18/19 = 94.74% rounded.**

**#Find a cluster of “healthy cereals”**

#We do not want to normalize the data because we want the exact value of the ratings to determine the healthy cereals. We still want to omit missing values.  
cereals<-na.omit(Cereal.Data)  
  
#show data frame for each cluster to analyze ratings  
cluster.1<-as.data.frame(cbind(cereals,clust.1))  
cluster.1[cluster.1$clust.1==1,]

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

cluster.1[cluster.1$clust.1==2,]

## mfr type calories protein fat sodium  
## 100%\_Natural\_Bran Q C 120 3 5 15  
## Basic\_4 G C 130 3 2 210  
## Clusters G C 110 3 2 140  
## Cracklin'\_Oat\_Bran K C 110 3 3 140  
## Crispy\_Wheat\_&\_Raisins G C 100 2 1 140  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats P C 120 3 2 160  
## Fruitful\_Bran K C 120 3 0 240  
## Great\_Grains\_Pecan P C 120 3 3 75  
## Just\_Right\_Fruit\_&\_Nut K C 140 3 1 170  
## Life Q C 100 4 2 150  
## Muesli\_Raisins,\_Dates,\_&\_Almonds R C 150 4 3 95  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans R C 150 4 3 150  
## Mueslix\_Crispy\_Blend K C 160 3 2 150  
## Nutri-Grain\_Almond-Raisin K C 140 3 2 220  
## Oatmeal\_Raisin\_Crisp G C 130 3 2 170  
## Post\_Nat.\_Raisin\_Bran P C 120 3 1 200  
## Quaker\_Oat\_Squares Q C 100 4 1 135  
## Raisin\_Bran K C 120 3 1 210  
## Raisin\_Nut\_Bran G C 100 3 2 140  
## Total\_Raisin\_Bran G C 140 3 1 190  
## fiber carbo sugars potass vitamins shelf  
## 100%\_Natural\_Bran 2.0 8.0 8 135 0 3  
## Basic\_4 2.0 18.0 8 100 25 3  
## Clusters 2.0 13.0 7 105 25 3  
## Cracklin'\_Oat\_Bran 4.0 10.0 7 160 25 3  
## Crispy\_Wheat\_&\_Raisins 2.0 11.0 10 120 25 3  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 5.0 12.0 10 200 25 3  
## Fruitful\_Bran 5.0 14.0 12 190 25 3  
## Great\_Grains\_Pecan 3.0 13.0 4 100 25 3  
## Just\_Right\_Fruit\_&\_Nut 2.0 20.0 9 95 100 3  
## Life 2.0 12.0 6 95 25 2  
## Muesli\_Raisins,\_Dates,\_&\_Almonds 3.0 16.0 11 170 25 3  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans 3.0 16.0 11 170 25 3  
## Mueslix\_Crispy\_Blend 3.0 17.0 13 160 25 3  
## Nutri-Grain\_Almond-Raisin 3.0 21.0 7 130 25 3  
## Oatmeal\_Raisin\_Crisp 1.5 13.5 10 120 25 3  
## Post\_Nat.\_Raisin\_Bran 6.0 11.0 14 260 25 3  
## Quaker\_Oat\_Squares 2.0 14.0 6 110 25 3  
## Raisin\_Bran 5.0 14.0 12 240 25 2  
## Raisin\_Nut\_Bran 2.5 10.5 8 140 25 3  
## Total\_Raisin\_Bran 4.0 15.0 14 230 100 3  
## weight cups rating clust.1  
## 100%\_Natural\_Bran 1.00 1.00 33.98368 2  
## Basic\_4 1.33 0.75 37.03856 2  
## Clusters 1.00 0.50 40.40021 2  
## Cracklin'\_Oat\_Bran 1.00 0.50 40.44877 2  
## Crispy\_Wheat\_&\_Raisins 1.00 0.75 36.17620 2  
## Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats 1.25 0.67 40.91705 2  
## Fruitful\_Bran 1.33 0.67 41.01549 2  
## Great\_Grains\_Pecan 1.00 0.33 45.81172 2  
## Just\_Right\_Fruit\_&\_Nut 1.30 0.75 36.47151 2  
## Life 1.00 0.67 45.32807 2  
## Muesli\_Raisins,\_Dates,\_&\_Almonds 1.00 1.00 37.13686 2  
## Muesli\_Raisins,\_Peaches,\_&\_Pecans 1.00 1.00 34.13976 2  
## Mueslix\_Crispy\_Blend 1.50 0.67 30.31335 2  
## Nutri-Grain\_Almond-Raisin 1.33 0.67 40.69232 2  
## Oatmeal\_Raisin\_Crisp 1.25 0.50 30.45084 2  
## Post\_Nat.\_Raisin\_Bran 1.33 0.67 37.84059 2  
## Quaker\_Oat\_Squares 1.00 0.50 49.51187 2  
## Raisin\_Bran 1.33 0.75 39.25920 2  
## Raisin\_Nut\_Bran 1.00 0.50 39.70340 2  
## Total\_Raisin\_Bran 1.50 1.00 28.59278 2

cluster.1[cluster.1$clust.1==3,]

