WEEK 14 IP DIMENSIONALITY REDUCTION

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09/09/2021

```
library(tinytex)
```

Defining The Question

To perform Dimensionality reduction on Carrefour kenya dataset that will inform inform the marketing department on the most relevant marketing strategies that will result in the highest no. of sales

Metric of success

Our project will be considered successful if we will effectively apply PCA to get the important features that can help in implementing the marketing strategies.

Experimental Design

- Problem Definition
- Loading the Data
- Checking the Data
- Data Cleaning
- Exploratory Data Analysis
- Modelling

Loading the Dataset

```
df <- read.csv('http://bit.ly/CarreFourDataset')
```

#previewing the head of the dataset

```
head(df)

##    Invoice.ID Branch Customer.type Gender           Product.line
Unit.price
## 1 750-67-8428      A        Member Female      Health and beauty
74.69
## 2 226-31-3081      C        Normal Female Electronic accessories
15.28
## 3 631-41-3108      A        Normal   Male     Home and lifestyle
46.33
## 4 123-19-1176      A        Member   Male      Health and beauty
58.22
## 5 373-73-7910      A        Normal   Male      Sports and travel
86.31
## 6 699-14-3026      C        Normal   Male Electronic accessories
```

```
85.39
##   Quantity     Tax      Date  Time     Payment   cogs
gross.margin.percentage
## 1        7 26.1415  1/5/2019 13:08     Ewallet 522.83
4.761905
## 2        5  3.8200  3/8/2019 10:29        Cash  76.40
4.761905
## 3        7 16.2155  3/3/2019 13:23 Credit card 324.31
4.761905
## 4        8 23.2880 1/27/2019 20:33     Ewallet 465.76
4.761905
## 5        7 30.2085  2/8/2019 10:37     Ewallet 604.17
4.761905
## 6        7 29.8865 3/25/2019 18:30     Ewallet 597.73
4.761905
##   gross.income Rating    Total
## 1      26.1415    9.1 548.9715
## 2       3.8200    9.6  80.2200
## 3      16.2155    7.4 340.5255
## 4      23.2880    8.4 489.0480
## 5      30.2085    5.3 634.3785
## 6      29.8865    4.1 627.6165
```

previewing the tail of the dataset

```
tail(df)
```

```
##        Invoice.ID Branch Customer.type Gender           Product.line
Unit.price
## 995   652-49-6720      C        Member Female Electronic accessories
60.95
## 996   233-67-5758      C        Normal   Male      Health and beauty
40.35
## 997   303-96-2227      B        Normal Female     Home and lifestyle
97.38
## 998   727-02-1313      A        Member   Male     Food and beverages
31.84
## 999   347-56-2442      A        Normal   Male     Home and lifestyle
65.82
## 1000 849-09-3807      A        Member Female    Fashion accessories
88.34
##      Quantity     Tax      Date  Time Payment   cogs
gross.margin.percentage
## 995         1  3.0475 2/18/2019 11:40 Ewallet  60.95
4.761905
## 996         1  2.0175 1/29/2019 13:46 Ewallet  40.35
4.761905
## 997        10 48.6900  3/2/2019 17:16 Ewallet 973.80
4.761905
## 998         1  1.5920  2/9/2019 13:22    Cash  31.84
4.761905
```

```
## 999         1  3.2910 2/22/2019 15:33    Cash  65.82
4.761905
## 1000        7 30.9190 2/18/2019 13:28    Cash 618.38
4.761905
##      gross.income Rating     Total
## 995        3.0475    5.9   63.9975
## 996        2.0175    6.2   42.3675
## 997       48.6900    4.4 1022.4900
## 998        1.5920    7.7   33.4320
## 999        3.2910    4.1   69.1110
## 1000      30.9190    6.6  649.2990
```

