Assignment 5 - 64060

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2023-11-30

This is my submission for Assignment 5, I know this is late but I wanted to submit something with quality analysis and was not ready by the due date. I have spent many hours refining this code and answering the questions. I look forward to the feedback on what I have done both correctly and incorrectly. Thank you!

library(dplyr)

## Warning: package 'dplyr' was built under R version 4.3.1

##   
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

library(cluster)  
library(caret)

## Warning: package 'caret' was built under R version 4.3.1

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.3.1

## Loading required package: lattice

library(ISLR)

## Warning: package 'ISLR' was built under R version 4.3.1

library(flexclust)

## Warning: package 'flexclust' was built under R version 4.3.1

## Loading required package: grid

## Loading required package: modeltools

## Warning: package 'modeltools' was built under R version 4.3.1

## Loading required package: stats4

library(factoextra)

## Warning: package 'factoextra' was built under R version 4.3.2

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

library(tidyverse)

## Warning: package 'tidyverse' was built under R version 4.3.1

## Warning: package 'tibble' was built under R version 4.3.1

## Warning: package 'tidyr' was built under R version 4.3.1

## Warning: package 'readr' was built under R version 4.3.1

## Warning: package 'purrr' was built under R version 4.3.1

## Warning: package 'stringr' was built under R version 4.3.1

## Warning: package 'forcats' was built under R version 4.3.1

## Warning: package 'lubridate' was built under R version 4.3.1

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ forcats 1.0.0 ✔ stringr 1.5.0  
## ✔ lubridate 1.9.2 ✔ tibble 3.2.1  
## ✔ purrr 1.0.1 ✔ tidyr 1.3.0  
## ✔ readr 2.1.4

## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ✖ purrr::lift() masks caret::lift()  
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

read.csv("Cereals.csv")

