Machine Learning - Final Exam

Tanmoy Kumar

12/10/2020

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

Load the Data

```
rm(list = ls())

library(caret)

## Loading required package: lattice

## Loading required package: ggplot2

library(dplyr)

##
## 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(ISLR)
library(tidyverse)

## -- Attaching packages --------------------------------------- tidyverse 1.3.0 --

## v tibble  3.0.4     v purrr   0.3.4
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.0

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## x purrr::lift()   masks caret::lift()

library(NbClust)
library(factoextra)

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

```r
library(ISLR)
library(ggplot2)
library(e1071)

set.seed(123)
BathSoapDF<-read.csv("BathSoap.csv")

# Data Structure
colnames(BathSoapDF)
```

```
##  [1] "Member.id"             "SEC"                   "FEH"
##  [4] "MT"                    "SEX"                   "AGE"
##  [7] "EDU"                   "HS"                    "CHILD"
## [10] "CS"                    "Affluence.Index"       "No..of.Brands"
## [13] "Brand.Runs"            "Total.Volume"          "No..of..Trans"
## [16] "Value"                 "Trans...Brand.Runs"    "Vol.Tran"
## [19] "Avg..Price"            "Pur.Vol.No.Promo...."  "Pur.Vol.Promo.6.."
## [22] "Pur.Vol.Other.Promo.." "Br..Cd..57..144"       "Br..Cd..55"
## [25] "Br..Cd..272"           "Br..Cd..286"           "Br..Cd..24"
## [28] "Br..Cd..481"           "Br..Cd..352"           "Br..Cd..5"
## [31] "Others.999"            "Pr.Cat.1"              "Pr.Cat.2"
## [34] "Pr.Cat.3"              "Pr.Cat.4"              "PropCat.5"
## [37] "PropCat.6"             "PropCat.7"             "PropCat.8"
## [40] "PropCat.9"             "PropCat.10"            "PropCat.11"
## [43] "PropCat.12"            "PropCat.13"            "PropCat.14"
## [46] "PropCat.15"
```

```r
str(BathSoapDF)
```

```
## 'data.frame':    600 obs. of  46 variables:
##  $ Member.id            : int  1010010 1010020 1014020 1014030 1014190 1017020 1017110
1017160 1017360 1017460 ...
##  $ SEC                  : int  4 3 2 4 4 4 4 4 4 1 ...
##  $ FEH                  : int  3 2 3 0 1 3 2 3 3 3 ...
##  $ MT                   : int  10 10 10 0 10 10 10 10 10 5 ...
##  $ SEX                  : int  1 2 2 0 2 2 2 2 2 1 ...
##  $ AGE                  : int  4 2 4 4 3 3 4 2 4 4 ...
##  $ EDU                  : int  4 4 5 0 4 4 1 4 4 7 ...
##  $ HS                   : int  2 4 6 0 4 5 3 5 6 3 ...
##  $ CHILD                : int  4 2 4 5 3 2 2 3 4 4 ...
##  $ CS                   : int  1 1 1 0 1 1 1 0 1 1 ...
##  $ Affluence.Index      : int  2 19 23 0 10 13 11 0 17 6 ...
##  $ No..of.Brands        : int  3 5 5 2 3 3 4 3 2 4 ...
##  $ Brand.Runs           : int  17 25 37 4 6 26 17 8 12 13 ...
##  $ Total.Volume         : int  8025 13975 23100 1500 8300 18175 9950 9300 26490 7455
...
##  $ No..of..Trans        : int  24 40 63 4 13 41 26 25 27 18 ...
##  $ Value                : num  818 1682 1950 114 591 ...
##  $ Trans...Brand.Runs   : num  1.41 1.6 1.7 1 2.17 1.58 1.53 3.13 2.25 1.38 ...
##  $ Vol.Tran             : num  334 349 367 375 638 ...
##  $ Avg..Price           : num  10.19 12.03 8.44 7.6 7.12 ...
##  $ Pur.Vol.No.Promo.... : chr  "100%" "89%" "94%" "100%" ...
##  $ Pur.Vol.Promo.6..    : chr  "0%" "10%" "2%" "0%" ...
##  $ Pur.Vol.Other.Promo..: chr  "0%" "2%" "4%" "0%" ...
##  $ Br..Cd..57..144      : chr  "38%" "2%" "3%" "40%" ...
##  $ Br..Cd..55           : chr  "13%" "8%" "55%" "60%" ...
```

```
##  $ Br..Cd..272         : chr  "0%" "0%" "0%" "0%" ...
##  $ Br..Cd..286         : chr  "0%" "0%" "3%" "0%" ...
##  $ Br..Cd..24          : chr  "0%" "0%" "0%" "0%" ...
##  $ Br..Cd..481         : chr  "0%" "6%" "0%" "0%" ...
##  $ Br..Cd..352         : chr  "0%" "0%" "0%" "0%" ...
##  $ Br..Cd..5           : chr  "0%" "14%" "2%" "0%" ...
##  $ Others.999          : chr  "49.2%" "69.9%" "37.9%" "0.0%" ...
##  $ Pr.Cat.1            : chr  "23%" "29%" "12%" "0%" ...
##  $ Pr.Cat.2            : chr  "56%" "55%" "32%" "40%" ...
##  $ Pr.Cat.3            : chr  "13%" "9%" "56%" "60%" ...
##  $ Pr.Cat.4            : chr  "7%" "6%" "0%" "0%" ...
##  $ PropCat.5           : chr  "50%" "46%" "24%" "40%" ...
##  $ PropCat.6           : chr  "0%" "35%" "12%" "0%" ...
##  $ PropCat.7           : chr  "0%" "3%" "3%" "0%" ...
##  $ PropCat.8           : chr  "0%" "2%" "1%" "0%" ...
##  $ PropCat.9           : chr  "0%" "1%" "1%" "0%" ...
##  $ PropCat.10          : chr  "0%" "0%" "0%" "0%" ...
##  $ PropCat.11          : chr  "0%" "6%" "0%" "0%" ...
##  $ PropCat.12          : chr  "3%" "0%" "2%" "0%" ...
##  $ PropCat.13          : chr  "0%" "0%" "0%" "0%" ...
##  $ PropCat.14          : chr  "13%" "8%" "56%" "60%" ...
##  $ PropCat.15          : chr  "34%" "0%" "0%" "0%" ...
```

```
colMeans(is.na(BathSoapDF))
```

```
##            Member.id                  SEC                  FEH
##                    0                    0                    0
##                   MT                  SEX                  AGE
##                    0                    0                    0
##                  EDU                   HS                CHILD
##                    0                    0                    0
##                   CS      Affluence.Index        No..of.Brands
##                    0                    0                    0
##           Brand.Runs         Total.Volume        No..of..Trans
##                    0                    0                    0
##                Value    Trans...Brand.Runs             Vol.Tran
##                    0                    0                    0
##           Avg..Price  Pur.Vol.No.Promo....     Pur.Vol.Promo.6..
##                    0                    0                    0
## Pur.Vol.Other.Promo..        Br..Cd..57..144           Br..Cd..55
##                    0                    0                    0
##          Br..Cd..272          Br..Cd..286           Br..Cd..24
##                    0                    0                    0
##          Br..Cd..481          Br..Cd..352            Br..Cd..5
##                    0                    0                    0
##           Others.999             Pr.Cat.1             Pr.Cat.2
##                    0                    0                    0
##             Pr.Cat.3             Pr.Cat.4            PropCat.5
##                    0                    0                    0
##            PropCat.6            PropCat.7            PropCat.8
##                    0                    0                    0
##            PropCat.9           PropCat.10           PropCat.11
##                    0                    0                    0
##           PropCat.12           PropCat.13           PropCat.14
##                    0                    0                    0
```

```
##           PropCat.15
##                    0

#No missing records present

#Sample Data
head(BathSoapDF)

##   Member.id SEC FEH MT SEX AGE EDU HS CHILD CS Affluence.Index No..of.Brands
## 1   1010010   4   3 10   1   4   4  2     4  1               2             3
## 2   1010020   3   2 10   2   2   4  4     2  1              19             5
## 3   1014020   2   3 10   2   4   5  6     4  1              23             5
## 4   1014030   4   0  0   0   4   0  0     5  0               0             2
## 5   1014190   4   1 10   2   3   4  4     3  1              10             3
## 6   1017020   4   3 10   2   3   4  5     2  1              13             3
##   Brand.Runs Total.Volume No..of..Trans  Value Trans...Brand.Runs Vol.Tran
## 1         17         8025            24  818.0               1.41   334.38
## 2         25        13975            40 1681.5               1.60   349.38
## 3         37        23100            63 1950.0               1.70   366.67
## 4          4         1500             4  114.0               1.00   375.00
## 5          6         8300            13  591.0               2.17   638.46
## 6         26        18175            41 1705.5               1.58   443.29
##   Avg..Price Pur.Vol.No.Promo.... Pur.Vol.Promo.6.. Pur.Vol.Other.Promo..
## 1      10.19                 100%                0%                   0%
## 2      12.03                  89%               10%                   2%
## 3       8.44                  94%                2%                   4%
## 4       7.60                 100%                0%                   0%
## 5       7.12                  61%               14%                  24%
## 6       9.38                 100%                0%                   0%
##   Br..Cd..57..144 Br..Cd..55 Br..Cd..272 Br..Cd..286 Br..Cd..24 Br..Cd..481
## 1             38%        13%          0%          0%         0%          0%
## 2              2%         8%          0%          0%         0%          6%
## 3              3%        55%          0%          3%         0%          0%
## 4             40%        60%          0%          0%         0%          0%
## 5              5%        14%          0%          0%         0%          0%
## 6              8%         7%          0%          0%         0%          0%
##   Br..Cd..352 Br..Cd..5 Others.999 Pr.Cat.1 Pr.Cat.2 Pr.Cat.3 Pr.Cat.4
## 1          0%        0%      49.2%      23%      56%      13%       7%
## 2          0%       14%      69.9%      29%      55%       9%       6%
## 3          0%        2%      37.9%      12%      32%      56%       0%
## 4          0%        0%       0.0%       0%      40%      60%       0%
## 5          0%        0%      80.7%       0%       5%      14%      81%
## 6          0%        0%      85.7%      22%      45%       7%      27%
##   PropCat.5 PropCat.6 PropCat.7 PropCat.8 PropCat.9 PropCat.10 PropCat.11
## 1       50%        0%        0%        0%        0%         0%         0%
## 2       46%       35%        3%        2%        1%         0%         6%
## 3       24%       12%        3%        1%        1%         0%         0%
## 4       40%        0%        0%        0%        0%         0%         0%
## 5       81%        0%        0%        5%        0%         0%         0%
## 6       49%       10%        0%        1%        7%         0%         0%
##   PropCat.12 PropCat.13 PropCat.14 PropCat.15
## 1         3%         0%        13%        34%
## 2         0%         0%         8%         0%
## 3         2%         0%        56%         0%
## 4         0%         0%        60%         0%
```

```
## 5          0%          0%         14%          0%
## 6          0%          0%          7%         27%
```

Converting the character values to numeric ones

```
#creating temporary DF with % value column
a<-BathSoapDF[20:46] %>% mutate_each(funs(as.numeric(gsub("%", "",., fixed = TRUE))/100))

## Warning: `funs()` is deprecated as of dplyr 0.8.0.
## Please use a list of either functions or lambdas:
##
##   # Simple named list:
##   list(mean = mean, median = median)
##
##   # Auto named with `tibble::lst()`:
##   tibble::lst(mean, median)
##
##   # Using lambdas
##   list(~ mean(., trim = .2), ~ median(., na.rm = TRUE))
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_warnings()` to see where this warning was generated.

## Warning: `mutate_each_()` is deprecated as of dplyr 0.7.0.
## Please use `across()` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_warnings()` to see where this warning was generated.