## mfr type calories protein fat sodium fiber carbo sugars  
## Apple\_Cinnamon\_Cheerios G C 110 2 2 180 1.5 10.5 10  
## Apple\_Jacks K C 110 2 0 125 1.0 11.0 14  
## Cap'n'Crunch Q C 120 1 2 220 0.0 12.0 12  
## Cinnamon\_Toast\_Crunch G C 120 1 3 210 0.0 13.0 9  
## Cocoa\_Puffs G C 110 1 1 180 0.0 12.0 13  
## Corn\_Pops K C 110 1 0 90 1.0 13.0 12  
## Count\_Chocula G C 110 1 1 180 0.0 12.0 13  
## Froot\_Loops K C 110 2 1 125 1.0 11.0 13  
## Frosted\_Flakes K C 110 1 0 200 1.0 14.0 11  
## Fruity\_Pebbles P C 110 1 1 135 0.0 13.0 12  
## Golden\_Crisp P C 100 2 0 45 0.0 11.0 15  
## Golden\_Grahams G C 110 1 1 280 0.0 15.0 9  
## Honey\_Graham\_Ohs Q C 120 1 2 220 1.0 12.0 11  
## Honey\_Nut\_Cheerios G C 110 3 1 250 1.5 11.5 10  
## Honey-comb P C 110 1 0 180 0.0 14.0 11  
## Lucky\_Charms G C 110 2 1 180 0.0 12.0 12  
## Multi-Grain\_Cheerios G C 100 2 1 220 2.0 15.0 6  
## Nut&Honey\_Crunch K C 120 2 1 190 0.0 15.0 9  
## Smacks K C 110 2 1 70 1.0 9.0 15  
## Trix G C 110 1 1 140 0.0 13.0 12  
## Wheaties\_Honey\_Gold G C 110 2 1 200 1.0 16.0 8  
## potass vitamins shelf weight cups rating clust.1  
## Apple\_Cinnamon\_Cheerios 70 25 1 1 0.75 29.50954 3  
## Apple\_Jacks 30 25 2 1 1.00 33.17409 3  
## Cap'n'Crunch 35 25 2 1 0.75 18.04285 3  
## Cinnamon\_Toast\_Crunch 45 25 2 1 0.75 19.82357 3  
## Cocoa\_Puffs 55 25 2 1 1.00 22.73645 3  
## Corn\_Pops 20 25 2 1 1.00 35.78279 3  
## Count\_Chocula 65 25 2 1 1.00 22.39651 3  
## Froot\_Loops 30 25 2 1 1.00 32.20758 3  
## Frosted\_Flakes 25 25 1 1 0.75 31.43597 3  
## Fruity\_Pebbles 25 25 2 1 0.75 28.02576 3  
## Golden\_Crisp 40 25 1 1 0.88 35.25244 3  
## Golden\_Grahams 45 25 2 1 0.75 23.80404 3  
## Honey\_Graham\_Ohs 45 25 2 1 1.00 21.87129 3  
## Honey\_Nut\_Cheerios 90 25 1 1 0.75 31.07222 3  
## Honey-comb 35 25 1 1 1.33 28.74241 3  
## Lucky\_Charms 55 25 2 1 1.00 26.73451 3  
## Multi-Grain\_Cheerios 90 25 1 1 1.00 40.10596 3  
## Nut&Honey\_Crunch 40 25 2 1 0.67 29.92429 3  
## Smacks 40 25 2 1 0.75 31.23005 3  
## Trix 25 25 2 1 1.00 27.75330 3  
## Wheaties\_Honey\_Gold 60 25 1 1 0.75 36.18756 3

cluster.1[cluster.1$clust.1==4,]