## name mfr type calories protein fat sodium  
## 1 100%\_Bran N C 70 4 1 130  
## 2 100%\_Natural\_Bran Q C 120 3 5 15  
## 3 All-Bran K C 70 4 1 260  
## 4 All-Bran\_with\_Extra\_Fiber K C 50 4 0 140  
## 5 Almond\_Delight R C 110 2 2 200  
## 6 Apple\_Cinnamon\_Cheerios G C 110 2 2 180  
## 7 Apple\_Jacks K C 110 2 0 125  
## 8 Basic\_4 G C 130 3 2 210  
## 9 Bran\_Chex R C 90 2 1 200  
## 10 Bran\_Flakes P C 90 3 0 210  
## 11 Cap'n'Crunch Q C 120 1 2 220  
## 12 Cheerios G C 110 6 2 290  
## 13 Cinnamon\_Toast\_Crunch G C 120 1 3 210  
## 14 Clusters G C 110 3 2 140  
## 15 Cocoa\_Puffs G C 110 1 1 180  
## 16 Corn\_Chex R C 110 2 0 280  
## 17 Corn\_Flakes K C 100 2 0 290  
## 18 Corn\_Pops K C 110 1 0 90  
## 19 Count\_Chocula G C 110 1 1 180  
## 20 Cracklin'\_Oat\_Bran K C 110 3 3 140  
## 21 Cream\_of\_Wheat\_(Quick) N H 100 3 0 80  
## 22 Crispix K C 110 2 0 220  
## 23 Crispy\_Wheat\_&\_Raisins G C 100 2 1 140  
## 24 Double\_Chex R C 100 2 0 190  
## 25 Froot\_Loops K C 110 2 1 125  
## 26 Frosted\_Flakes K C 110 1 0 200  
## 27 Frosted\_Mini-Wheats K C 100 3 0 0  
## 28 Fruit\_&\_Fibre\_Dates,\_Walnuts,\_and\_Oats P C 120 3 2 160  
## 29 Fruitful\_Bran K C 120 3 0 240  
## 30 Fruity\_Pebbles P C 110 1 1 135  
## 31 Golden\_Crisp P C 100 2 0 45  
## 32 Golden\_Grahams G C 110 1 1 280  
## 33 Grape\_Nuts\_Flakes P C 100 3 1 140  
## 34 Grape-Nuts P C 110 3 0 170  
## 35 Great\_Grains\_Pecan P C 120 3 3 75  
## 36 Honey\_Graham\_Ohs Q C 120 1 2 220  
## 37 Honey\_Nut\_Cheerios G C 110 3 1 250  
## 38 Honey-comb P C 110 1 0 180  
## 39 Just\_Right\_Crunchy\_\_Nuggets K C 110 2 1 170  
## 40 Just\_Right\_Fruit\_&\_Nut K C 140 3 1 170  
## 41 Kix G C 110 2 1 260  
## 42 Life Q C 100 4 2 150  
## 43 Lucky\_Charms G C 110 2 1 180  
## 44 Maypo A H 100 4 1 0  
## 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  
## 48 Multi-Grain\_Cheerios G C 100 2 1 220  
## 49 Nut&Honey\_Crunch K C 120 2 1 190  
## 50 Nutri-Grain\_Almond-Raisin K C 140 3 2 220  
## 51 Nutri-grain\_Wheat K C 90 3 0 170  
## 52 Oatmeal\_Raisin\_Crisp G C 130 3 2 170  
## 53 Post\_Nat.\_Raisin\_Bran P C 120 3 1 200  
## 54 Product\_19 K C 100 3 0 320  
## 55 Puffed\_Rice Q C 50 1 0 0  
## 56 Puffed\_Wheat Q C 50 2 0 0  
## 57 Quaker\_Oat\_Squares Q C 100 4 1 135  
## 58 Quaker\_Oatmeal Q H 100 5 2 0  
## 59 Raisin\_Bran K C 120 3 1 210  
## 60 Raisin\_Nut\_Bran G C 100 3 2 140  
## 61 Raisin\_Squares K C 90 2 0 0  
## 62 Rice\_Chex R C 110 1 0 240  
## 63 Rice\_Krispies K C 110 2 0 290  
## 64 Shredded\_Wheat N C 80 2 0 0  
## 65 Shredded\_Wheat\_'n'Bran N C 90 3 0 0  
## 66 Shredded\_Wheat\_spoon\_size N C 90 3 0 0  
## 67 Smacks K C 110 2 1 70  
## 68 Special\_K K C 110 6 0 230  
## 69 Strawberry\_Fruit\_Wheats N C 90 2 0 15  
## 70 Total\_Corn\_Flakes G C 110 2 1 200  
## 71 Total\_Raisin\_Bran G C 140 3 1 190  
## 72 Total\_Whole\_Grain G C 100 3 1 200  
## 73 Triples G C 110 2 1 250  
## 74 Trix G C 110 1 1 140  
## 75 Wheat\_Chex R C 100 3 1 230  
## 76 Wheaties G C 100 3 1 200  
## 77 Wheaties\_Honey\_Gold G C 110 2 1 200  
## fiber carbo sugars potass vitamins shelf weight cups rating  
## 1 10.0 5.0 6 280 25 3 1.00 0.33 68.40297  
## 2 2.0 8.0 8 135 0 3 1.00 1.00 33.98368  
## 3 9.0 7.0 5 320 25 3 1.00 0.33 59.42551  
## 4 14.0 8.0 0 330 25 3 1.00 0.50 93.70491  
## 5 1.0 14.0 8 NA 25 3 1.00 0.75 34.38484  
## 6 1.5 10.5 10 70 25 1 1.00 0.75 29.50954  
## 7 1.0 11.0 14 30 25 2 1.00 1.00 33.17409  
## 8 2.0 18.0 8 100 25 3 1.33 0.75 37.03856  
## 9 4.0 15.0 6 125 25 1 1.00 0.67 49.12025  
## 10 5.0 13.0 5 190 25 3 1.00 0.67 53.31381  
## 11 0.0 12.0 12 35 25 2 1.00 0.75 18.04285  
## 12 2.0 17.0 1 105 25 1 1.00 1.25 50.76500  
## 13 0.0 13.0 9 45 25 2 1.00 0.75 19.82357  
## 14 2.0 13.0 7 105 25 3 1.00 0.50 40.40021  
## 15 0.0 12.0 13 55 25 2 1.00 1.00 22.73645  
## 16 0.0 22.0 3 25 25 1 1.00 1.00 41.44502  
## 17 1.0 21.0 2 35 25 1 1.00 1.00 45.86332  
## 18 1.0 13.0 12 20 25 2 1.00 1.00 35.78279  
## 19 0.0 12.0 13 65 25 2 1.00 1.00 22.39651  
## 20 4.0 10.0 7 160 25 3 1.00 0.50 40.44877  
## 21 1.0 21.0 0 NA 0 2 1.00 1.00 64.53382  
## 22 1.0 21.0 3 30 25 3 1.00 1.00 46.89564  
## 23 2.0 11.0 10 120 25 3 1.00 0.75 36.17620  
## 24 1.0 18.0 5 80 25 3 1.00 0.75 44.33086  
## 25 1.0 11.0 13 30 25 2 1.00 1.00 32.20758  
## 26 1.0 14.0 11 25 25 1 1.00 0.75 31.43597  
## 27 3.0 14.0 7 100 25 2 1.00 0.80 58.34514  
## 28 5.0 12.0 10 200 25 3 1.25 0.67 40.91705  
## 29 5.0 14.0 12 190 25 3 1.33 0.67 41.01549  
## 30 0.0 13.0 12 25 25 2 1.00 0.75 28.02576  
## 31 0.0 11.0 15 40 25 1 1.00 0.88 35.25244  
## 32 0.0 15.0 9 45 25 2 1.00 0.75 23.80404  
## 33 3.0 15.0 5 85 25 3 1.00 0.88 52.07690  
## 34 3.0 17.0 3 90 25 3 1.00 0.25 53.37101  
## 35 3.0 13.0 4 100 25 3 1.00 0.33 45.81172  
## 36 1.0 12.0 11 45 25 2 1.00 1.00 21.87129  
## 37 1.5 11.5 10 90 25 1 1.00 0.75 31.07222  
## 38 0.0 14.0 11 35 25 1 1.00 1.33 28.74241  
## 39 1.0 17.0 6 60 100 3 1.00 1.00 36.52368  
## 40 2.0 20.0 9 95 100 3 1.30 0.75 36.47151  
## 41 0.0 21.0 3 40 25 2 1.00 1.50 39.24111  
## 42 2.0 12.0 6 95 25 2 1.00 0.67 45.32807  
## 43 0.0 12.0 12 55 25 2 1.00 1.00 26.73451  
## 44 0.0 16.0 3 95 25 2 1.00 1.00 54.85092  
## 45 3.0 16.0 11 170 25 3 1.00 1.00 37.13686  
## 46 3.0 16.0 11 170 25 3 1.00 1.00 34.13976  
## 47 3.0 17.0 13 160 25 3 1.50 0.67 30.31335  
## 48 2.0 15.0 6 90 25 1 1.00 1.00 40.10596  
## 49 0.0 15.0 9 40 25 2 1.00 0.67 29.92429  
## 50 3.0 21.0 7 130 25 3 1.33 0.67 40.69232  
## 51 3.0 18.0 2 90 25 3 1.00 1.00 59.64284  
## 52 1.5 13.5 10 120 25 3 1.25 0.50 30.45084  
## 53 6.0 11.0 14 260 25 3 1.33 0.67 37.84059  
## 54 1.0 20.0 3 45 100 3 1.00 1.00 41.50354  
## 55 0.0 13.0 0 15 0 3 0.50 1.00 60.75611  
## 56 1.0 10.0 0 50 0 3 0.50 1.00 63.00565  
## 57 2.0 14.0 6 110 25 3 1.00 0.50 49.51187  
## 58 2.7 NA NA 110 0 1 1.00 0.67 50.82839  
## 59 5.0 14.0 12 240 25 2 1.33 0.75 39.25920  
## 60 2.5 10.5 8 140 25 3 1.00 0.50 39.70340  
## 61 2.0 15.0 6 110 25 3 1.00 0.50 55.33314  
## 62 0.0 23.0 2 30 25 1 1.00 1.13 41.99893  
## 63 0.0 22.0 3 35 25 1 1.00 1.00 40.56016  
## 64 3.0 16.0 0 95 0 1 0.83 1.00 68.23588  
## 65 4.0 19.0 0 140 0 1 1.00 0.67 74.47295  
## 66 3.0 20.0 0 120 0 1 1.00 0.67 72.80179  
## 67 1.0 9.0 15 40 25 2 1.00 0.75 31.23005  
## 68 1.0 16.0 3 55 25 1 1.00 1.00 53.13132  
## 69 3.0 15.0 5 90 25 2 1.00 1.00 59.36399  
## 70 0.0 21.0 3 35 100 3 1.00 1.00 38.83975  
## 71 4.0 15.0 14 230 100 3 1.50 1.00 28.59278  
## 72 3.0 16.0 3 110 100 3 1.00 1.00 46.65884  
## 73 0.0 21.0 3 60 25 3 1.00 0.75 39.10617  
## 74 0.0 13.0 12 25 25 2 1.00 1.00 27.75330  
## 75 3.0 17.0 3 115 25 1 1.00 0.67 49.78744  
## 76 3.0 17.0 3 110 25 1 1.00 1.00 51.59219  
## 77 1.0 16.0 8 60 25 1 1.00 0.75 36.18756