#Adding column of numeric values to the
BathSoapDF<-cbind(BathSoapDF[1:19], a)

#validating data conversion
str(BathSoapDF)

## 'data.frame':    600 obs. of  46 variables:
##  $ Member.id            : int  1010010 1010020 1014020 1014030 1014190 1017020 1017110
1017160 1017360 1017460 ...
##  $ SEC                  : int  4 3 2 4 4 4 4 4 4 1 ...
##  $ FEH                  : int  3 2 3 0 1 3 2 3 3 3 ...
##  $ MT                   : int  10 10 10 0 10 10 10 10 10 5 ...
##  $ SEX                  : int  1 2 2 0 2 2 2 2 2 1 ...
##  $ AGE                  : int  4 2 4 4 3 3 4 2 4 4 ...
##  $ EDU                  : int  4 4 5 0 4 4 1 4 4 7 ...
##  $ HS                   : int  2 4 6 0 4 5 3 5 6 3 ...
##  $ CHILD                : int  4 2 4 5 3 2 2 3 4 4 ...
##  $ CS                   : int  1 1 1 0 1 1 1 0 1 1 ...
##  $ Affluence.Index      : int  2 19 23 0 10 13 11 0 17 6 ...
##  $ No..of.Brands        : int  3 5 5 2 3 3 4 3 2 4 ...
##  $ Brand.Runs           : int  17 25 37 4 6 26 17 8 12 13 ...
##  $ Total.Volume         : int  8025 13975 23100 1500 8300 18175 9950 9300 26490 7455
...
##  $ No..of..Trans        : int  24 40 63 4 13 41 26 25 27 18 ...
##  $ Value                : num  818 1682 1950 114 591 ...
##  $ Trans...Brand.Runs   : num  1.41 1.6 1.7 1 2.17 1.58 1.53 3.13 2.25 1.38 ...
##  $ Vol.Tran             : num  334 349 367 375 638 ...
##  $ Avg..Price           : num  10.19 12.03 8.44 7.6 7.12 ...
##  $ Pur.Vol.No.Promo.... : num  1 0.89 0.94 1 0.61 1 0.98 0.94 0.9 1 ...
##  $ Pur.Vol.Promo.6..    : num  0 0.1 0.02 0 0.14 0 0.02 0 0.1 0 ...
```

```
##  $ Pur.Vol.Other.Promo..: num  0 0.02 0.04 0 0.24 0 0 0.06 0 0 ...
##  $ Br..Cd..57..144      : num  0.38 0.02 0.03 0.4 0.05 0.08 0.45 0.04 0.39 0.07 ...
##  $ Br..Cd..55           : num  0.13 0.08 0.55 0.6 0.14 0.07 0.05 0.79 0 0.12 ...
##  $ Br..Cd..272          : num  0 0 0 0 0 0 0.01 0 0 0 ...
##  $ Br..Cd..286          : num  0 0 0.03 0 0 0 0 0 0 0 ...
##  $ Br..Cd..24           : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Br..Cd..481          : num  0 0.06 0 0 0 0 0 0 0 0 ...
##  $ Br..Cd..352          : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Br..Cd..5            : num  0 0.14 0.02 0 0 0 0 0 0 0.4 ...
##  $ Others.999           : num  0.492 0.699 0.379 0 0.807 0.857 0.495 0.167 0.615 0.41
...
##  $ Pr.Cat.1             : num  0.23 0.29 0.12 0 0 0.22 0.07 0.04 0.11 0.61 ...
##  $ Pr.Cat.2             : num  0.56 0.55 0.32 0.4 0.05 0.45 0.66 0.04 0.89 0.1 ...
##  $ Pr.Cat.3             : num  0.13 0.09 0.56 0.6 0.14 0.07 0.05 0.9 0 0.12 ...
##  $ Pr.Cat.4             : num  0.07 0.06 0 0 0.81 0.27 0.23 0.02 0 0.17 ...
##  $ PropCat.5            : num  0.5 0.46 0.24 0.4 0.81 0.49 0.82 0.06 0.7 0.24 ...
##  $ PropCat.6            : num  0 0.35 0.12 0 0 0.1 0 0 0.28 0.46 ...
##  $ PropCat.7            : num  0 0.03 0.03 0 0 0 0.02 0 0 0.15 ...
##  $ PropCat.8            : num  0 0.02 0.01 0 0.05 0.01 0.01 0 0 0 ...
##  $ PropCat.9            : num  0 0.01 0.01 0 0 0.07 0 0 0.02 0 ...
##  $ PropCat.10           : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ PropCat.11           : num  0 0.06 0 0 0 0 0 0 0 0 ...
##  $ PropCat.12           : num  0.03 0 0.02 0 0 0 0 0.01 0 0 ...
##  $ PropCat.13           : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ PropCat.14           : num  0.13 0.08 0.56 0.6 0.14 0.07 0.05 0.9 0 0.12 ...
##  $ PropCat.15           : num  0.34 0 0 0 0 0.27 0.1 0.03 0 0.03 ...
```

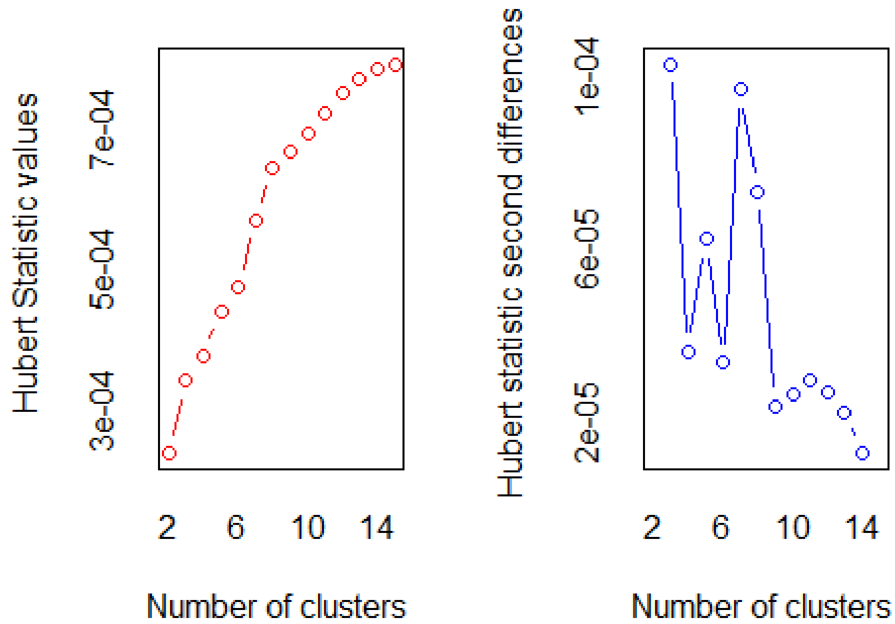
```
head(BathSoapDF)
```

```
##   Member.id SEC FEH MT SEX AGE EDU HS CHILD CS Affluence.Index No..of.Brands
## 1   1010010   4   3 10   1   4   4  2     4  1               2             3
## 2   1010020   3   2 10   2   2   4  4     2  1              19             5
## 3   1014020   2   3 10   2   4   5  6     4  1              23             5
## 4   1014030   4   0  0   0   4   0  0     5  0               0             2
## 5   1014190   4   1 10   2   3   4  4     3  1              10             3
## 6   1017020   4   3 10   2   3   4  5     2  1              13             3
##   Brand.Runs Total.Volume No..of..Trans  Value Trans...Brand.Runs Vol.Tran
## 1         17         8025            24  818.0               1.41   334.38
## 2         25        13975            40 1681.5               1.60   349.38
## 3         37        23100            63 1950.0               1.70   366.67
## 4          4         1500             4  114.0               1.00   375.00
## 5          6         8300            13  591.0               2.17   638.46
## 6         26        18175            41 1705.5               1.58   443.29
##   Avg..Price Pur.Vol.No.Promo.... Pur.Vol.Promo.6.. Pur.Vol.Other.Promo..
## 1      10.19                 1.00              0.00                  0.00
## 2      12.03                 0.89              0.10                  0.02
## 3       8.44                 0.94              0.02                  0.04
## 4       7.60                 1.00              0.00                  0.00
## 5       7.12                 0.61              0.14                  0.24
## 6       9.38                 1.00              0.00                  0.00
##   Br..Cd..57..144 Br..Cd..55 Br..Cd..272 Br..Cd..286 Br..Cd..24 Br..Cd..481
## 1            0.38       0.13           0        0.00          0        0.00
## 2            0.02       0.08           0        0.00          0        0.06
## 3            0.03       0.55           0        0.03          0        0.00
## 4            0.40       0.60           0        0.00          0        0.00
## 5            0.05       0.14           0        0.00          0        0.00
```

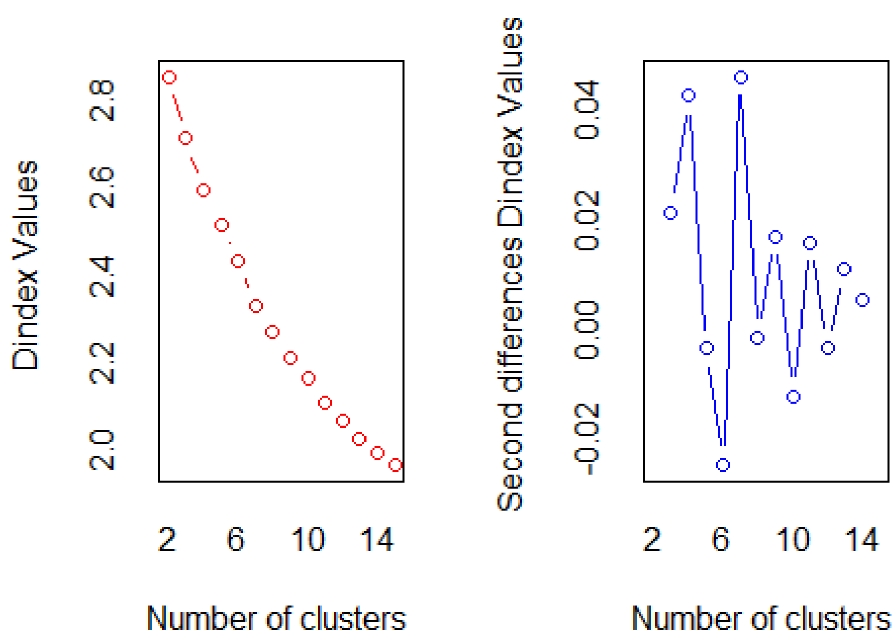
```
## 6            0.08       0.07           0        0.00          0        0.00
##   Br..Cd..352 Br..Cd..5 Others.999 Pr.Cat.1 Pr.Cat.2 Pr.Cat.3 Pr.Cat.4
## 1           0      0.00      0.492     0.23     0.56     0.13     0.07
## 2           0      0.14      0.699     0.29     0.55     0.09     0.06
## 3           0      0.02      0.379     0.12     0.32     0.56     0.00
## 4           0      0.00      0.000     0.00     0.40     0.60     0.00
## 5           0      0.00      0.807     0.00     0.05     0.14     0.81
## 6           0      0.00      0.857     0.22     0.45     0.07     0.27
##   PropCat.5 PropCat.6 PropCat.7 PropCat.8 PropCat.9 PropCat.10 PropCat.11
## 1      0.50      0.00      0.00      0.00      0.00          0       0.00
## 2      0.46      0.35      0.03      0.02      0.01          0       0.06
## 3      0.24      0.12      0.03      0.01      0.01          0       0.00
## 4      0.40      0.00      0.00      0.00      0.00          0       0.00
## 5      0.81      0.00      0.00      0.05      0.00          0       0.00
## 6      0.49      0.10      0.00      0.01      0.07          0       0.00
##   PropCat.12 PropCat.13 PropCat.14 PropCat.15
## 1       0.03          0       0.13       0.34
## 2       0.00          0       0.08       0.00
## 3       0.02          0       0.56       0.00
## 4       0.00          0       0.60       0.00
## 5       0.00          0       0.14       0.00
## 6       0.00          0       0.07       0.27
```

Kmeans clustering

```
#The variables that describe purchase behavior (including brand loyalty)
BrandLoyality<-
select(BathSoapDF,"Br..Cd..57..144","Br..Cd..55","Br..Cd..272","Br..Cd..286","Br..Cd..24"
,"Br..Cd..481","Br..Cd..352","Br..Cd..5")
BathSoapDF$Loyality <- apply(BrandLoyality,MARGIN = 1,FUN = max)
BathSoapDF$LoyalBrand_1_8 <- max.col(BrandLoyality)
Brand_Other <- select(BathSoapDF,"Loyality","Others.999")
BathSoapDF$Brand_1_Other_2_Loyal <- max.col(Brand_Other)

#1.Use k-means clustering to identify clusters of households based on:
# a.The variables that describe purchase behavior (including brand loyalty)
#Purchase behavior (volume, frequency, susceptibility to discounts, and brand loyalty)

BSa <-
select(BathSoapDF,"No..of.Brands","Brand.Runs","Total.Volume","No..of..Trans","Value",
              "Trans...Brand.Runs","Avg..Price",

"Pur.Vol.No.Promo....","Pur.Vol.Promo.6..","Pur.Vol.Other.Promo..","Brand_1_Other_2_Loyal
","LoyalBrand_1_8")

#scaling the data set
BSaScale <- scale(BSa)