## mfr type calories protein fat sodium fiber carbo  
## Bran\_Chex R C 90 2 1 200 4 15  
## Bran\_Flakes P C 90 3 0 210 5 13  
## Cheerios G C 110 6 2 290 2 17  
## Corn\_Chex R C 110 2 0 280 0 22  
## Corn\_Flakes K C 100 2 0 290 1 21  
## Crispix K C 110 2 0 220 1 21  
## Double\_Chex R C 100 2 0 190 1 18  
## Frosted\_Mini-Wheats K C 100 3 0 0 3 14  
## Grape\_Nuts\_Flakes P C 100 3 1 140 3 15  
## Grape-Nuts P C 110 3 0 170 3 17  
## Just\_Right\_Crunchy\_\_Nuggets K C 110 2 1 170 1 17  
## Kix G C 110 2 1 260 0 21  
## Maypo A H 100 4 1 0 0 16  
## Nutri-grain\_Wheat K C 90 3 0 170 3 18  
## Product\_19 K C 100 3 0 320 1 20  
## Puffed\_Rice Q C 50 1 0 0 0 13  
## Puffed\_Wheat Q C 50 2 0 0 1 10  
## Raisin\_Squares K C 90 2 0 0 2 15  
## Rice\_Chex R C 110 1 0 240 0 23  
## Rice\_Krispies K C 110 2 0 290 0 22  
## Shredded\_Wheat N C 80 2 0 0 3 16  
## Shredded\_Wheat\_'n'Bran N C 90 3 0 0 4 19  
## Shredded\_Wheat\_spoon\_size N C 90 3 0 0 3 20  
## Special\_K K C 110 6 0 230 1 16  
## Strawberry\_Fruit\_Wheats N C 90 2 0 15 3 15  
## Total\_Corn\_Flakes G C 110 2 1 200 0 21  
## Total\_Whole\_Grain G C 100 3 1 200 3 16  
## Triples G C 110 2 1 250 0 21  
## Wheat\_Chex R C 100 3 1 230 3 17  
## Wheaties G C 100 3 1 200 3 17  
## sugars potass vitamins shelf weight cups rating  
## Bran\_Chex 6 125 25 1 1.00 0.67 49.12025  
## Bran\_Flakes 5 190 25 3 1.00 0.67 53.31381  
## Cheerios 1 105 25 1 1.00 1.25 50.76500  
## Corn\_Chex 3 25 25 1 1.00 1.00 41.44502  
## Corn\_Flakes 2 35 25 1 1.00 1.00 45.86332  
## Crispix 3 30 25 3 1.00 1.00 46.89564  
## Double\_Chex 5 80 25 3 1.00 0.75 44.33086  
## Frosted\_Mini-Wheats 7 100 25 2 1.00 0.80 58.34514  
## Grape\_Nuts\_Flakes 5 85 25 3 1.00 0.88 52.07690  
## Grape-Nuts 3 90 25 3 1.00 0.25 53.37101  
## Just\_Right\_Crunchy\_\_Nuggets 6 60 100 3 1.00 1.00 36.52368  
## Kix 3 40 25 2 1.00 1.50 39.24111  
## Maypo 3 95 25 2 1.00 1.00 54.85092  
## Nutri-grain\_Wheat 2 90 25 3 1.00 1.00 59.64284  
## Product\_19 3 45 100 3 1.00 1.00 41.50354  
## Puffed\_Rice 0 15 0 3 0.50 1.00 60.75611  
## Puffed\_Wheat 0 50 0 3 0.50 1.00 63.00565  
## Raisin\_Squares 6 110 25 3 1.00 0.50 55.33314  
## Rice\_Chex 2 30 25 1 1.00 1.13 41.99893  
## Rice\_Krispies 3 35 25 1 1.00 1.00 40.56016  
## Shredded\_Wheat 0 95 0 1 0.83 1.00 68.23588  
## Shredded\_Wheat\_'n'Bran 0 140 0 1 1.00 0.67 74.47295  
## Shredded\_Wheat\_spoon\_size 0 120 0 1 1.00 0.67 72.80179  
## Special\_K 3 55 25 1 1.00 1.00 53.13132  
## Strawberry\_Fruit\_Wheats 5 90 25 2 1.00 1.00 59.36399  
## Total\_Corn\_Flakes 3 35 100 3 1.00 1.00 38.83975  
## Total\_Whole\_Grain 3 110 100 3 1.00 1.00 46.65884  
## Triples 3 60 25 3 1.00 0.75 39.10617  
## Wheat\_Chex 3 115 25 1 1.00 0.67 49.78744  
## Wheaties 3 110 25 1 1.00 1.00 51.59219  
## clust.1  
## Bran\_Chex 4  
## Bran\_Flakes 4  
## Cheerios 4  
## Corn\_Chex 4  
## Corn\_Flakes 4  
## Crispix 4  
## Double\_Chex 4  
## Frosted\_Mini-Wheats 4  
## Grape\_Nuts\_Flakes 4  
## Grape-Nuts 4  
## Just\_Right\_Crunchy\_\_Nuggets 4  
## Kix 4  
## Maypo 4  
## Nutri-grain\_Wheat 4  
## Product\_19 4  
## Puffed\_Rice 4  
## Puffed\_Wheat 4  
## Raisin\_Squares 4  
## Rice\_Chex 4  
## Rice\_Krispies 4  
## Shredded\_Wheat 4  
## Shredded\_Wheat\_'n'Bran 4  
## Shredded\_Wheat\_spoon\_size 4  
## Special\_K 4  
## Strawberry\_Fruit\_Wheats 4  
## Total\_Corn\_Flakes 4  
## Total\_Whole\_Grain 4  
## Triples 4  
## Wheat\_Chex 4  
## Wheaties 4

**#Based on the ratings of the various cereals in each cluster, cluster 1 consists of the highest rated cereals; therefore, cluster 1 has the healthiest cereals followed by cluster 4. Cluster 3 has the unhealthiest cereals due to the lowest ratings of cereals in that cluster.**