Cereals.df <-read.csv("Cereals.csv", header = TRUE)  
summary(Cereals.df)

## name mfr type calories   
## Length:77 Length:77 Length:77 Min. : 50.0   
## Class :character Class :character Class :character 1st Qu.:100.0   
## Mode :character Mode :character Mode :character Median :110.0   
## Mean :106.9   
## 3rd Qu.:110.0   
## Max. :160.0   
##   
## protein fat sodium fiber   
## Min. :1.000 Min. :0.000 Min. : 0.0 Min. : 0.000   
## 1st Qu.:2.000 1st Qu.:0.000 1st Qu.:130.0 1st Qu.: 1.000   
## Median :3.000 Median :1.000 Median :180.0 Median : 2.000   
## Mean :2.545 Mean :1.013 Mean :159.7 Mean : 2.152   
## 3rd Qu.:3.000 3rd Qu.:2.000 3rd Qu.:210.0 3rd Qu.: 3.000   
## Max. :6.000 Max. :5.000 Max. :320.0 Max. :14.000   
##   
## carbo sugars potass vitamins   
## Min. : 5.0 Min. : 0.000 Min. : 15.00 Min. : 0.00   
## 1st Qu.:12.0 1st Qu.: 3.000 1st Qu.: 42.50 1st Qu.: 25.00   
## Median :14.5 Median : 7.000 Median : 90.00 Median : 25.00   
## Mean :14.8 Mean : 7.026 Mean : 98.67 Mean : 28.25   
## 3rd Qu.:17.0 3rd Qu.:11.000 3rd Qu.:120.00 3rd Qu.: 25.00   
## Max. :23.0 Max. :15.000 Max. :330.00 Max. :100.00   
## NA's :1 NA's :1 NA's :2   
## shelf weight cups rating   
## Min. :1.000 Min. :0.50 Min. :0.250 Min. :18.04   
## 1st Qu.:1.000 1st Qu.:1.00 1st Qu.:0.670 1st Qu.:33.17   
## Median :2.000 Median :1.00 Median :0.750 Median :40.40   
## Mean :2.208 Mean :1.03 Mean :0.821 Mean :42.67   
## 3rd Qu.:3.000 3rd Qu.:1.00 3rd Qu.:1.000 3rd Qu.:50.83   
## Max. :3.000 Max. :1.50 Max. :1.500 Max. :93.70   
##

## Investigating which data is missing, but this is for columns and I need to view rows, so I moved to rowMeans next. Missing data was in the carbs, sugars, and potassium columns.  
colMeans(is.na(Cereals.df))

## name mfr type calories protein fat sodium   
## 0.00000000 0.00000000 0.00000000 0.00000000 0.00000000 0.00000000 0.00000000   
## fiber carbo sugars potass vitamins shelf weight   
## 0.00000000 0.01298701 0.01298701 0.02597403 0.00000000 0.00000000 0.00000000   
## cups rating   
## 0.00000000 0.00000000

## Using rowMeans I can see that I need to remove Almond Delight, Cream of Wheat, and Quaker Oatmeal.  
rowMeans(is.na(Cereals.df))

## [1] 0.0000 0.0000 0.0000 0.0000 0.0625 0.0000 0.0000 0.0000 0.0000 0.0000  
## [11] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  
## [21] 0.0625 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  
## [31] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  
## [41] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  
## [51] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1250 0.0000 0.0000  
## [61] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  
## [71] 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

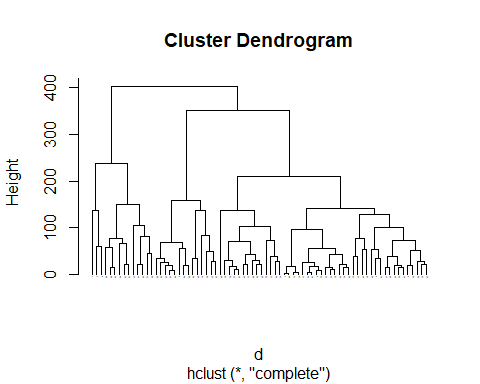
## After some trial and error I decided to use the na.omit code to remove rows with missing data, I feel comfortable with this based on my review above that I now have 74 rows, omitting the 3 I expected from the original list of 77. I also need to run the clustering using numerical data only, so I need to remove columns 2 and 3 as they are categorical.  
  