# Finding the Best Number Of Clusters Comparing with Most of the methods
NbClust(data = BSaScale,distance = "euclidean",min.nc = 2, max.nc = 15, method =
"kmeans")
```



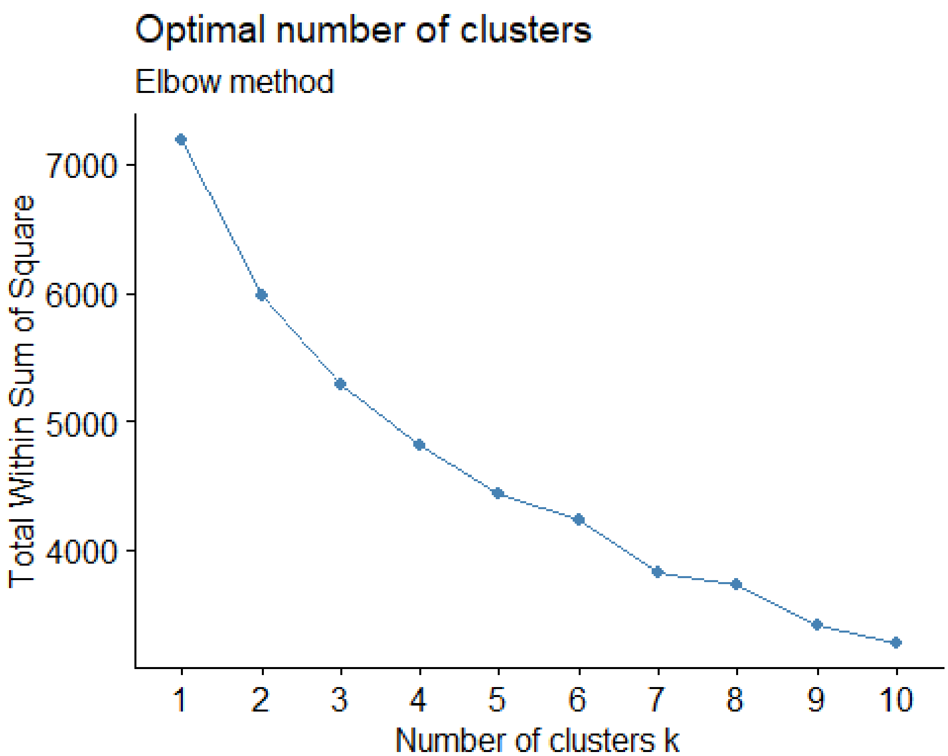

```
## *** : The Hubert index is a graphical method of determining the number of clusters.
##                In the plot of Hubert index, we seek a significant knee that
corresponds to a
##                significant increase of the value of the measure i.e the significant
peak in Hubert
##                index second differences plot.
##
```



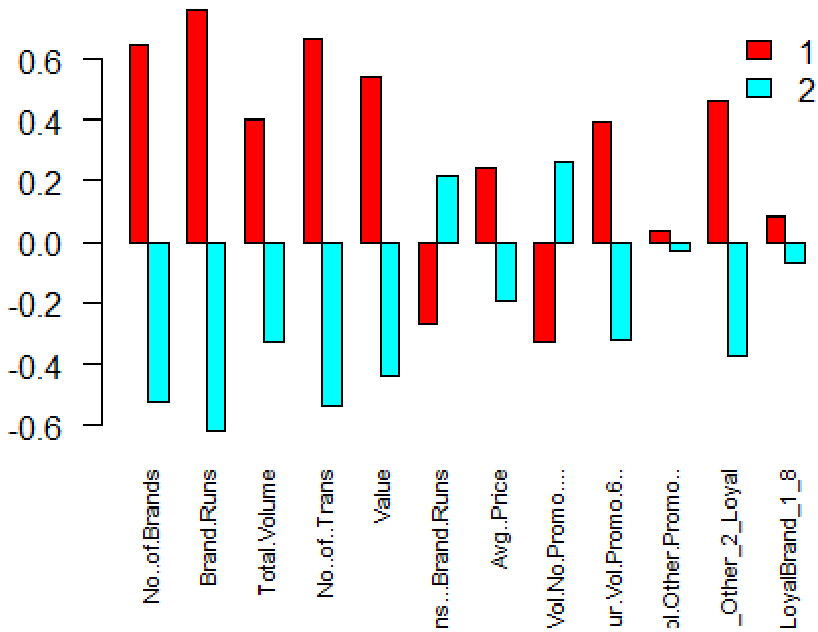
```
## *** : The D index is a graphical method of determining the number of clusters.
##                 In the plot of D index, we seek a significant knee (the significant
peak in Dindex
##                 second differences plot) that corresponds to a significant increase of
the value of
##                 the measure.
##
## *******************************************************************
## * Among all indices:
## * 5 proposed 2 as the best number of clusters
## * 5 proposed 3 as the best number of clusters
## * 1 proposed 4 as the best number of clusters
## * 1 proposed 6 as the best number of clusters
## * 3 proposed 7 as the best number of clusters
## * 1 proposed 9 as the best number of clusters
## * 1 proposed 10 as the best number of clusters
## * 5 proposed 14 as the best number of clusters
## * 1 proposed 15 as the best number of clusters
##
##                    ***** Conclusion *****
##
## * According to the majority rule, the best number of clusters is  2
##
##
## *******************************************************************

## $All.index
##        KL       CH Hartigan     CCC    Scott      Marriot    TrCovW   TraceW
## 2  1.3245 121.6933  78.6948 -4.9109  629.945 6.643862e+27 412380.92 5972.578
## 3  1.4398 108.0203  55.4463 -6.8143 1148.336 6.300557e+27 294451.52 5278.010
## 4  1.2230  97.0211  44.4244 -7.1779 1515.290 6.076402e+27 224896.07 4829.473
## 5  1.7472  89.1459  31.0086 -6.4935 1914.282 4.882769e+27 192260.27 4494.466
## 6  0.3197  81.0986  57.4932 -6.4605 2491.526 2.686618e+27 181217.54 4271.838
## 7  1.4986  83.5647  42.5980 -1.1425 3207.911 1.108058e+27 154812.99 3894.856
## 8  1.0320  82.7179  41.3446  2.5855 3270.846 1.303145e+27 133955.69 3633.821
## 9  1.5613  82.4615  29.9749  6.7576 3590.680 9.678197e+26 112685.74 3396.606
## 10 1.2645  80.2114  25.2248  6.9942 3966.501 6.386759e+26 100733.77 3232.649
## 11 1.5472  77.6672  18.9463  8.7804 4231.248 4.970907e+26  95564.06 3100.108
## 12 0.5722  74.4735  26.4804  9.5960 4393.121 4.516953e+26  88472.59 3003.495
## 13 1.5015  73.4234  19.9002 11.8635 4652.514 3.440446e+26  79521.40 2874.062
## 14 2.6844  71.4819  11.4981 13.0854 4842.020 2.909476e+26  73969.14 2779.822
## 15 0.8947  68.3829  11.6376 12.9766 4978.479 2.660538e+26  71439.89 2726.328
##     Friedman  Rubin Cindex     DB Silhouette   Duda  Pseudot2   Beale Ratkowsky
## 2   280.8452 1.2035 0.2065 2.2140     0.1746 1.1228  -41.5750 -0.8907    0.2558
## 3  1620.7853 1.3619 0.2201 1.8938     0.1796 1.0782  -25.8818 -0.5900    0.2723
## 4  1624.8484 1.4884 0.2080 1.9148     0.1467 1.2475  -52.1792 -1.6132    0.2737
## 5  1638.6195 1.5993 0.1991 1.8538     0.1422 0.7927   46.5528  2.1259    0.2608
## 6  1631.1230 1.6826 0.1937 1.8033     0.1392 1.8671 -129.1055 -3.7676    0.2548
## 7  1641.8136 1.8455 0.1787 1.6898     0.1544 2.1572  -86.9041 -4.3497    0.2502
## 8  2048.1705 1.9781 0.2193 1.5967     0.1511 1.2564  -33.8741 -1.6551    0.2466
## 9  2053.9962 2.1162 0.2106 1.5611     0.1611 1.6296  -56.7947 -3.1199    0.2397
## 10 2049.2589 2.2236 0.2119 1.4885     0.1683 1.3734  -40.2373 -2.1939    0.2340
## 11 2023.2354 2.3186 0.2078 1.5303     0.1568 1.4987  -46.9214 -2.6897    0.2270
## 12 2036.1861 2.3932 0.2064 1.5591     0.1470 1.7624  -43.6911 -3.4918    0.2198
## 13 2260.5658 2.5010 0.2018 1.5183     0.1508 1.2883  -24.3929 -1.8073    0.2143
## 14 2271.9805 2.5858 0.1974 1.4873     0.1547 1.7073  -55.5135 -3.3427    0.2087
```

```
## 15 2457.6753 2.6365 0.1959 1.5051     0.1477 1.4138  -26.0510 -2.3523    0.2028
##         Ball Ptbiserial    Frey McClain   Dunn Hubert SDindex Dindex   SDbw
## 2  2986.2889     0.2452 -0.1731  0.8004 0.0370  2e-04  1.7279 2.8561 0.9338
## 3  1759.3366     0.3357  0.6283  1.1013 0.0428  3e-04  1.7394 2.7148 1.0791
## 4  1207.3683     0.3284  0.0232  1.7667 0.0285  4e-04  1.8106 2.5949 1.0257
## 5   898.8932     0.3508  1.0079  1.9687 0.0316  4e-04  1.7972 2.5176 1.0050
## 6   711.9730     0.3202 -0.1460  2.7340 0.0428  5e-04  1.8088 2.4369 0.9427
## 7   556.4080     0.3721  0.3222  2.7058 0.0227  6e-04  1.8445 2.3315 0.9061
## 8   454.2276     0.3667  0.0529  3.0682 0.0556  6e-04  1.8726 2.2721 0.9648
## 9   377.4007     0.3762  0.1878  3.2353 0.0556  7e-04  1.7937 2.2112 0.9161
## 10  323.2650     0.3756  0.7317  3.4636 0.0575  7e-04  1.7705 2.1674 0.8440
## 11  281.8280     0.3554  2.4689  4.0600 0.0560  7e-04  1.8375 2.1115 0.7970
## 12  250.2912     0.3247  0.0779  4.9774 0.0560  8e-04  1.8708 2.0715 0.7570
## 13  221.0817     0.3262  0.1674  5.1436 0.0560  8e-04  1.7150 2.0282 0.7080
## 14  198.5587     0.3234  0.8617  5.4489 0.0338  8e-04  1.7142 1.9957 0.6969
## 15  181.7552     0.3114 -1.3717  5.9696 0.0537  8e-04  1.8484 1.9688 0.6773
##
## $All.CriticalValues
##    CritValue_Duda CritValue_PseudoT2 Fvalue_Beale
## 2          0.8776            52.9942       1.0000
## 3          0.8745            51.2440       1.0000
## 4          0.8650            41.0445       1.0000
## 5          0.8619            28.5210       0.0129
## 6          0.8456            50.7520       1.0000
## 7          0.8415            30.5234       1.0000
## 8          0.8436            30.7752       1.0000
## 9          0.8147            33.4329       1.0000
## 10         0.8109            34.5094       1.0000
## 11         0.8202            30.9171       1.0000
## 12         0.8125            23.3120       1.0000
## 13         0.8154            24.6722       1.0000
## 14         0.8101            31.4077       1.0000
## 15         0.7893            23.7638       1.0000
##
## $Best.nc
##                      KL       CH Hartigan     CCC    Scott      Marriot
## Number_clusters 14.0000   2.0000   6.0000 14.0000   7.0000 7.000000e+00
## Value_Index      2.6844 121.6933  26.4846 13.0854 716.3854 1.773647e+27
##                    TrCovW   TraceW Friedman   Rubin Cindex      DB Silhouette
## Number_clusters       3.0   3.0000     3.00 14.0000 7.0000 14.0000     3.0000
## Value_Index      117929.4 246.0316  1339.94 -0.0341 0.1787  1.4873     0.1796
##                    Duda PseudoT2   Beale Ratkowsky     Ball PtBiserial Frey
## Number_clusters 2.0000    2.000  2.0000    4.0000    3.000     9.0000    1
## Value_Index     1.1228  -41.575 -0.8907    0.2737 1226.952     0.3762   NA
##                 McClain    Dunn Hubert SDindex Dindex    SDbw
## Number_clusters  2.0000 10.0000      0 14.0000      0 15.0000
## Value_Index      0.8004  0.0575      0  1.7142      0  0.6773
##
## $Best.partition
##   [1] 1 2 2 1 1 2 1 1 2 1 2 2 1 1 1 2 2 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 2 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 2 1 1 2 2 1 1 2 2 1 1 2 1 2 2 1 1 1 2 1 1
##  [75] 1 1 1 1 2 1 1 2 1 2 1 2 2 2 1 1 2 2 1 2 2 2 1 2 1 1 1 1 2 2 1 2 2 1 2 2 1
## [112] 1 1 2 2 2 2 1 2 2 2 2 1 2 2 1 2 1 1 2 2 2 1 2 1 2 1 2 1 1 1 1 1 1 2 1 1 2
## [149] 2 1 1 1 1 1 2 2 2 1 1 2 1 1 2 2 1 1 2 1 2 1 2 2 1 1 2 1 1 1 1 1 1 2 2 2 2
## [186] 1 2 2 1 2 1 2 1 1 1 2 2 2 2 1 1 1 2 1 1 1 1 2 1 2 1 1 2 1 2 1 1 2 1 2 1 2
```