Data Exploration

```
View(df)
```

checking the structure of the dataset

```
str(df)

## 'data.frame':    1000 obs. of  16 variables:
##  $ Invoice.ID             : chr  "750-67-8428" "226-31-3081" "631-41-3108"
"123-19-1176" ...
##  $ Branch                 : chr  "A" "C" "A" "A" ...
##  $ Customer.type          : chr  "Member" "Normal" "Normal" "Member" ...
##  $ Gender                 : chr  "Female" "Female" "Male" "Male" ...
##  $ Product.line           : chr  "Health and beauty" "Electronic
accessories" "Home and lifestyle" "Health and beauty" ...
##  $ Unit.price             : num  74.7 15.3 46.3 58.2 86.3 ...
##  $ Quantity               : int  7 5 7 8 7 7 6 10 2 3 ...
##  $ Tax                    : num  26.14 3.82 16.22 23.29 30.21 ...
##  $ Date                   : chr  "1/5/2019" "3/8/2019" "3/3/2019"
"1/27/2019" ...
##  $ Time                   : chr  "13:08" "10:29" "13:23" "20:33" ...
##  $ Payment                : chr  "Ewallet" "Cash" "Credit card" "Ewallet"
...
##  $ cogs                   : num  522.8 76.4 324.3 465.8 604.2 ...
##  $ gross.margin.percentage: num  4.76 4.76 4.76 4.76 4.76 ...
##  $ gross.income           : num  26.14 3.82 16.22 23.29 30.21 ...
##  $ Rating                 : num  9.1 9.6 7.4 8.4 5.3 4.1 5.8 8 7.2 5.9 ...
##  $ Total                  : num  549 80.2 340.5 489 634.4 ...
```

Our dataset has 1000 rows and 16 columns. 8 of which have a character data type, one is an integer and the other 7 are numerical.

##checking the structure of our dataset

```
summary(df)

##   Invoice.ID           Branch          Customer.type         Gender
##  Length:1000        Length:1000        Length:1000        Length:1000
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
```

```
##
##
##
##  Product.line        Unit.price      Quantity        Tax
##  Length:1000        Min.   :10.08   Min.   : 1.00   Min.   : 0.5085
##  Class :character   1st Qu.:32.88   1st Qu.: 3.00   1st Qu.: 5.9249
##  Mode  :character   Median :55.23   Median : 5.00   Median :12.0880
##                     Mean   :55.67   Mean   : 5.51   Mean   :15.3794
##                     3rd Qu.:77.94   3rd Qu.: 8.00   3rd Qu.:22.4453
##                     Max.   :99.96   Max.   :10.00   Max.   :49.6500
##      Date               Time             Payment               cogs
##  Length:1000        Length:1000        Length:1000        Min.   : 10.17
##  Class :character   Class :character   Class :character   1st Qu.:118.50
##  Mode  :character   Mode  :character   Mode  :character   Median :241.76
##                                                           Mean   :307.59
##                                                           3rd Qu.:448.90
##                                                           Max.   :993.00
##  gross.margin.percentage  gross.income        Rating           Total
##  Min.   :4.762           Min.   : 0.5085   Min.   : 4.000   Min.   :
10.68
##  1st Qu.:4.762           1st Qu.: 5.9249   1st Qu.: 5.500   1st Qu.:
124.42
##  Median :4.762           Median :12.0880   Median : 7.000   Median :
253.85
##  Mean   :4.762           Mean   :15.3794   Mean   : 6.973   Mean   :
322.97
##  3rd Qu.:4.762           3rd Qu.:22.4453   3rd Qu.: 8.500   3rd Qu.:
471.35
##  Max.   :4.762           Max.   :49.6500   Max.   :10.000   Max.
:1042.65
```

Data cleaning

checking foe missing values

```
colSums(is.na(df))

##              Invoice.ID                  Branch           Customer.type
##                       0                       0                       0
##                  Gender            Product.line              Unit.price
##                       0                       0                       0
##                Quantity                     Tax                    Date
##                       0                       0                       0
##                    Time                 Payment                    cogs
##                       0                       0                       0
## gross.margin.percentage            gross.income                  Rating
##                       0                       0                       0
##                   Total
##                       0
```