Cereal.df <- na.omit(Cereals.df)  
df<- Cereal.df[,c(4:16)]  
summary(df)

## calories protein fat sodium fiber   
## Min. : 50 Min. :1.000 Min. :0 Min. : 0.0 Min. : 0.000   
## 1st Qu.:100 1st Qu.:2.000 1st Qu.:0 1st Qu.:135.0 1st Qu.: 0.250   
## Median :110 Median :2.500 Median :1 Median :180.0 Median : 2.000   
## Mean :107 Mean :2.514 Mean :1 Mean :162.4 Mean : 2.176   
## 3rd Qu.:110 3rd Qu.:3.000 3rd Qu.:1 3rd Qu.:217.5 3rd Qu.: 3.000   
## Max. :160 Max. :6.000 Max. :5 Max. :320.0 Max. :14.000   
## carbo sugars potass vitamins   
## Min. : 5.00 Min. : 0.000 Min. : 15.00 Min. : 0.00   
## 1st Qu.:12.00 1st Qu.: 3.000 1st Qu.: 41.25 1st Qu.: 25.00   
## Median :14.50 Median : 7.000 Median : 90.00 Median : 25.00   
## Mean :14.73 Mean : 7.108 Mean : 98.51 Mean : 29.05   
## 3rd Qu.:17.00 3rd Qu.:11.000 3rd Qu.:120.00 3rd Qu.: 25.00   
## Max. :23.00 Max. :15.000 Max. :330.00 Max. :100.00   
## shelf weight cups rating   
## Min. :1.000 Min. :0.500 Min. :0.2500 Min. :18.04   
## 1st Qu.:1.250 1st Qu.:1.000 1st Qu.:0.6700 1st Qu.:32.45   
## Median :2.000 Median :1.000 Median :0.7500 Median :40.25   
## Mean :2.216 Mean :1.031 Mean :0.8216 Mean :42.37   
## 3rd Qu.:3.000 3rd Qu.:1.000 3rd Qu.:1.0000 3rd Qu.:50.52   
## Max. :3.000 Max. :1.500 Max. :1.5000 Max. :93.70

## Now that I have cleaned up the data, I am ready to complete the assigned analysis. First I will apply hierarchical clustering using Euclidean distance, first I will normalize the data.  
  
d <- dist(df, method = "euclidean")  
d.norm <- dist(df[,c(1:13)], method = "euclidean")  
scale(d.norm)