```
## [223] 1 1 2 1 1 2 2 1 1 2 1 1 1 1 2 1 1 1 2 2 1 1 1 1 1 1 1 1 1 2 1 2 1 1 1 2 2
## [260] 2 1 1 2 1 2 1 1 1 2 2 2 2 1 2 1 1 2 2 1 1 2 1 2 2 2 2 2 1 2 2 2 1 1 1 1 1
## [297] 1 2 2 2 1 1 1 2 2 1 2 1 1 1 2 2 2 2 2 2 1 1 2 1 2 2 2 2 1 1 2 1 1 1 2 1 2
## [334] 2 1 2 2 2 1 1 1 1 1 1 2 2 2 1 2 2 1 1 2 1 2 2 2 2 2 2 1 1 2 2 2 2 2 2 2 1
## [371] 1 1 1 1 1 1 1 1 2 2 1 1 2 2 2 1 1 2 2 2 2 2 1 1 2 1 2 1 1 1 1 2 1 2 1 1 1
## [408] 1 2 2 1 1 2 1 1 2 2 1 1 1 2 1 1 1 1 2 2 1 2 1 2 1 1 1 1 1 2 2 1 1 1 1 2 2
## [445] 1 1 1 2 1 1 1 1 1 1 1 2 1 2 2 2 2 2 2 1 2 2 2 1 1 2 2 1 2 2 2 2 2 2 1 2 1
## [482] 2 2 1 1 1 2 2 2 2 1 2 1 1 2 2 1 2 2 2 1 2 1 1 1 1 1 1 2 2 1 1 1 2 2 1 1 2
## [519] 1 2 1 1 1 2 1 1 2 1 2 1 2 1 2 1 2 1 1 1 1 1 2 2 2 2 2 1 1 1 2 2 1 1 1 2 2
## [556] 1 1 2 2 1 2 1 2 2 2 2 2 2 1 2 1 2 1 2 2 1 2 1 1 2 2 1 2 2 1 2 2 2 1 2 1 1
## [593] 1 1 1 1 2 2 1 1

# According to the majority rule, the best number of clusters is  2

# Elbow method Approches

fviz_nbclust(BSaScale, kmeans, method = "wss")+labs(subtitle = "Elbow method")
```

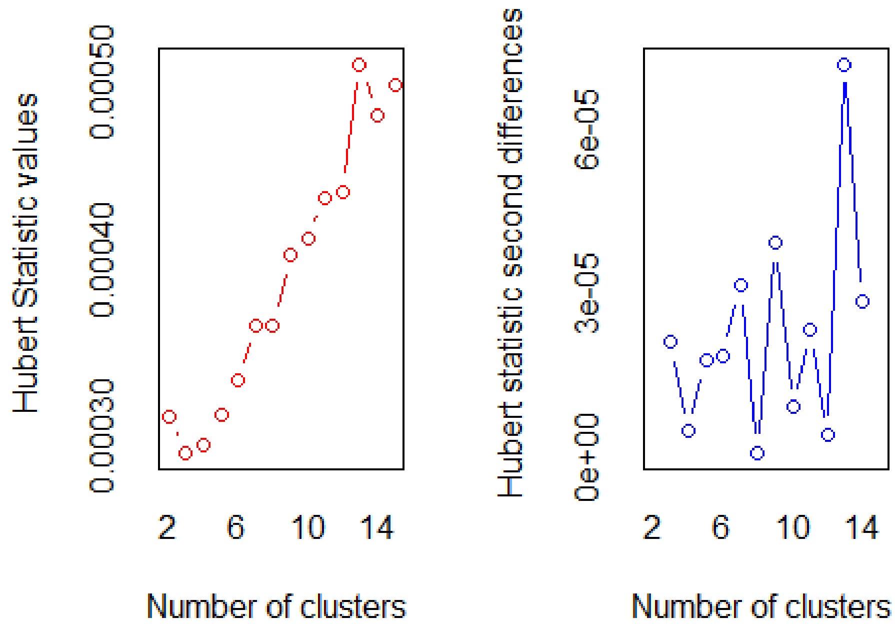



```
BSaK <- kmeans(BSaScale,centers = 2,nstart = 25)

library(cluster)
BSaK$size

## [1] 269 331

barplot(BSaK$centers,beside = TRUE,col = rainbow(2),cex.names = .7,las=2,
        args.legend = list(x ='topright', bty='n'),legend.text = (1:nrow(BSaK$centers)))
```

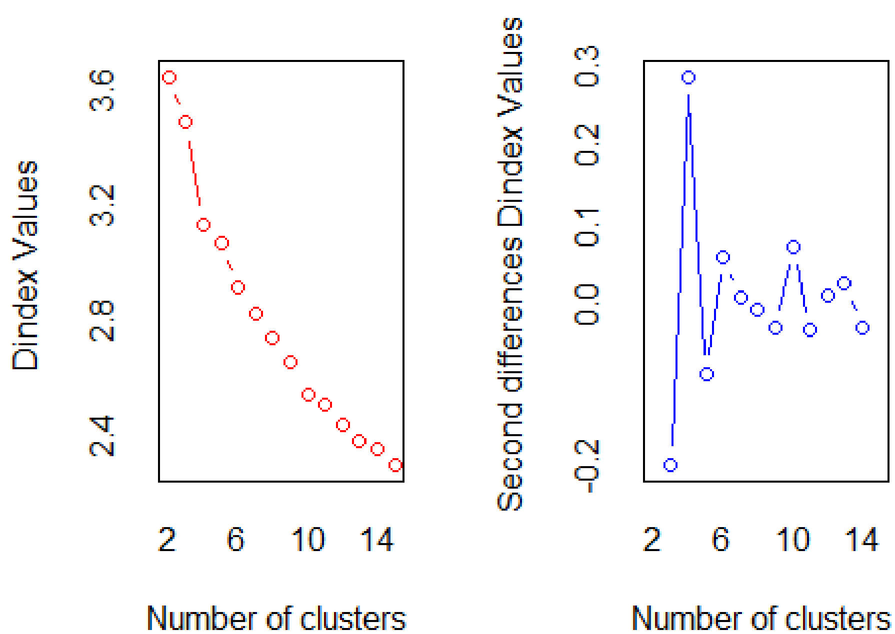


#b.The variables that describe the basis for purchase

```
#Basis of purchase (price, selling proposition)
BSb <- select(BathSoapDF,"Pr.Cat.1","Pr.Cat.2","Pr.Cat.3","Pr.Cat.4",
              "PropCat.5","PropCat.6","PropCat.7","PropCat.8","PropCat.9","PropCat.10",
              "PropCat.11","PropCat.12","PropCat.13","PropCat.14","PropCat.15",
              "Pur.Vol.No.Promo....","Pur.Vol.Promo.6..","Pur.Vol.Other.Promo..")
#BSb
#Scaling the Data
BSbScale <- scale(BSb)

# Finding the Best Number Of Clusters Comparing with Most of the methods
NbClust(data = BSbScale,distance = "euclidean",min.nc = 2, max.nc = 15, method =
"kmeans")
```



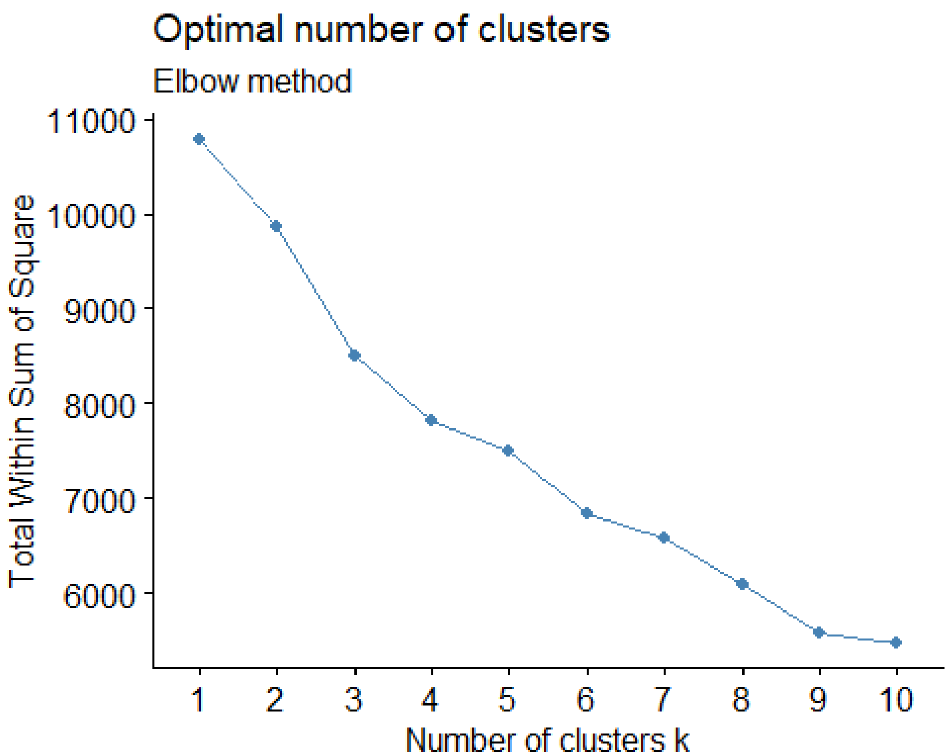

```
## *** : The Hubert index is a graphical method of determining the number of clusters.
##                In the plot of Hubert index, we seek a significant knee that
corresponds to a
##                significant increase of the value of the measure i.e the significant
peak in Hubert
##                index second differences plot.
##
```



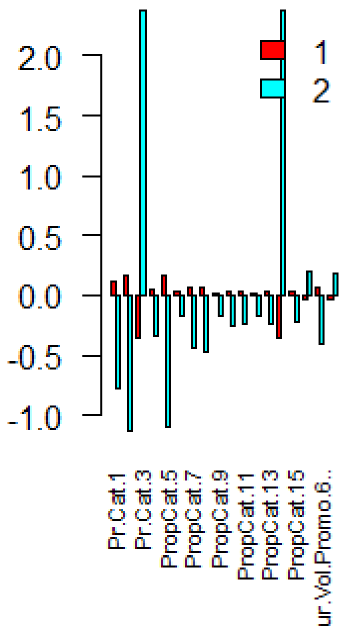
```
## *** : The D index is a graphical method of determining the number of clusters.
##                In the plot of D index, we seek a significant knee (the significant
peak in Dindex
##                second differences plot) that corresponds to a significant increase of
the value of
##                the measure.
##
## *******************************************************************
## * Among all indices:
## * 4 proposed 2 as the best number of clusters
## * 1 proposed 3 as the best number of clusters
## * 6 proposed 4 as the best number of clusters
## * 2 proposed 6 as the best number of clusters
## * 2 proposed 10 as the best number of clusters
## * 1 proposed 11 as the best number of clusters
## * 1 proposed 12 as the best number of clusters
## * 6 proposed 13 as the best number of clusters
##
##                   ***** Conclusion *****
##
## * According to the majority rule, the best number of clusters is  4
##
##
## *******************************************************************