##We have no missing values in our dataset

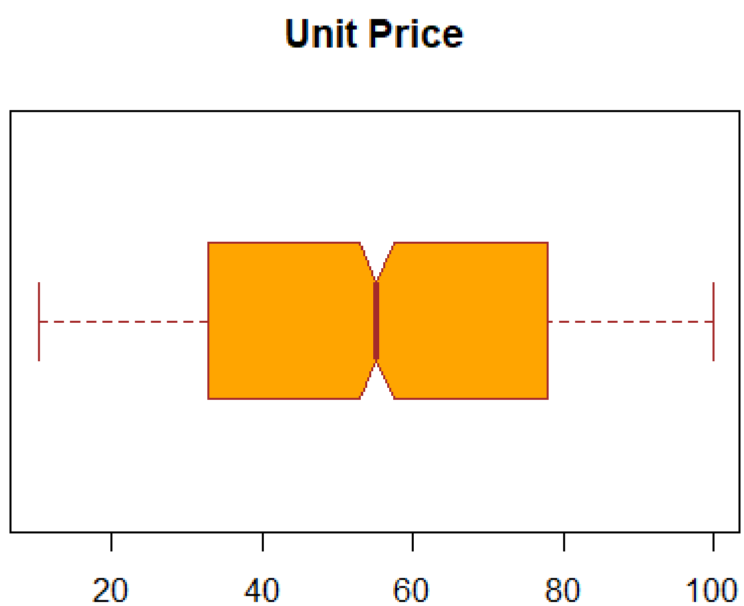
checking for duplicates

```
df[duplicated(df),]

##  [1] Invoice.ID              Branch                  Customer.type
##  [4] Gender                  Product.line            Unit.price
##  [7] Quantity                Tax                     Date
## [10] Time                    Payment                 cogs
## [13] gross.margin.percentage gross.income            Rating
## [16] Total
## <0 rows> (or 0-length row.names)
```

##There are no duplicates in our dataset

Checking for outliers

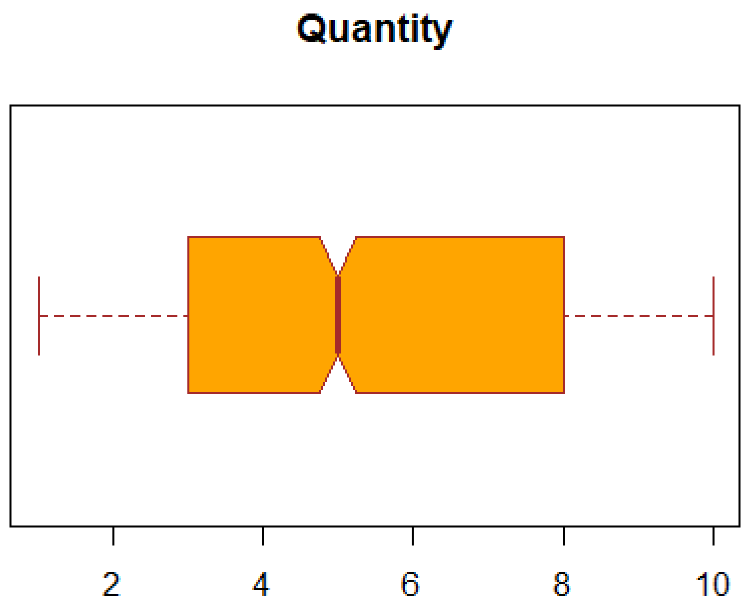
```
boxplot(df$Unit.price,
        main ="Unit Price",
        col = "orange",
        border  = 'brown',
        horizontal = TRUE,
        notch = TRUE)
```