## 1 2 3 4 6 7  
## 1 -3.539715178 0.243820017 -1.78028098 -3.03205823 1.93324595 2.12003896  
## 2 -0.275720641 -2.601740313 0.73704969 -0.16839535 1.24020659 0.49953292  
## 3 -1.276367087 1.931424542 -3.72060797 -2.03564706 2.63245357 3.20183585  
## 4 -2.529573313 1.030352319 -1.91321230 -3.94861916 2.79799418 3.02819909  
## 6 0.166597769 -0.003796532 0.08497211 0.23668189 -1.60311137 -0.88191555  
## 7 0.710877129 -0.363103826 0.88638438 0.76387986 -0.52178188 -1.97328111  
## 8 -0.072272771 0.296315957 -0.37730650 -0.02847086 -0.83976053 -0.17641566  
## 9 -0.671856967 0.150379603 -0.79590329 -0.60032303 -0.57007029 0.01040530  
## 10 -1.491592892 0.400107508 -1.71332578 -1.43414021 0.42044008 0.96308218  
## 11 0.956769909 0.728839930 0.48222824 0.91905899 -0.72586554 -0.42406903  
## 12 0.471533191 1.432248509 -0.57096325 0.28014926 0.26555252 0.94793138  
## 13 0.746989982 0.535664433 0.36335438 0.73820017 -0.94400743 -0.56418489  
## 14 -0.512919243 -0.696611916 -0.15747080 -0.34310247 -0.74069503 -0.73878232  
## 15 0.424532473 0.088225084 0.29863755 0.47542504 -1.33455401 -0.99243857  
## 16 1.447948103 1.577048381 0.54119273 1.25576729 0.15759600 0.52210524  
## 17 1.368187381 1.667957404 0.39169808 1.15224876 0.26249283 0.69024069  
## 18 0.916725109 -0.572872731 1.23459127 0.95351274 0.03205100 -1.38787056  
## 19 0.269634148 0.029480312 0.16604964 0.33598204 -1.45104568 -0.91627901  
## 20 -1.378407304 -0.712976135 -0.80374576 -1.11044011 -0.03169902 0.12638003  
## 22 0.946236042 0.766631597 0.49480645 0.87510045 -0.64351411 -0.42033958  
## 23 -0.773720623 -0.719652258 -0.35459573 -0.57464202 -0.57045196 -0.50339038  
## 24 -0.004862446 0.102811314 -0.12521233 0.04355848 -1.21214875 -0.62800711  
## 25 0.712596133 -0.363922792 0.88712470 0.76609290 -0.52365722 -1.94589575  
## 26 0.948653696 0.540534131 0.62366156 0.91956413 -0.81949913 -0.76911257  
## 27 0.188655524 -1.791681050 1.14744917 0.21664950 1.32889878 0.36118623  
## 28 -1.826632184 -0.269718815 -1.36858396 -1.55787638 0.49534690 0.81073551  
## 29 -0.989628339 0.774332637 -1.69505888 -1.03006484 0.53797796 1.18469288  
## 30 0.805052787 -0.209183360 0.90022512 0.84673243 -0.59283538 -1.76943852  
## 31 0.759128645 -1.080752908 1.33768023 0.80252201 0.59690518 -0.67373763  
## 32 1.200726274 1.472166018 0.28130209 1.03943485 0.03420837 0.52310126  
## 33 -0.242589201 -0.577930901 0.06315754 -0.12425857 -0.81302707 -0.98628377  
## 34 -0.230610291 -0.211072137 -0.15461042 -0.13960190 -1.06079658 -0.71479005  
## 35 -0.279808956 -1.515142472 0.43825184 -0.12319810 0.15662803 -0.56320033  
## 36 0.794450814 0.664779175 0.33676434 0.76717922 -0.82889035 -0.41561710  
## 37 0.304895284 0.884512015 -0.36738130 0.24485547 -0.44932270 0.24482108  
## 38 0.722708418 0.221850778 0.55731502 0.73837689 -1.04387096 -1.08446988  
## 39 0.474685543 0.287844648 0.39493692 0.48393552 -0.38250163 -0.48523170  
## 40 0.084958626 0.151715751 0.04523080 0.13518272 -0.24083359 -0.15774192  
## 41 1.076673465 1.228071385 0.32233602 0.94294944 -0.22593064 0.20623285  
## 42 -0.382231630 -0.503859499 -0.12287989 -0.24754442 -0.91287575 -0.82354088  
## 43 0.411748034 0.084876366 0.29113685 0.46048724 -1.35605062 -1.00100721  
## 44 0.262031886 -1.758246530 1.19547920 0.28814995 1.31146392 0.31977524  
## 45 -1.139525585 -1.210567947 -0.32928019 -0.89325082 0.57606261 0.40705365  
## 46 -1.175892453 -0.501652913 -0.81091868 -0.95238036 0.17242461 0.39144489  
## 47 -0.936101886 -0.494145077 -0.64005086 -0.73561611 0.09996130 0.29222590  
## 48 0.023774287 0.474881223 -0.35576979 0.02576319 -0.85176196 -0.16055798  
## 49 0.705725659 0.306060734 0.47336867 0.71625254 -1.07164883 -0.90335884  
## 50 -0.364668163 0.409981667 -0.76285179 -0.33163249 -0.34067515 0.29561920  
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## 6 -0.80627237 -0.09818070 -0.758490401 -0.695381958 -0.960997488 -0.73908254  
## 7 -0.48547701 0.73167947 0.092520751 0.035257426 -1.634552859 0.30326518  
## 8 -0.56946132 -0.59738073 -0.897890876 -0.850987295 -0.264224542 -1.21958669  
## 9 -0.29722849 -0.80854565 -1.002770650 -0.530559114 -0.026362262 -1.34813174  
## 10 0.55186935 -1.47020967 -0.359982299 0.150528213 0.935917505 -0.62932624  
## 11 -0.87785193 0.49530276 -0.300902070 -1.018885389 -0.627210204 -0.45289951  
## 12 -0.02536845 -0.07010908 -0.226053335 -0.834008027 0.775318474 -0.89612864  
## 13 -0.90933074 0.30630550 -0.462131119 -0.996379930 -0.748974072 -0.57946852  
## 14 -0.30254236 -0.49771614 -0.624427612 -0.097154966 -0.636856914 -0.41800279  
## 15 -0.86428472 0.14715258 -0.581910163 -0.685066981 -1.117899532 -0.54073804  
## 16 -0.44238396 0.97437406 0.186446436 -1.032194786 0.296662466 -0.22437489  
## 17 -0.32420891 0.92607932 0.183590805 -0.999667777 0.468449541 -0.28423460  
## 18 -0.06540065 1.11247975 0.613529867 0.494548217 -1.108018126 0.83366380  
## 19 -0.81748985 -0.01614096 -0.679281636 -0.684085227 -1.015778524 -0.64741442  
## 20 0.29899288 -1.19998209 -0.391884516 0.286883317 0.212094741 -0.25682966  
## 22 -0.93627479 0.61443383 -0.336903188 -1.071433402 -0.604231092 -0.50442545  
## 23 -0.14729300 -0.67152127 -0.615124373 -0.005924361 -0.407404616 -0.42016267  
## 24 -0.77178749 -0.21127569 -0.921698280 -0.799851545 -0.697400551 -1.02683092  
## 25 -0.48620490 0.73136059 0.092876733 0.034782805 -1.640805485 0.30390697  
## 26 -0.95790780 0.64572886 -0.277343656 -0.823934187 -0.964225551 -0.32609507  
## 27 1.32457130 1.12951682 1.619123394 1.632680654 0.621956102 1.79458877  
## 28 0.73417817 -1.73459032 -0.073495064 0.517664273 0.852681799 -0.08604061  
## 29 0.59828332 -1.51763660 -0.205015982 0.058650078 1.112626615 -0.61574700  
## 30 -0.58311773 0.76397125 0.059662484 -0.070153384 -1.821545209 0.24553403  
## 31 0.53331095 1.24791598 1.092824472 1.025457328 -0.390309980 1.31553454  
## 32 -0.42234985 0.65529141 0.008461173 -1.139355880 0.300851899 -0.43519598  
## 33 -0.44853511 -0.14348526 -0.578817506 -0.161333043 -0.873037188 -0.36758533  
## 34 -0.61597677 -0.36173307 -0.872196691 -0.512668725 -0.705881146 -0.83041862  
## 35 0.33258093 0.11130584 0.342414211 0.683203925 -0.317100577 0.62272422  
## 36 -0.88357976 0.32634214 -0.442155853 -1.100643640 -0.604401985 -0.61802004  
## 37 -0.49805899 -0.22722194 -0.671688488 -1.197316068 0.088514563 -1.25164626  
## 38 -0.92358095 0.47769390 -0.371265713 -0.652801422 -1.257490458 -0.32515287  
## 39 -1.53522663 -0.19733063 -1.330827225 -0.217687802 -0.519170758 -0.09615962  
## 40 -1.00429304 -0.87392706 -1.454599729 -0.097891466 -0.163428528 -0.17554846  
## 41 -0.65852951 0.60969194 -0.191436080 -1.337407497 -0.001455509 -0.57013192  
## 42 -0.45438925 -0.35385067 -0.729573466 -0.252772965 -0.750652094 -0.56106353  
## 43 -0.87672507 0.14570370 -0.601037630 -0.696926683 -1.121640056 -0.56196201  
## 44 1.29706396 1.17391397 1.621111933 1.618943549 0.580018232 1.79847012  