## $All.index
##        KL      CH Hartigan     CCC     Scott      Marriot    TrCovW   TraceW
## 2  0.2965 55.3667  53.0274 -8.7999  630.7445 6.819258e+36 498313.33 9868.326
## 3  0.3665 56.5571  96.4249 -7.3074 1444.3222 3.953962e+36 426083.94 9064.533
## 4  5.4313 75.8091  29.3513  6.4321 2496.7547 1.216561e+36 285242.24 7804.056
## 5  0.3407 66.8823  57.2734  6.7894 3031.0413 7.802331e+35 263711.62 7437.767
## 6  1.7304 69.9930  37.3615 16.3637 4108.1212 1.866253e+35 227184.96 6784.687
## 7  0.9979 68.1083  37.1870 22.2624 4711.4427 9.293202e+34 206321.54 6383.196
## 8  0.9898 67.2383  37.7379 28.8713 5407.1454 3.807000e+34 190510.06 6006.527
## 9  0.7410 67.1875  50.1464 36.2256 5781.3992 2.582224e+34 166934.28 5646.578
## 10 1.8443 70.2424  30.5843 47.5442 6508.4173 9.490208e+33 145329.22 5204.938
## 11 0.6974 69.4358  42.6349 54.0049 6784.7676 7.244894e+33 127861.81 4948.423
## 12 0.7734 71.4470  57.0200 64.3995 7383.9834 3.176013e+33 112623.18 4614.408
## 13 2.1071 76.4656 -18.6824 79.3419 8219.6312 9.258582e+32  96147.72 4206.493
## 14 0.9888 66.7861  29.2534 70.8544 7902.0137 1.823111e+33  99237.05 4344.774
## 15 0.4141 67.0863  70.5464 75.8040 8270.3814 1.132677e+33  90552.36 4138.194
##     Friedman  Rubin Cindex     DB Silhouette   Duda  Pseudot2   Beale Ratkowsky
## 2   2456.081 1.0926 0.2323 3.0147     0.1862 1.2784  -48.5655 -2.7012    0.1548
## 3   7853.092 1.1895 0.2187 2.5493     0.1668 2.2587 -249.0964 -6.9058    0.1932
## 4  16346.042 1.3816 0.2028 2.1424     0.2099 1.2667  -32.4246 -2.6078    0.2220
## 5  16805.180 1.4496 0.1904 2.1674     0.2091 0.3630  112.3142 21.5141    0.2210
## 6  19921.901 1.5892 0.1876 1.7951     0.2176 3.4768 -101.8698 -8.7825    0.2197
## 7  19958.433 1.6891 0.1713 1.8083     0.2220 1.7821  -52.6632 -5.4114    0.2210
## 8  20336.638 1.7950 0.1687 1.7009     0.2277 3.2584 -187.1376 -8.5434    0.2175
## 9  19974.427 1.9095 0.1543 1.6657     0.2289 3.3396  -37.8302 -8.1671    0.2206
## 10 20613.236 2.0715 0.1460 1.5888     0.2526 1.3959  -32.6185 -3.4943    0.2188
## 11 20459.026 2.1789 0.1796 1.5148     0.2579 2.5327  -74.4358 -7.4494    0.2166
## 12 19961.773 2.3366 0.1782 1.4621     0.2693 2.6224  -78.5708 -7.5845    0.2141
## 13 21055.662 2.5632 0.1728 1.3697     0.2693 3.4932  -87.0747 -8.7401    0.2145
## 14 22411.438 2.4816 0.1717 1.5334     0.2624 0.4892  111.7206 12.8606    0.2025
## 15 22803.090 2.6055 0.1635 1.4668     0.2639 3.4462  -31.9421 -8.6388    0.1998
```

```
##         Ball Ptbiserial    Frey McClain   Dunn Hubert SDindex Dindex   SDbw
## 2  4934.1631     0.2995  0.6969  0.4476 0.0450  3e-04  1.4709 3.6496 1.4504
## 3  3021.5111     0.3296  0.0442  0.8819 0.0371  3e-04  1.3549 3.4931 1.3563
## 4  1951.0140     0.3883  0.2435  1.1886 0.0369  3e-04  1.2596 3.1377 1.1492
## 5  1487.5534     0.4096 -0.4025  1.5299 0.0369  3e-04  1.3437 3.0689 1.3291
## 6  1130.7812     0.4263  0.2423  1.5059 0.0369  3e-04  1.1851 2.9157 1.0926
## 7   911.8851     0.4416  0.4476  1.9811 0.0369  4e-04  1.2221 2.8244 1.1749
## 8   750.8159     0.4381  0.2235  2.1147 0.0351  4e-04  1.1904 2.7428 1.1384
## 9   627.3975     0.4410  0.0309  2.6121 0.0351  4e-04  1.2842 2.6574 1.2643
## 10  520.4938     0.4557 -0.0430  2.7055 0.0334  4e-04  1.1620 2.5444 1.1114
## 11  449.8566     0.4677  0.2074  2.7018 0.0425  4e-04  1.2899 2.5062 1.1844
## 12  384.5340     0.4669  0.1846  2.8027 0.0452  4e-04  1.2130 2.4376 1.1144
## 13  323.5764     0.4662  1.9080  2.9286 0.0452  5e-04  1.5073 2.3817 1.2505
## 14  310.3410     0.4486  0.0722  3.2062 0.0452  5e-04  1.3388 2.3544 1.1693
## 15  275.8796     0.4543  3.2220  3.2966 0.0431  5e-04  1.3324 2.2993 1.1798
##
## $All.CriticalValues
##    CritValue_Duda CritValue_PseudoT2 Fvalue_Beale
## 2          0.8778            31.0535            1
## 3          0.8725            65.3217            1
## 4          0.8695            23.1180            1
## 5          0.8241            13.6625            0
## 6          0.8466            25.9096            1
## 7          0.8474            21.6170            1
## 8          0.8458            49.2083            1
## 9          0.7040            22.7003            1
## 10         0.8435            21.3433            1
## 11         0.8400            23.4208            1
## 12         0.8241            27.1115            1
## 13         0.8201            26.7658            1
## 14         0.8426            19.9831            0
## 15         0.7998            11.2628            1
##
## $Best.nc
##                      KL      CH Hartigan     CCC   Scott      Marriot   TrCovW
## Number_clusters 4.0000 13.0000  13.0000 13.0000    6.00 4.000000e+00      4.0
## Value_Index     5.4313 76.4656  75.7024 79.3419 1077.08 2.301073e+36 140841.7
##                   TraceW Friedman   Rubin Cindex      DB Silhouette   Duda
## Number_clusters   4.0000     4.00 13.0000 10.000 13.0000    13.0000 2.0000
## Value_Index     894.1887  8492.95 -0.3082  0.146  1.3697     0.2693 1.2784
##                 PseudoT2   Beale Ratkowsky     Ball PtBiserial Frey McClain
## Number_clusters   2.0000  2.0000     4.000    3.000    11.0000    1  2.0000
## Value_Index     -48.5655 -2.7012     0.222 1912.652     0.4677   NA  0.4476
##                    Dunn Hubert SDindex Dindex   SDbw
## Number_clusters 12.0000      0  10.000      0 6.0000
## Value_Index      0.0452      0   1.162      0 1.0926
##
## $Best.partition
##   [1] 4 4 2 2 3 4 4 2 4 1 3 4 4 4 4 4 4 4 4 3 2 2 2 2 2 1 4 4 4 2 2 4 2 2 2 4 4
##  [38] 4 2 2 4 2 2 2 4 4 4 4 4 2 1 2 4 2 3 2 4 2 4 2 4 4 2 2 4 4 2 2 4 4 4 4 4 2 4
##  [75] 4 1 4 2 4 4 4 2 2 1 3 4 3 4 1 2 1 4 2 1 4 4 2 4 2 4 4 4 4 3 4 4 1 4 4 3 2
## [112] 4 4 3 3 1 4 2 4 4 3 1 4 1 4 2 4 4 4 1 4 4 1 4 2 1 4 4 4 3 4 2 4 2 1 2 2 3
## [149] 4 3 4 4 2 2 4 1 1 2 4 2 2 2 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 2 2 4 4 4 4 3 4
## [186] 4 4 4 4 3 4 1 4 4 4 4 4 4 1 4 4 4 4 4 2 4 4 4 2 4 4 3 3 4 4 1 4 3 2 1 4 4
## [223] 2 1 4 4 4 4 1 3 2 4 2 4 2 2 2 2 2 1 4 4 3 4 2 4 2 1 1 4 4 3 4 4 4 4 4 3 4
```

```
## [260] 4 1 4 4 4 4 4 4 4 4 1 4 4 4 4 4 3 4 1 4 3 4 4 4 4 4 4 2 4 4 1 4 1 4 3 4 4
## [297] 2 4 4 1 4 4 3 4 1 4 4 4 3 1 1 3 4 1 4 4 4 4 4 1 2 3 4 4 4 2 4 2 4 4 4 4 4
## [334] 4 4 3 4 4 4 4 4 4 4 1 4 3 3 1 4 4 4 1 1 4 1 4 1 4 1 3 1 4 4 1 1 3 3 4 1 4
## [371] 4 1 4 4 2 1 4 1 4 4 1 1 3 1 4 1 4 4 4 4 1 1 1 1 3 1 1 3 1 4 4 1 4 1 3 1 1
## [408] 4 4 4 4 1 1 4 1 3 4 1 4 4 4 4 1 4 4 4 3 1 1 4 4 4 4 1 1 4 3 1 4 1 4 1 4 1
## [445] 1 4 4 4 4 4 1 4 4 4 4 4 4 1 3 1 3 3 3 1 3 2 4 4 1 1 3 1 1 4 4 4 4 3 1 1 1
## [482] 3 4 1 1 4 1 4 1 1 3 4 1 4 1 1 1 1 4 4 2 3 4 4 1 1 4 4 4 3 1 4 4 3 3 4 1 3
## [519] 1 4 4 3 4 4 4 4 4 4 4 4 3 2 4 4 4 4 2 4 4 4 4 3 4 1 3 4 4 4 4 1 4 4 1 4 4
## [556] 4 4 4 3 1 3 4 1 4 3 3 4 3 4 1 4 4 1 3 4 2 1 1 1 3 3 1 4 3 4 3 4 4 4 4 4 1
## [593] 3 4 4 3 1 4 3 4

# According to the majority rule, the best number of clusters is  2

# Traditional Approches
fviz_nbclust(BSbScale, kmeans, method = "wss")+labs(subtitle = "Elbow method")
```

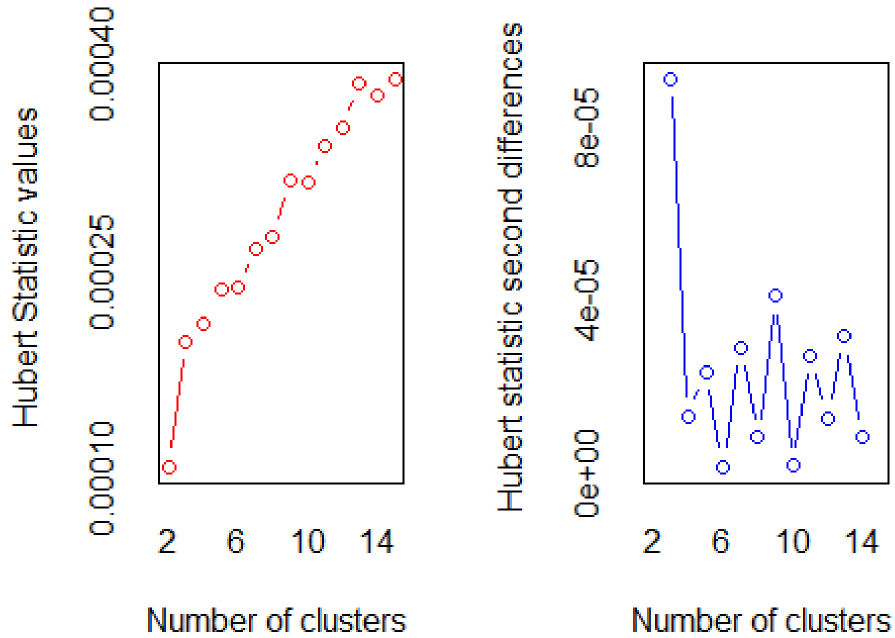



```
# 2,9 are the best cluster from 3 approches
BSbK <- kmeans(BSbScale,centers = 2,nstart = 25)


# Allow us to represent the cluster solution into 2 dimensions
#'2D-Representation of the Cluster solution - Purchase Behavior')
BSaK$size

## [1] 269 331

#dev.off()
barplot(BSbK$centers,beside = TRUE,col = rainbow(2),cex.names = .7,las=2,
        args.legend = list(x ='topright', bty='n'),legend.text = (1:nrow(BSbK$centers)))
```

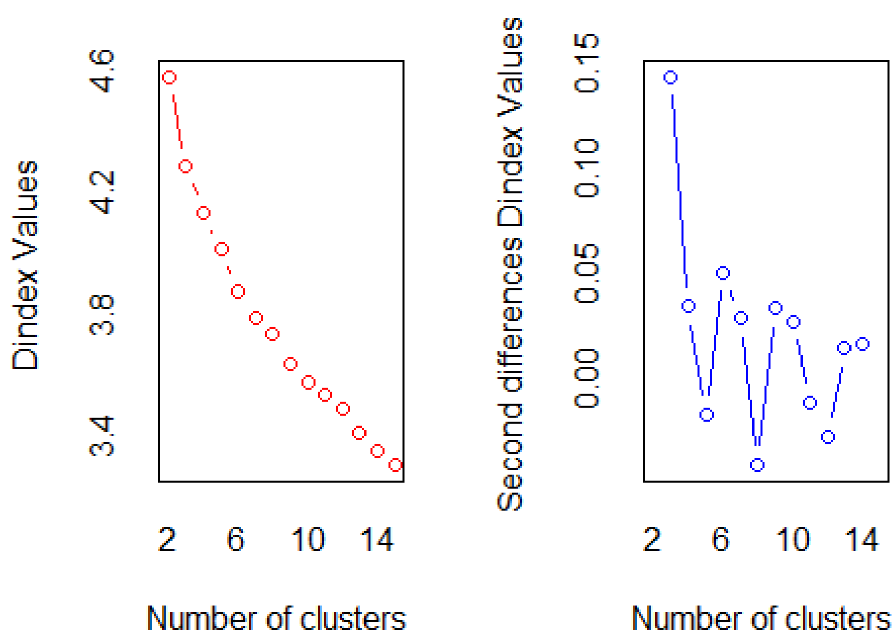


c.The variables that describe both purchase behavior and basis of purchase

```
BSc <-
select(BathSoapDF,"No..of.Brands","Brand.Runs","Total.Volume","No..of..Trans","Value",
              "Trans...Brand.Runs","Avg..Price",

"Pur.Vol.No.Promo....","Pur.Vol.Promo.6..","Pur.Vol.Other.Promo..","Brand_1_Other_2_Loyal
","LoyalBrand_1_8",
              "Pr.Cat.1","Pr.Cat.2","Pr.Cat.3","Pr.Cat.4",
              "PropCat.5","PropCat.6","PropCat.7","PropCat.8","PropCat.9","PropCat.10",
              "PropCat.11","PropCat.12","PropCat.13","PropCat.14","PropCat.15",
              "Pur.Vol.No.Promo....","Pur.Vol.Promo.6..","Pur.Vol.Other.Promo..")