##no oiutliers in the unit_price column

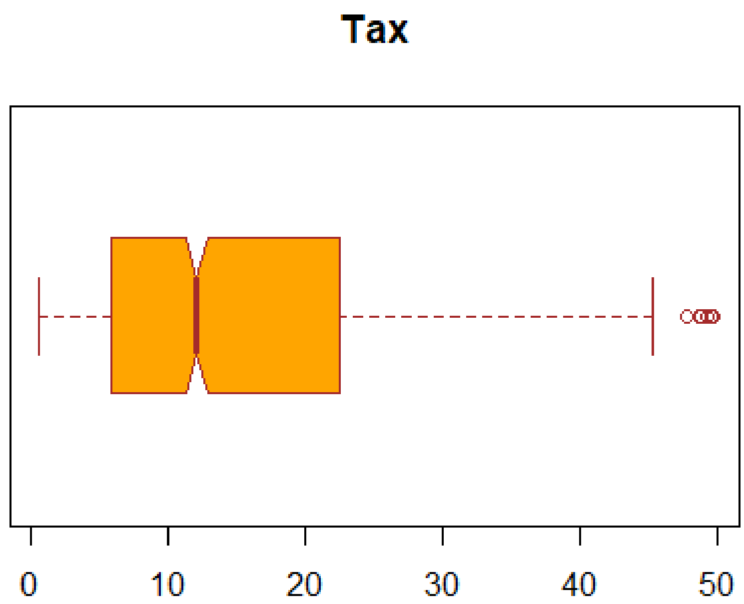
```
boxplot(df$Quantity,
        main ="Quantity",
        col = "orange",
        border  = 'brown',
```

```
        horizontal = TRUE,
        notch = TRUE)
```



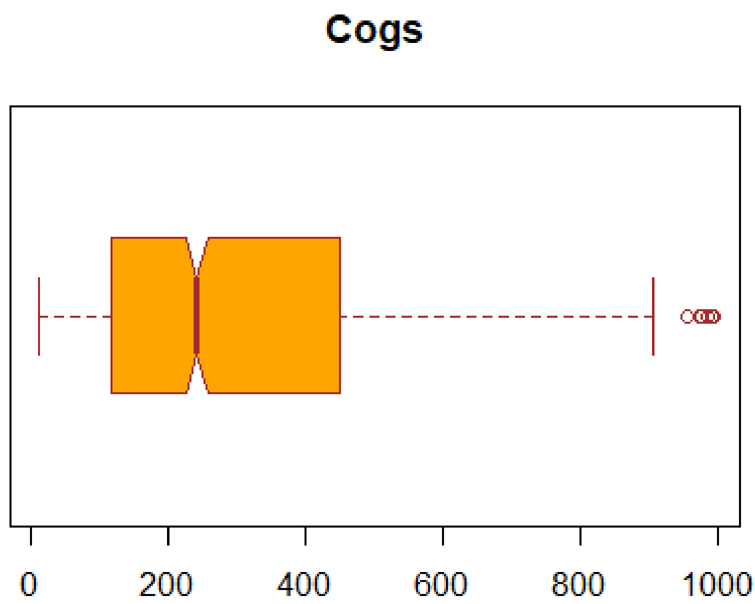
##no outliers in quantity column

```
boxplot(df$Tax,
        main ="Tax",
        col = "orange",
        border  = 'brown',
        horizontal = TRUE,
        notch = TRUE)
```



#there a few outliers in the tax column

```
boxplot(df$cogs,
        main ="Cogs",
        col = "orange",
        border  = 'brown',
        horizontal = TRUE,
        notch = TRUE)
```