## 45 0.81080902 -0.89401724 0.415736936 0.867351471 0.547524634 0.58664255  
## 46 0.44451330 -1.45730125 -0.180702425 0.353169021 0.448088771 -0.11762642  
## 47 0.36832364 -1.32642781 -0.169277303 0.305879552 0.346263749 -0.09861777  
## 48 -0.66229433 -0.32546926 -0.940670057 -1.058043118 -0.274515754 -1.42015814  
## 49 -0.94762009 0.36818095 -0.442269820 -0.788484063 -1.070377385 -0.44918738  
## 50 -0.19138288 -1.00899075 -0.758899195 -0.573457021 0.220732224 -1.15983840  
## 51 -0.56867688 -0.25498211 -0.857806298 -0.468375925 -0.628580137 -0.82005048  
## 52 -0.29500760 -0.90640761 -0.786379314 -0.306414488 -0.318129460 -0.75748611  
## 53 1.53180662 -1.82571670 0.764666736 1.027650120 1.879451342 0.51640948  
## 54 -0.27696463 0.82121533 0.134029887 -0.289387560 1.165055296 0.29870662  
## 55 1.46450056 2.42801054 2.275970116 1.747706549 0.566682401 2.21772619  
## 56 1.46402629 2.02522591 2.065686141 1.704471963 0.600247795 2.03745003  
## 57 -0.20521474 -0.47991857 -0.579875171 -0.004011406 -0.519804341 -0.36282753  
## 59 1.24096556 -1.87871892 0.432153022 0.746616836 1.624978656 0.17399413  
## 60 0.06736667 -0.92297009 -0.545806987 0.129465028 -0.092848619 -0.37752010  
## 61 1.37800984 1.06474432 1.615988246 1.659429739 0.703655276 1.78942551  
## 62 -0.82718428 0.67651367 -0.231926209 -1.215282069 -0.311656357 -0.49730672  
## 63 -0.33389912 0.89297987 0.193992241 -1.018951391 0.454784029 -0.26977430  
## 64 1.49272571 1.43248036 1.846240445 1.670236904 0.694164845 1.84438268  
## 65 1.72546760 1.05027142 1.875454850 1.794025860 1.060073543 1.85108251  
## 66 1.60238742 1.19211438 1.838099811 1.723075470 0.876862062 1.82803876  
## 67 0.19348965 0.97714084 0.719418463 0.708061806 -0.782208664 0.96399368  
## 68 -0.83579770 0.24816801 -0.595694508 -1.293027719 -0.363338282 -0.90780062  
## 69 1.08724977 1.06368602 1.371912767 1.433621565 0.370317161 1.57495151  
## 70 -2.14485589 0.23934043 -1.021601499 -0.426045053 -0.376545240 -0.05184674  
## 71 0.91872925 -3.35792360 -0.019200850 0.915452546 1.614414194 0.51597203  
## 72 -0.96585494 -1.02367700 -2.482556997 -0.292014803 0.128353384 -0.58954763  
## 73 -0.69935775 0.23959639 -0.491019178 -1.624294011 -0.086277898 -0.91529134  
## 74 -0.63118788 0.74296346 0.014930408 -0.130384313 -1.899495876 0.19033458  
## 75 -0.37113669 -0.62837562 -0.931074114 -0.848369885 0.121498996 -1.88010014  
## 76 -0.48464794 -0.64321283 -1.042684922 -0.692967882 -0.224650458 -1.39478779  
## 77 -0.91714244 0.06726747 -0.730846647 -0.975722403 -0.808474656 -0.84282498  
## 76 77  
## 1 1.41402516 1.90629007  
## 2 1.46560541 1.39499125  
## 3 1.99347577 2.40082580  
## 4 2.28474645 2.66470503  
## 6 -0.94654821 -1.17658742  
## 7 0.10649649 -0.34913000  
## 8 -1.20972973 -0.85987693  
## 9 -1.52356824 -0.52140007  
## 10 -0.43132520 0.40310982  
## 11 -0.32440960 -0.96633552  
## 12 -0.26894145 -0.04811375  
## 13 -0.52261754 -1.13956438  
## 14 -0.76300418 -0.43589210  
## 15 -0.68131401 -1.15617068  
## 16 0.19984755 -0.25331421  
## 17 0.19370054 -0.15299294  
## 18 0.65148021 0.17141529  
## 19 -0.81617792 -1.15354987  
## 20 -0.45648635 0.16801253  
## 22 -0.39799201 -0.97019497  
## 23 -0.74363429 -0.28517858  
## 24 -1.27897481 -1.14654918  
## 25 0.10762056 -0.34959730  
## 26 -0.31041056 -1.01080539  
## 27 1.63725284 1.44966980  
## 28 -0.08299902 0.59136339  
## 29 -0.23387160 0.45314411  
## 30 0.07438174 -0.44703632  
## 31 1.13283279 0.74608894  
## 32 0.02133831 -0.33264529  
## 33 -0.71543763 -0.54355435  
## 34 -1.19455909 -0.85678199  
## 35 0.36448170 0.38796051  
## 36 -0.49965382 -1.07714524  
## 37 -0.81819621 -0.67456449  
## 38 -0.42046438 -1.04578338  
## 39 -0.16428122 -0.35475698  
## 40 -0.23221425 -0.17669399  
## 41 -0.21814516 -0.60241534  
## 42 -0.92677333 -0.61688164  
## 43 -0.71241658 -1.18624329  
## 44 1.64050280 1.43204424  
## 45 0.44659308 0.75296042  
## 46 -0.19980814 0.31951494  
## 47 -0.18341845 0.25244868  
## 48 -1.31208714 -0.97939562  
## 49 -0.50941488 -1.15809561  
## 50 -0.96814821 -0.37990884  
## 51 -1.18010946 -0.75904936  
## 52 -0.99260170 -0.50654564  
## 53 0.80419581 1.37799113  
## 54 0.86674594 0.54431771  
## 55 2.12767122 1.61199376  
## 56 1.91865065 1.55177507  
## 57 -0.71325941 -0.31205288  
## 59 0.46230517 1.09128387  
## 60 -0.65346216 -0.06631444  
## 61 1.63558727 1.48731004  
## 62 -0.26872116 -0.78384778  
## 63 0.20859431 -0.16631444  
## 64 1.69601313 1.50703549  
## 65 1.72255101 1.67948003  
## 66 1.68554546 1.58236381  
## 67 0.76222206 0.38619364  
## 68 -0.74176615 -1.01252490  
## 69 1.39573411 1.22533255  
## 70 0.02064115 -0.37482218  
## 71 0.75384320 1.20834586  
## 72 -0.53983938 -0.20057748  
## 73 -0.58313761 -0.79215245  
## 74 0.02562363 -0.50915660  
## 75 -1.31735768 -0.58228927  
## 76 -1.84703078 -0.74977973  
## 77 -0.91599681 -1.52538496  
## attr(,"scaled:center")  
## 1 2 3 4 6 7 8 9   
## 213.2146 179.7604 261.4201 262.1289 101.2041 123.4273 108.8468 111.3274   
## 10 11 12 13 14 15 16 17   
## 145.0124 123.3290 154.4537 115.3146 104.3458 105.6336 157.8070 161.5854   
## 18 19 20 22 23 24 25 26   
## 142.6970 103.3037 122.3885 123.4971 107.7744 101.3464 123.4232 120.1901   
## 27 28 29 30 31 32 33 34   
## 182.8474 143.8772 154.4729 123.3152 160.2579 151.4801 104.9277 100.4411   
## 35 36 37 38 39 40 41 42   
## 133.0422 118.3244 124.9805 112.7136 128.0803 128.8964 138.4351 101.9162   
## 43 44 45 46 47 48 49 50   
## 104.8491 182.6548 148.3466 132.9176 132.2604 109.5252 111.5549 121.8390   
## 51 52 53 54 55 56 57 59   
## 103.9153 106.8341 191.4143 197.9298 212.0367 200.9116 107.1717 177.6501   
## 60 61 62 63 64 65 66 67   
## 113.9860 183.8803 131.7805 161.0377 188.2407 194.0031 189.5512 145.1565   
## 68 69 70 71 72 73 74 75   
## 118.5986 172.2934 138.7995 185.0624 129.6481 126.8017 122.1724 118.0373   
## 76 77   
## 106.2492 105.3309   
## attr(,"scaled:scale")  
## 1 2 3 4 6 7 8 9   
## 60.23495 69.09239 70.26273 66.38494 63.12981 62.54928 62.38583 54.33178   
## 10 11 12 13 14 15 16 17   
## 54.06254 76.62086 74.39266 73.81997 50.52183 66.29514 85.85920 85.38468   
## 18 19 20 22 23 24 25 26   
## 63.42672 64.19773 47.12833 76.00839 48.32271 61.68000 62.59749 73.78927   
## 27 28 29 30 31 32 33 34   
## 78.53541 51.79636 60.28935 64.00381 67.88082 84.03143 52.01141 55.54094   
## 35 36 37 38 39 40 41 42   
## 54.95454 75.65816 72.15368 69.07368 55.61889 50.07522 82.52619 52.26253   
## 43 44 45 46 47 48 49 50   
## 66.38149 78.56202 49.18049 49.12747 48.08462 66.03876 70.62897 59.10776   
## 51 52 53 54 55 56 57 59   
## 53.33317 51.67957 63.41171 81.15602 76.03736 76.53531 48.76744 61.94072   
## 60 61 62 63 64 65 66 67   
## 46.70393 77.92083 80.00517 86.18193 78.43494 74.77166 77.11072 63.36231   
## 68 69 70 71 72 73 74 75   
## 74.03754 74.90618 64.71274 55.11216 52.22362 78.06570 64.31831 62.78245   
## 76 77   
## 57.52435 69.05204