#scaling the data set
BScScale <- scale(BSc)

NbClust(data = BScScale,distance = "euclidean",min.nc = 2, max.nc = 15, method =
"kmeans")
```



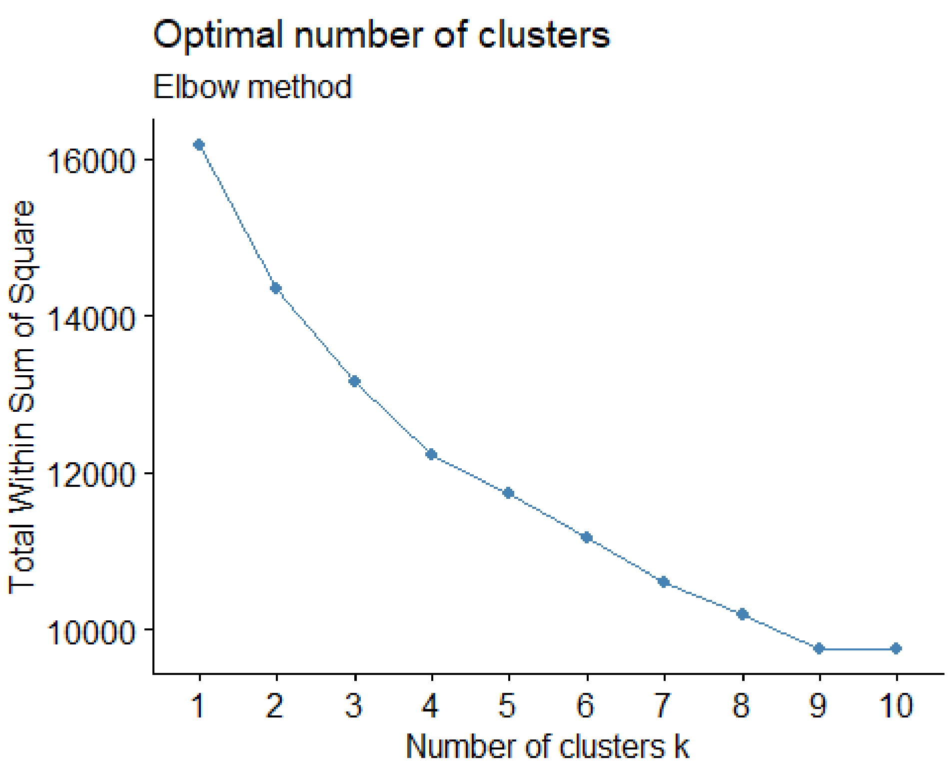

```
## *** : The Hubert index is a graphical method of determining the number of clusters.
##                 In the plot of Hubert index, we seek a significant knee that
corresponds to a
##                 significant increase of the value of the measure i.e the significant
peak in Hubert
##                 index second differences plot.
##
```



```
## *** : The D index is a graphical method of determining the number of clusters.
##                 In the plot of D index, we seek a significant knee (the significant
peak in Dindex
##                 second differences plot) that corresponds to a significant increase of
the value of
##                 the measure.
##
## *******************************************************************
## * Among all indices:
## * 4 proposed 2 as the best number of clusters
## * 7 proposed 3 as the best number of clusters
## * 1 proposed 4 as the best number of clusters
## * 1 proposed 11 as the best number of clusters
## * 6 proposed 13 as the best number of clusters
## * 4 proposed 15 as the best number of clusters
##
##                    ***** Conclusion *****
##
## * According to the majority rule, the best number of clusters is  3
##
##
## *******************************************************************

## $All.index
##        KL      CH Hartigan     CCC     Scott      Marriot   TrCovW    TraceW
## 2  0.7661 65.3654  64.7677 -5.6338  772.3769 5.268605e+57 539106.8 14579.377
## 3  1.5011 68.4916  45.1633 -0.1319 1946.9655 1.673719e+57 431654.2 13154.634
## 4  1.3175 64.0623  35.3155  3.1821 2496.2444 1.191183e+57 353455.4 12229.470
## 5  1.0094 59.6224  34.2018  5.7072 3005.8596 7.960254e+56 299964.1 11545.359
## 6  1.2569 57.1838  28.2555 10.4075 3861.6394 2.753312e+56 271462.9 10917.782
## 7  2.1125 54.5372  16.1820 14.4719 4448.9880 1.408030e+56 246995.0 10422.025
## 8  0.3858 50.2486  33.0193 15.7646 5173.5452 5.497228e+55 246909.7 10145.179
## 9  1.5353 50.4619  23.2772 22.7030 5713.8576 2.827207e+55 216479.9  9609.217
## 10 1.3087 49.1248  18.7417 27.2549 6302.8808 1.307746e+55 204044.0  9245.088
## 11 1.0997 47.4104  17.3209 30.7699 6569.8670 1.014046e+55 189715.0  8960.454
## 12 0.4313 45.8645  36.5029 34.1382 6838.6083 7.711047e+54 176164.7  8704.479
## 13 4.6229 47.6132  10.4426 43.9038 7764.1532 1.935111e+54 158869.3  8195.693
## 14 0.4808 45.4582  18.3591 45.4823 8049.1563 1.395671e+54 154157.6  8052.442
## 15 0.5612 44.7685  31.4402 49.9215 8483.8234 7.764026e+53 147395.9  7807.827
##     Friedman  Rubin Cindex     DB Silhouette   Duda  Pseudot2    Beale
## 2   4692.499 1.1093 0.3242 3.0066     0.1021 1.1921  -46.0855  -3.0475
## 3  13878.719 1.2295 0.3059 2.6517     0.1353 4.6182 -141.0234 -14.6641
## 4  15103.851 1.3225 0.3018 2.4174     0.1257 1.8051 -131.5762  -8.3888
## 5  16748.706 1.4008 0.2538 2.2527     0.1238 0.9748    5.5077   0.4883
## 6  20111.558 1.4813 0.2488 2.1007     0.1375 1.2356  -32.9906  -3.5978
## 7  20225.202 1.5518 0.2351 2.0335     0.1418 2.8387 -121.7729 -11.9945
## 8  20883.096 1.5942 0.2361 2.0797     0.1280 1.0899   -9.3226  -1.5537
## 9  20314.540 1.6831 0.2209 1.9699     0.1396 1.4404  -21.7097  -5.6687
## 10 20727.743 1.7494 0.2156 1.9958     0.1481 1.4388  -27.1429  -5.6475
## 11 20875.159 1.8049 0.2728 1.9158     0.1505 1.5369  -37.3809  -6.4768
## 12 21227.015 1.8580 0.2683 1.8897     0.1500 1.4324  -24.4511  -5.5899
## 13 21907.753 1.9734 0.2616 1.7147     0.1577 1.0999  -10.7128  -1.7060
## 14 22012.431 2.0085 0.2038 1.7896     0.1328 2.9028 -106.8472 -12.2864
## 15 22174.851 2.0714 0.1973 1.7638     0.1511 0.7695   24.2577   5.6257
##    Ratkowsky      Ball Ptbiserial    Frey McClain   Dunn Hubert SDindex Dindex
## 2     0.1859 7289.6883     0.1586 -0.4231  0.8921 0.0761  1e-04  1.2252 4.5815
```

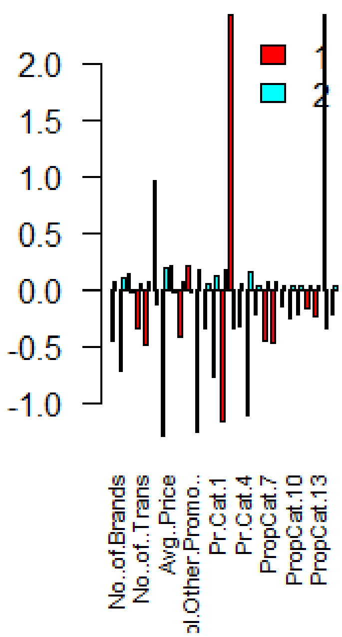
```
## 3     0.2085 4384.8780     0.2771  0.4616  1.1736 0.0909  2e-04  1.2480 4.2858
## 4     0.2165 3057.3675     0.2828  0.1295  1.9362 0.0606  2e-04  1.2236 4.1332
## 5     0.2148 2309.0717     0.3039  0.2900  2.5347 0.0809  2e-04  1.1929 4.0148
## 6     0.2094 1819.6303     0.3035 -0.0114  2.9447 0.0646  2e-04  1.1442 3.8796
## 7     0.2098 1488.8607     0.3358 -2.5055  3.3473 0.0619  3e-04  1.1645 3.7946
## 8     0.1993 1268.1474     0.3060 -0.0226  3.9700 0.0728  3e-04  1.1536 3.7382
## 9     0.2015 1067.6907     0.3389  0.1551  4.3465 0.0832  3e-04  1.1722 3.6405
## 10    0.1977  924.5088     0.3385 -0.0657  4.7673 0.0832  3e-04  1.1345 3.5764
## 11    0.1936  814.5868     0.3480  0.3741  4.7776 0.1069  3e-04  1.2460 3.5393
## 12    0.1894  725.3733     0.3370 -0.2236  5.3863 0.0877  4e-04  1.2316 3.4908
## 13    0.1888  630.4379     0.3480  0.7576  5.2168 0.0751  4e-04  1.2610 3.4148
## 14    0.1827  575.1744     0.3288 -0.0026  6.0538 0.0592  4e-04  1.1530 3.3530
## 15    0.1803  520.5218     0.3386  0.1780  6.2065 0.0683  4e-04  1.1125 3.3080
##      SDbw
## 2  1.0343
## 3  1.0131
## 4  1.0847
## 5  1.0826
## 6  1.0264
## 7  1.1543
## 8  0.9999
## 9  1.1191
## 10 1.0955
## 11 1.1430
## 12 1.1056
## 13 1.0576
## 14 0.8899
## 15 0.8762
##
## $All.CriticalValues
##    CritValue_Duda CritValue_PseudoT2 Fvalue_Beale
## 2          0.9250            23.1970       1.0000
## 3          0.8760            25.4727       1.0000
## 4          0.8950            34.6064       1.0000
## 5          0.9152            19.7479       0.9879
## 6          0.9100            17.1002       1.0000
## 7          0.8441            34.7312       1.0000
## 8          0.9009            12.4301       1.0000
## 9          0.8471            12.8144       1.0000
## 10         0.8441            16.4419       1.0000
## 11         0.8471            19.3118       1.0000
## 12         0.8441            14.9640       1.0000
## 13         0.8911            14.4248       1.0000
## 14         0.8811            21.9928       1.0000
## 15         0.8898            10.0343       0.0000
##
## $Best.nc
##                      KL      CH Hartigan     CCC    Scott     Marriot   TrCovW
## Number_clusters 13.0000  3.0000  13.0000 15.0000    3.000 3.00000e+00      3.0
## Value_Index      4.6229 68.4916  26.0602 49.9215 1174.589 3.11235e+57 107452.5
##                    TraceW Friedman   Rubin  Cindex      DB Silhouette   Duda
## Number_clusters   3.0000     3.00 13.0000 15.0000 13.0000    13.0000 2.0000
## Value_Index     499.5785  9186.22 -0.0802  0.1973  1.7147     0.1577 1.1921
##                 PseudoT2   Beale Ratkowsky    Ball PtBiserial Frey McClain
## Number_clusters   2.0000  2.0000    4.0000    3.00     13.000    1  2.0000
```