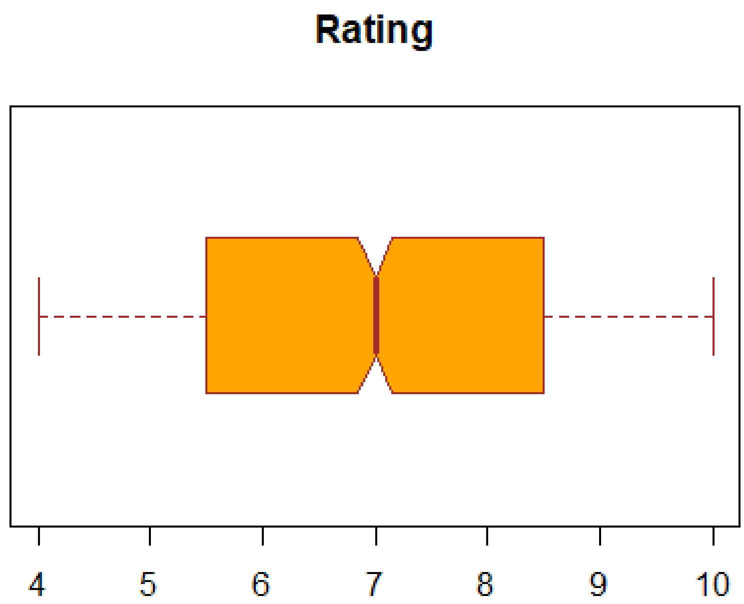


#there are a few outliers in the cogs column

```
boxplot(df$gross.income,
        main ="Gross Income",
        col = "orange",
        border  = 'brown',
        horizontal = TRUE,
        notch = TRUE)
```

#there are a few outliers in the gross income column

```
boxplot(df$Rating,
        main ="Rating",
        col = "orange",
        border  = 'brown',
        horizontal = TRUE,
        notch = TRUE)
```



#no outliers in the rating column

Exploratory Data Analysis

Univariate Analysis

Measures of Central Tendency

#Finding the mean of the numeric columns

```
colMeans(df[sapply(df,is.numeric)])

##              Unit.price                Quantity                     Tax
##               55.672130                5.510000               15.379369
##                    cogs gross.margin.percentage            gross.income
##              307.587380                4.761905               15.379369
##                  Rating                   Total
##                6.972700              322.966749
```

#Finding the median of the numeric columns

```
unitprice_median <- median(df$Unit.price)
qty_median <- median(df$Quantity)
tax_median <- median(df$Tax)
cogs_median <- median(df$cogs)
income_median <- median(df$gross.income)
rating_median <- median (df$Rating)
```

```
unitprice_median

## [1] 55.23

qty_median

## [1] 5

tax_median

## [1] 12.088

cogs_median

## [1] 241.76

income_median

## [1] 12.088

rating_median

## [1] 7
```

#Finding the range in our columns. The results will give us the minimum and maximum values in our numeric columns.

```
range(df$Unit.price)

## [1] 10.08 99.96

range(df$Quantity)

## [1]  1 10

range(df$Tax)

## [1]  0.5085 49.6500

range(df$cogs)

## [1]  10.17 993.00

range(df$gross.income)

## [1]  0.5085 49.6500

range(df$Rating)

## [1]  4 10
```

#Getting the quantiles in our columns.

```
quantile(df$Unit.price)
```

```
##      0%    25%    50%    75%   100%
## 10.080 32.875 55.230 77.935 99.960

quantile(df$Quantity)

##   0%  25%  50%  75% 100%
##    1    3    5    8   10

quantile(df$Tax)

##        0%       25%       50%       75%      100%
##  0.508500  5.924875 12.088000 22.445250 49.650000

quantile(df$cogs)

##       0%      25%      50%      75%     100%
##  10.1700 118.4975 241.7600 448.9050 993.0000

quantile(df$gross.income)

##        0%       25%       50%       75%      100%
##  0.508500  5.924875 12.088000 22.445250 49.650000

quantile(df$Rating)

##   0%  25%  50%  75% 100%
##  4.0  5.5  7.0  8.5 10.0
```

#Finding the variance of the numeric columns. This shows how the data values are dispersed around the mean.