## I will now plot the data set using complete linkage  
  
hc1 <- hclust(d, method = "complete")  
plot(hc1, cex = .05, hang = -1)



print(hc1)

##   
## Call:  
## hclust(d = d, method = "complete")  
##   
## Cluster method : complete   
## Distance : euclidean   
## Number of objects: 74

## Now I will look at the agnes functions with different linkages, and compare for the best linkage method. The "complete" method has the best linkage at 0.923.  
  
hc\_single <- agnes(df, method = "single")  
hc\_complete <- agnes(df, method = "complete")  
hc\_average <- agnes(df, method = "average")  
  
print(hc\_single$ac)

## [1] 0.7311616

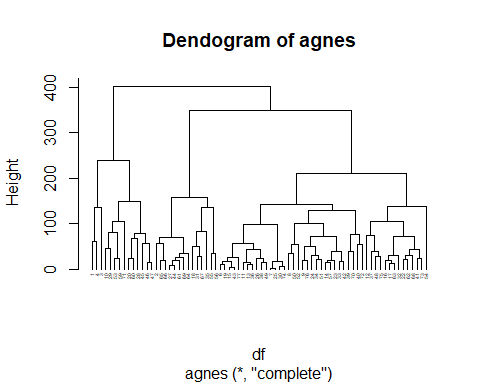
print(hc\_complete$ac)

## [1] 0.922957

print(hc\_average$ac)

## [1] 0.8792621

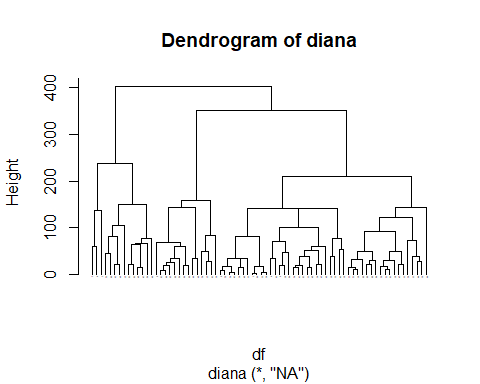
pltree(hc\_complete, cex = 0.3, hang = -1, main = "Dendogram of agnes")



## I am now going to look at the function diana and compare to agnes computed above.  
  
hc\_diana <- diana(df)  
hc\_diana$dc

## [1] 0.92013

pltree(hc\_diana, cex = .02, hang = -1, main = "Dendrogram of diana")



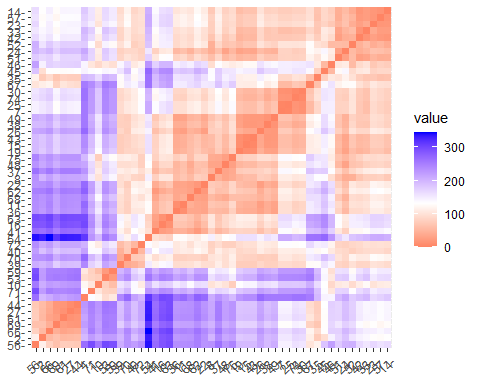
## After looking at all option, agnes function "Complete" is still the best and I would choose this to create the clusters. I will now partition the data, 70% train, 30% validation.  
set.seed(1)  
train.rows <- sample(rownames(df),dim(df)[1]\*0.7)  
train.data <- df[train.rows, ]  
valid.rows <- setdiff(row.names(df), train.rows)  
valid.data <- df[valid.rows, ]  
summary(train.data)