```
## Value_Index     -46.0855 -3.0475    0.2165 2904.81      0.348   NA  0.8921
##                     Dunn Hubert SDindex Dindex    SDbw
## Number_clusters 11.0000      0 15.0000      0 15.0000
## Value_Index      0.1069      0  1.1125      0  0.8762
##
## $Best.partition
##   [1] 2 3 1 1 2 2 2 1 2 3 2 2 2 2 2 2 2 2 2 3 1 1 1 1 1 3 2 2 2 1 1 2 1 1 1 2 2
##  [38] 2 1 1 2 1 1 1 2 2 2 2 1 3 1 2 1 2 1 2 1 2 1 2 2 1 1 2 2 1 2 3 2 2 2 2 1 2
##  [75] 2 3 2 1 2 2 2 1 1 3 2 2 2 2 3 1 3 2 1 3 3 2 1 2 1 2 2 2 2 2 2 2 2 3 2 3 2 1
## [112] 2 2 3 3 3 3 1 3 2 2 3 2 3 2 1 2 2 2 3 3 3 3 2 1 3 2 2 2 2 2 1 2 1 3 1 1 2
## [149] 2 3 2 2 1 1 2 3 3 1 2 1 1 1 2 2 2 2 2 2 2 2 2 2 3 2 1 2 2 2 1 1 2 2 2 3 3 3
## [186] 2 2 2 2 3 2 3 2 2 2 2 2 2 3 2 2 2 2 2 1 2 2 2 2 3 2 2 3 2 2 3 2 3 1 3 2 2
## [223] 1 3 2 2 2 3 3 2 1 2 1 2 1 1 1 1 1 3 2 3 2 2 1 2 1 3 3 2 2 3 2 3 2 2 2 1 2
## [260] 2 3 2 3 2 3 2 2 2 2 3 2 2 2 2 3 3 3 3 2 2 2 2 2 2 2 2 2 2 2 3 3 3 2 2 2 2
## [297] 1 2 2 3 3 2 2 2 3 2 3 2 2 3 3 3 3 3 2 3 2 2 3 3 2 3 2 2 2 1 2 1 2 2 2 2 2
## [334] 3 2 3 3 3 2 2 2 2 2 3 2 3 3 3 2 2 2 2 3 2 3 2 3 2 3 3 3 2 2 3 3 3 3 3 3 2
## [371] 2 3 2 2 1 3 2 3 2 2 3 3 3 3 2 3 2 3 2 3 3 3 3 2 3 3 3 3 3 2 2 3 2 3 3 3 3
## [408] 2 3 2 2 3 3 2 3 3 2 3 2 2 2 2 3 2 2 3 3 3 3 2 2 2 2 3 3 2 3 3 2 3 2 3 2 3
## [445] 3 2 2 2 2 2 3 2 2 2 2 2 3 3 3 3 3 3 3 3 3 2 2 2 3 3 3 3 3 3 2 2 2 3 3 3 3
## [482] 3 3 3 3 2 3 2 3 3 3 3 2 2 3 3 3 3 2 2 1 3 2 2 3 3 2 2 2 3 3 2 2 3 3 2 3 3
## [519] 3 2 2 3 2 2 2 2 2 2 2 2 3 1 2 2 3 2 1 2 2 2 3 3 2 3 3 2 2 2 2 3 2 3 3 2 2
## [556] 2 2 3 3 3 3 2 3 2 3 3 2 3 2 3 2 2 3 3 3 1 3 3 3 3 3 3 2 3 2 3 2 2 3 3 2 3
## [593] 3 2 2 2 3 2 2 2

# According to the majority rule, the best number of clusters is  2

# Traditional Approches
fviz_nbclust(BScScale, kmeans, method = "wss")+labs(subtitle = "Elbow method")
```



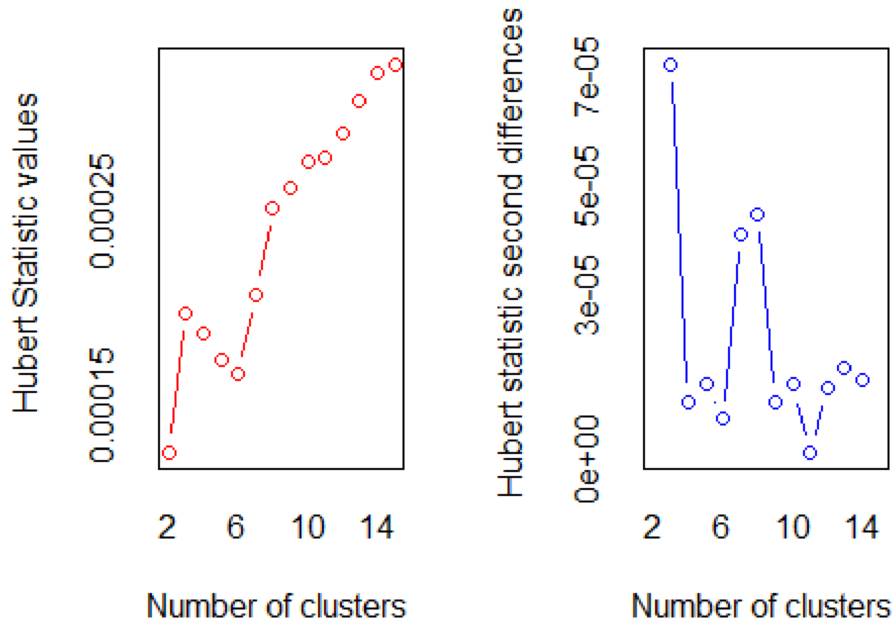

```
#2 is the best cluster from 3 approches
BScK <- kmeans(BScScale,centers =2,nstart = 25)
```

```
# Allow us to represent the cluster solution into 2 dimensions
#clusplot(BScScale,BScK$cluster,lines = 0,labels = 2,shade = TRUE,color = TRUE,main =
#'2D-Representation of the Cluster solution - Purchase Behavior')
BScK$size

## [1]  75 525

#dev.off()
barplot(BScK$centers,beside = TRUE,col = rainbow(2),cex.names = .7,las=2,
        args.legend = list(x ='topright', bty='n'),legend.text = (1:nrow(BScK$centers)))
```

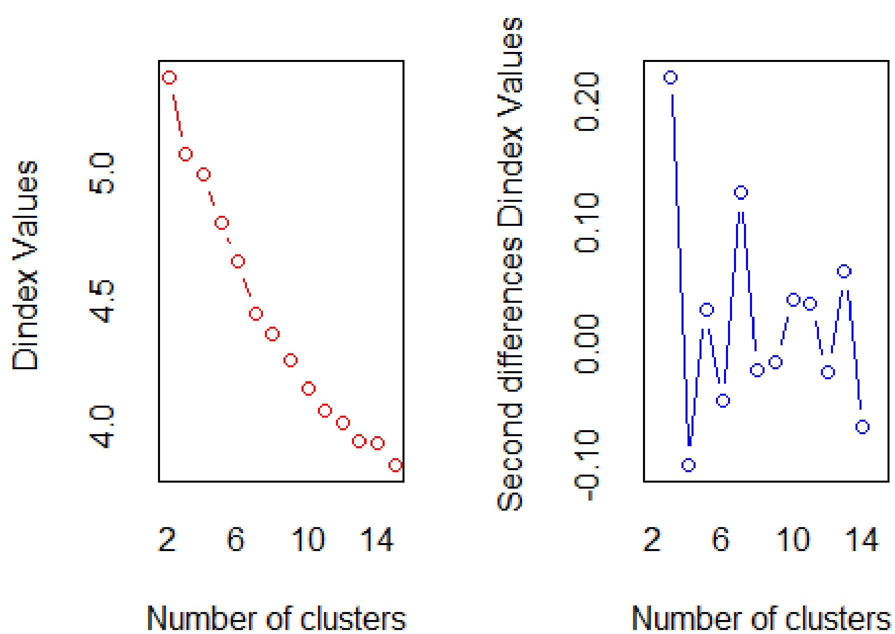


2.Select what you think is the best segmentation and comment on the characteristics (demographic,brand loyalty, and basis for purchase) of these clusters.

```
BS2 <- select(BathSoapDF,"Brand_1_Other_2_Loyal","LoyalBrand_1_8",
              "Pr.Cat.1","Pr.Cat.2","Pr.Cat.3","Pr.Cat.4",
              "PropCat.5","PropCat.6","PropCat.7","PropCat.8","PropCat.9","PropCat.10",
              "PropCat.11","PropCat.12","PropCat.13","PropCat.14","PropCat.15",
              "Pur.Vol.No.Promo....","Pur.Vol.Promo.6..","Pur.Vol.Other.Promo..",
              "SEC","FEH","MT","SEX","EDU","HS","CS",

"Br..Cd..57..144","Br..Cd..55","Br..Cd..272","Br..Cd..286","Br..Cd..24","Br..Cd..481","Br
..Cd..352","Br..Cd..5","Others.999")

BS2Scale <- scale(BS2)
NbClust(data = BS2Scale,distance = "euclidean",min.nc = 2, max.nc = 15, method =
"kmeans")
```



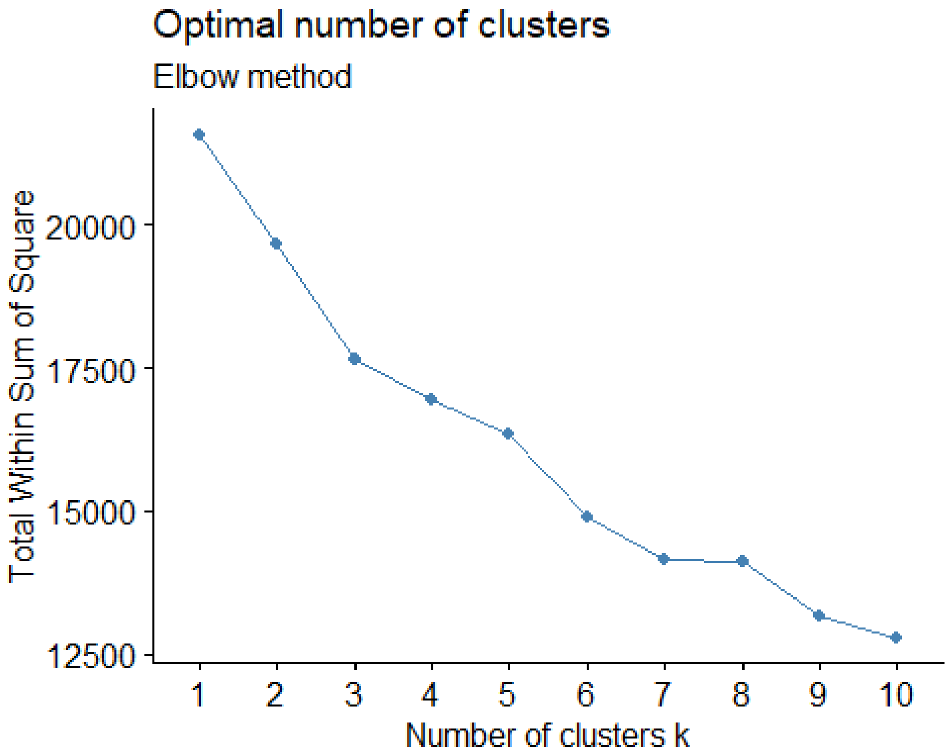

```
## *** : The Hubert index is a graphical method of determining the number of clusters.
##                 In the plot of Hubert index, we seek a significant knee that
corresponds to a
##                 significant increase of the value of the measure i.e the significant
peak in Hubert
##                 index second differences plot.
##
```



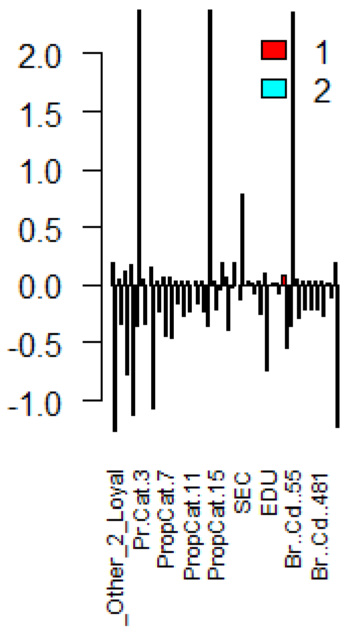
```
## *** : The D index is a graphical method of determining the number of clusters.
##                 In the plot of D index, we seek a significant knee (the significant
peak in Dindex
##                 second differences plot) that corresponds to a significant increase of
the value of
##                 the measure.
##
## *******************************************************************
## * Among all indices:
## * 4 proposed 2 as the best number of clusters
## * 9 proposed 3 as the best number of clusters
## * 1 proposed 5 as the best number of clusters
## * 1 proposed 6 as the best number of clusters
## * 1 proposed 7 as the best number of clusters
## * 1 proposed 8 as the best number of clusters
## * 1 proposed 11 as the best number of clusters
## * 2 proposed 12 as the best number of clusters
## * 1 proposed 13 as the best number of clusters
## * 1 proposed 14 as the best number of clusters
## * 1 proposed 15 as the best number of clusters
##
##                    ***** Conclusion *****
##
## * According to the majority rule, the best number of clusters is  3
##
##
## *******************************************************************

## $All.index
##        KL      CH Hartigan     CCC    Scott      Marriot   TrCovW   TraceW
## 2  0.3999 43.7461  67.9377 -9.8795  881.646 2.781714e+75 737828.3 20094.04
## 3  6.5094 58.2293  18.0083 -0.7356 2578.521 3.700464e+74 555420.1 18044.08
## 4  0.3080 45.9163  35.8056 -4.7364 3259.662 2.114008e+74 530934.5 17515.73
## 5  1.2059 45.3812  30.4413 -0.3805 3310.691 3.033826e+74 442427.9 16523.08
## 6  0.5366 44.1763  54.1086  3.1667 3997.503 1.390666e+74 397307.2 15718.87
## 7  1.7964 49.1023  32.9123 15.8164 4831.460 4.714961e+73 314833.5 14406.55
## 8  0.9870 49.0425  34.1474 22.8316 5617.048 1.662776e+73 278493.0 13649.01
## 9  0.9496 49.5720  37.0561 31.1502 6148.432 8.679811e+72 240735.3 12904.66
## 10 2.1762 50.8580  18.9414 41.0390 7072.665 2.296378e+72 208101.4 12143.26
## 11 0.8095 49.0525  23.0054 45.3067 7715.022 9.525227e+71 197213.0 11765.54
## 12 0.9896 48.3441  23.6653 50.9590 8220.825 4.879103e+71 181144.0 11323.27
## 13 8.4445 47.9893  -0.0549 57.1970 8769.856 2.293307e+71 163875.6 10885.18
## 14 0.0868 44.2140  32.1841 55.0244 8969.743 1.906114e+71 166375.0 10886.19
## 15 6.4866 45.5318   6.7433 64.7466 9425.537 1.023671e+71 144791.5 10319.43
##      Friedman  Rubin Cindex     DB Silhouette   Duda  Pseudot2    Beale
## 2    2216.180 1.0732 0.3154 3.4182     0.1063 1.9743 -200.3535 -12.4963
## 3    5798.795 1.1951 0.2965 2.6438     0.1040 0.9037   20.5737   2.7011
## 4    6994.369 1.2311 0.2953 2.3248     0.1041 3.4671 -291.7452 -17.8545
## 5   18821.197 1.3051 0.2881 2.5920     0.1108 1.2618  -57.4694  -5.2634
## 6   23203.934 1.3719 0.2915 2.3698     0.1129 1.7864 -154.9587 -11.1569
## 7   21817.679 1.4968 0.2721 2.0254     0.1217 2.4246  -86.3710 -14.8275
## 8   22760.078 1.5799 0.2726 1.8823     0.1312 1.5423  -42.8954  -8.8616
## 9   23605.011 1.6710 0.2671 1.7872     0.1435 1.1789   -7.1320  -3.7444
## 10  24984.366 1.7758 0.2564 1.6791     0.1579 2.4184  -64.5154 -14.7318
## 11  25434.490 1.8328 0.2562 1.6415     0.1620 6.8640 -228.9559 -21.4154
## 12  26001.233 1.9044 0.2449 1.6966     0.1730 1.1269  -24.8781  -2.8527
```

```
## 13 28524.036 1.9810 0.2441 1.7642     0.1644 1.5152  -64.9418  -8.6037
## 14 28960.542 1.9809 0.2317 1.9054     0.1541 4.0704  -62.6091 -17.8416
## 15 28532.421 2.0896 0.2356 1.7577     0.1682 1.6040  -52.3399  -9.4667
##    Ratkowsky       Ball Ptbiserial    Frey McClain   Dunn Hubert SDindex Dindex
## 2     0.1419 10047.0201     0.1812 -0.1783  0.6145 0.0780  1e-04  1.2793 5.3838
## 3     0.1893  6014.6948     0.2823  1.1553  1.0693 0.0947  2e-04  1.3038 5.0805
## 4     0.1794  4378.9321     0.2795  0.2366  1.1694 0.0917  2e-04  1.2182 4.9966
## 5     0.1884  3304.6159     0.3115 -1.7307  1.9658 0.0825  2e-04  1.1828 4.8124
## 6     0.1848  2619.8121     0.2597 -0.3129  2.5701 0.0923  2e-04  1.1305 4.6554
## 7     0.1970  2058.0790     0.3036 -0.3166  2.4722 0.0413  2e-04  1.1179 4.4510
## 8     0.1981  1706.1267     0.3520  0.2260  2.3623 0.0424  3e-04  1.4084 4.3707
## 9     0.1970  1433.8506     0.3550 -0.1501  2.6473 0.0424  3e-04  1.3386 4.2690
## 10    0.1969  1214.3264     0.3924  1.4023  2.6774 0.0424  3e-04  1.2482 4.1515
## 11    0.1916  1069.5947     0.3902  0.2043  2.7214 0.0891  3e-04  1.1825 4.0701
## 12    0.1903   943.6061     0.3927  0.3529  3.2848 0.0424  3e-04  1.1780 4.0213
## 13    0.1867   837.3213     0.3744  0.2474  4.2417 0.0441  3e-04  1.2558 3.9488
## 14    0.1804   777.5853     0.3709  0.6532  4.5214 0.0424  3e-04  1.3471 3.9351
## 15    0.1814   687.9622     0.3383  0.3546  5.8493 0.0441  3e-04  1.3109 3.8518
##      SDbw
## 2  1.1051
## 3  1.2734
## 4  1.1410
## 5  1.0740
## 6  1.0181
## 7  1.1114
## 8  1.4993
## 9  1.3642
## 10 1.2789
## 11 1.2026
## 12 1.1909
## 13 1.0678
## 14 1.1496
## 15 1.0652
##
## $All.CriticalValues
##    CritValue_Duda CritValue_PseudoT2 Fvalue_Beale
## 2          0.9255            32.7024            1
## 3          0.9285            14.8623            0
## 4          0.8919            49.7001            1
## 5          0.9352            19.2081            1
## 6          0.9296            26.6629            1
## 7          0.9109            14.3806            1
## 8          0.9062            12.6270            1
## 9          0.8525             8.1316            1
## 10         0.8950            12.8999            1
## 11         0.8891            33.4275            1
## 12         0.9292            16.8424            1
## 13         0.9220            16.1518            1
## 14         0.7898            22.0932            1
## 15         0.8979            15.8089            1
##
## $Best.nc
##                      KL      CH Hartigan     CCC    Scott      Marriot   TrCovW
## Number_clusters 13.0000  3.0000   3.0000 15.0000    3.000 3.000000e+00      3.0
## Value_Index      8.4445 58.2293  49.9294 64.7466 1696.874 2.253022e+75 182408.2
```

```
##                    TraceW Friedman   Rubin  Cindex      DB Silhouette   Duda
## Number_clusters    3.0     5.00  3.0000 14.0000 11.0000     12.000 2.0000
## Value_Index     1521.6 11826.83 -0.0859  0.2317  1.6415      0.173 1.9743
##                  PseudoT2    Beale Ratkowsky     Ball PtBiserial Frey McClain
## Number_clusters    2.0000   2.0000    8.0000    3.000    12.0000    1  2.0000
## Value_Index     -200.3535 -12.4963    0.1981 4032.325     0.3927   NA  0.6145
##                   Dunn Hubert SDindex Dindex   SDbw
## Number_clusters 3.0000      0  7.0000      0 6.0000
## Value_Index     0.0947      0  1.1179      0 1.0181
##
## $Best.partition
##   [1] 3 3 2 1 3 3 2 2 3 3 3 3 3 2 3 2 3 2 3 1 1 2 2 1 1 3 2 2 3 1 2 3 1 2 2 3 3
##  [38] 3 2 1 3 2 2 1 3 3 1 2 1 3 2 2 2 3 2 2 2 3 2 2 3 2 2 2 3 2 2 3 3 2 2 3 2 3
##  [75] 2 3 3 2 3 3 3 2 2 3 1 2 3 2 1 2 3 2 2 3 3 3 2 2 2 2 2 2 2 3 3 3 3 3 3 3 2
## [112] 3 3 3 3 3 3 2 3 3 3 3 2 3 3 2 2 2 3 3 3 3 2 3 1 3 3 3 2 3 3 2 3 2 3 2 2 3
## [149] 3 3 1 2 1 2 3 3 2 2 3 2 2 2 2 3 2 3 3 3 2 3 3 3 3 2 2 2 2 2 2 3 3 3 3 3 3
## [186] 2 3 3 2 3 3 3 1 2 2 3 2 3 3 2 2 2 3 3 2 3 1 3 2 3 2 3 3 2 3 1 2 3 2 3 2 2
## [223] 2 3 3 2 2 3 3 1 2 2 2 2 2 2 2 1 2 1 3 3 3 2 2 2 2 3 3 3 1 3 1 3 3 2 2 2 2
## [260] 3 3 3 3 2 3 2 2 2 2 3 3 3 2 3 3 3 3 3 2 1 2 3 3 2 3 1 3 2 3 3 3 3 2 3 3 3
## [297] 2 3 2 3 1 1 3 3 3 2 3 3 3 3 3 3 3 3 2 3 3 3 3 3 3 3 3 2 3 2 1 3 2 2 3 2 2 3
## [334] 3 1 3 3 3 3 3 3 3 2 3 3 2 3 3 3 2 3 2 3 3 2 3 3 3 2 3 3 3 2 3 3 3 3 3 3 3 1
## [371] 3 3 2 2 2 3 3 3 2 2 1 1 3 1 3 3 2 3 3 3 3 3 3 1 3 3 3 1 1 2 1 3 2 3 1 1 1
## [408] 3 3 3 3 1 3 2 3 3 3 1 2 2 3 1 1 3 3 1 1 1 3 2 3 3 3 3 3 2 3 3 2 3 1 3 3 3
## [445] 3 3 2 3 2 1 3 2 2 3 2 3 3 3 3 3 3 3 3 2 3 2 3 2 1 3 3 1 3 3 3 2 3 3 2 3 1
## [482] 3 3 3 3 2 1 2 3 3 3 1 1 2 3 3 3 3 3 3 1 3 3 2 3 3 1 1 3 3 1 3 2 3 3 2 3 3
## [519] 2 1 2 3 2 3 2 2 3 3 3 2 3 2 3 2 3 1 1 2 2 3 3 3 3 3 3 3 3 2 3 3 2 3 1 3 1
## [556] 1 3 3 3 3 3 2 3 3 3 3 3 3 2 3 1 2 3 3 3 2 1 3 3 3 3 3 2 3 2 3 2 3 3 3 3 3
## [593] 3 3 2 3 3 2 3 2

# According to the majority rule, the best number of clusters is  2

# Traditional Approches
fviz_nbclust(BS2Scale, kmeans, method = "wss")+labs(subtitle = "Elbow method")
```




```
#2 is the best cluster from 3 approches
BS2K <- kmeans(BS2Scale,centers =2,nstart = 25)

# Allow us to represent the cluster solution into 2 dimensions
BS2K$size

## [1] 522  78

#dev.off()
barplot(BS2K$centers,beside = TRUE,col = rainbow(2),cex.names = .7,las=2,
        args.legend = list(x ='topright', bty='n'),legend.text = (1:nrow(BS2K$centers)))
```



Question 3 - Model that classifies the data into these segments.

```
BS2$Cluster <- BS2K$cluster
BS2K$size

## [1] 522  78

Mail <- BS2[BS2$Cluster==1,]
#View(Mail) # Exclude these Members
# Excluding these people as they are loyal so we need to exclude the 522 out of the total
600 entries.
# So therefore on targeting direct-mail promotions for this market segment would succeed
```