## calories protein fat sodium   
## Min. : 50.0 Min. :1.00 Min. :0.0000 Min. : 0.0   
## 1st Qu.:100.0 1st Qu.:2.00 1st Qu.:0.0000 1st Qu.:132.5   
## Median :110.0 Median :2.00 Median :1.0000 Median :180.0   
## Mean :108.8 Mean :2.49 Mean :0.9804 Mean :160.0   
## 3rd Qu.:115.0 3rd Qu.:3.00 3rd Qu.:1.0000 3rd Qu.:210.0   
## Max. :150.0 Max. :6.00 Max. :5.0000 Max. :320.0   
## fiber carbo sugars potass   
## Min. : 0.000 Min. : 5.00 Min. : 0.00 Min. : 25.00   
## 1st Qu.: 0.000 1st Qu.:12.00 1st Qu.: 3.00 1st Qu.: 40.00   
## Median : 1.500 Median :14.00 Median : 7.00 Median : 90.00   
## Mean : 1.804 Mean :14.82 Mean : 7.51 Mean : 90.29   
## 3rd Qu.: 3.000 3rd Qu.:17.00 3rd Qu.:11.00 3rd Qu.:110.00   
## Max. :10.000 Max. :23.00 Max. :15.00 Max. :280.00   
## vitamins shelf weight cups   
## Min. : 0.00 Min. :1.000 Min. :0.50 Min. :0.3300   
## 1st Qu.: 25.00 1st Qu.:2.000 1st Qu.:1.00 1st Qu.:0.7500   
## Median : 25.00 Median :2.000 Median :1.00 Median :1.0000   
## Mean : 32.35 Mean :2.275 Mean :1.03 Mean :0.8592   
## 3rd Qu.: 25.00 3rd Qu.:3.000 3rd Qu.:1.00 3rd Qu.:1.0000   
## Max. :100.00 Max. :3.000 Max. :1.50 Max. :1.5000   
## rating   
## Min. :18.04   
## 1st Qu.:31.33   
## Median :39.24   
## Mean :40.70   
## 3rd Qu.:48.20   
## Max. :72.80

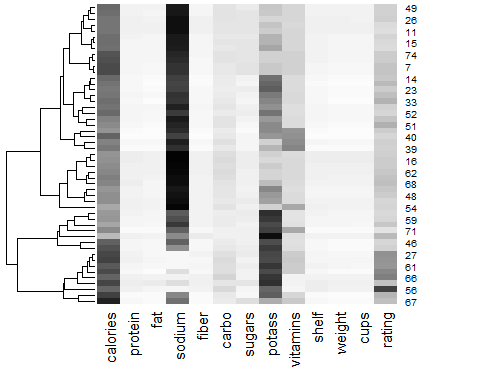
summary(valid.data)

## calories protein fat sodium fiber   
## Min. : 50 Min. :1.000 Min. :0.000 Min. : 0.0 Min. : 0   
## 1st Qu.: 95 1st Qu.:2.000 1st Qu.:0.000 1st Qu.:140.0 1st Qu.: 1   
## Median :110 Median :3.000 Median :1.000 Median :180.0 Median : 3   
## Mean :103 Mean :2.565 Mean :1.043 Mean :167.6 Mean : 3   
## 3rd Qu.:110 3rd Qu.:3.000 3rd Qu.:2.000 3rd Qu.:230.0 3rd Qu.: 4   
## Max. :160 Max. :6.000 Max. :3.000 Max. :290.0 Max. :14   
## carbo sugars potass vitamins   
## Min. : 7.00 Min. : 0.000 Min. : 15.0 Min. : 0.00   
## 1st Qu.:11.50 1st Qu.: 2.500 1st Qu.: 52.5 1st Qu.:25.00   
## Median :15.00 Median : 7.000 Median :105.0 Median :25.00   
## Mean :14.52 Mean : 6.217 Mean :116.7 Mean :21.74   
## 3rd Qu.:17.00 3rd Qu.: 9.500 3rd Qu.:150.0 3rd Qu.:25.00   
## Max. :21.00 Max. :15.000 Max. :330.0 Max. :25.00   
## shelf weight cups rating   
## Min. :1.000 Min. :0.500 Min. :0.2500 Min. :19.82   
## 1st Qu.:1.000 1st Qu.:1.000 1st Qu.:0.6700 1st Qu.:35.99   
## Median :2.000 Median :1.000 Median :0.7500 Median :40.92   
## Mean :2.087 Mean :1.032 Mean :0.7383 Mean :46.08   
## 3rd Qu.:3.000 3rd Qu.:1.000 3rd Qu.:0.9400 3rd Qu.:52.48   
## Max. :3.000 Max. :1.500 Max. :1.2500 Max. :93.70

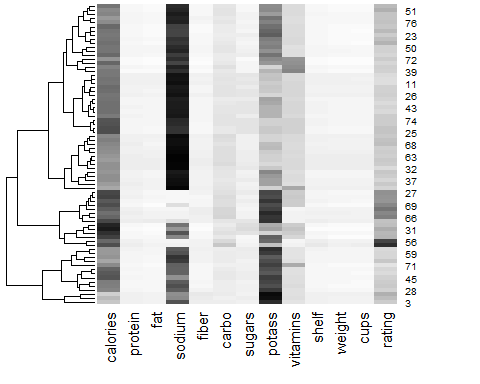
## In this code chunk I am attempting to review the distance outputs for stability, in comparison to what I saw before in the complete linkage output. I cannot glean anything useful from this chart, I think I must be missing a crucial step.   
get\_dist(train.data, method = "euclidean", ) %>%  
fviz\_dist()



##Lastly I am going to create a heatmap for the clusters from the training data and the complete linkage data, in that order.   
heatmap(as.matrix(train.data), Colv = NA, hclustfun = hclust, col=rev(paste("gray",1:99,sep = "")))



heatmap(as.matrix(df), Colv = NA, hclustfun = hclust, col=rev(paste("gray",1:99,sep = "")))



## In conclusion, the school should offer the cereals in Cluster 3, because they have the highest rating, and low sodium, moderate vitamins, and are calorie dense. This is important for students that may not get 3 full meals at home. The last code line I was trying to write involved zooming in on the selected cluster, but I could not get the margins to work properly so I cannot see the actual cereals included in Cluster 3 (which is obviously an issue!)  
plot(hc1, cex = .03, hang = -1, )  
rect.hclust(hc\_complete, k = 4, border = 1:4)