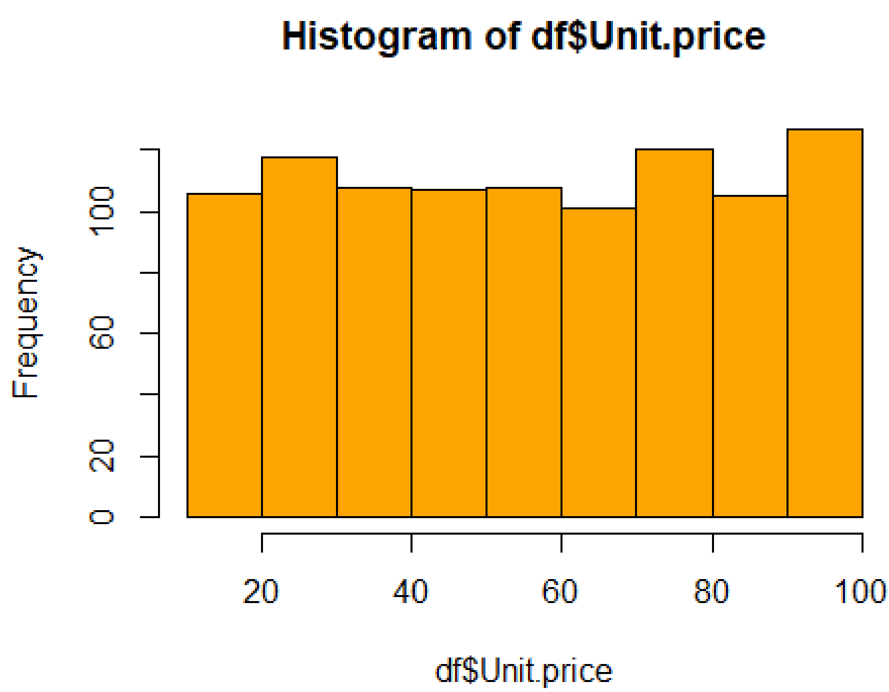
```
var(df$Unit.price)

## [1] 701.9653

var(df$Quantity)

## [1] 8.546446

var(df$Tax)

## [1] 137.0966

var(df$cogs)

## [1] 54838.64

var(df$gross.income)

## [1] 137.0966

var(df$Rating)

## [1] 2.953518
```

#Finding the standard deviation of our numeric columns

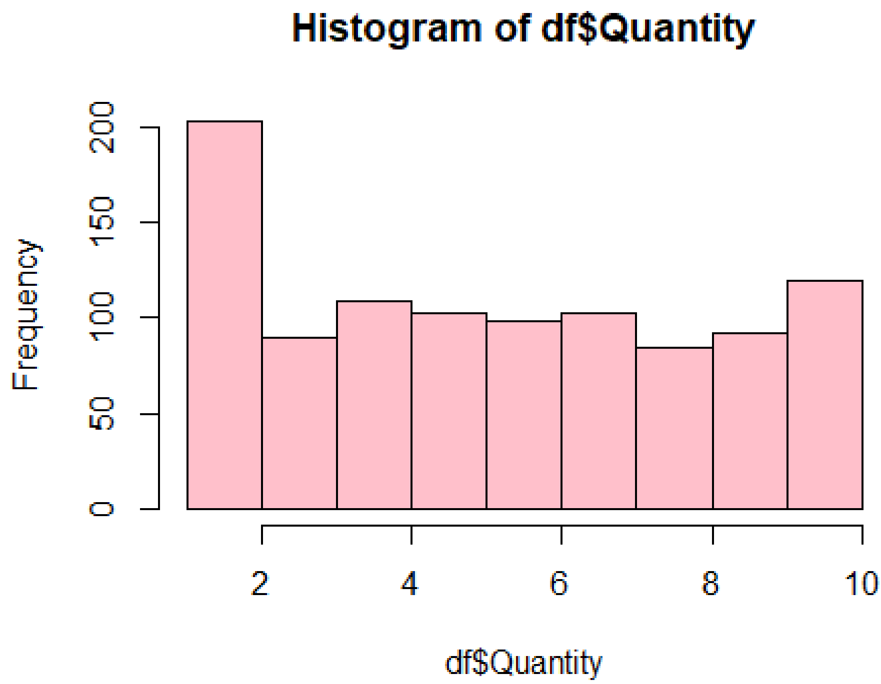
```
sd(df$Unit.price)

## [1] 26.49463

sd(df$Quantity)

## [1] 2.923431

sd(df$Tax)

## [1] 11.70883

sd(df$cogs)

## [1] 234.1765

sd(df$gross.income)

## [1] 11.70883

sd(df$Rating)

## [1] 1.71858
```

Histograms

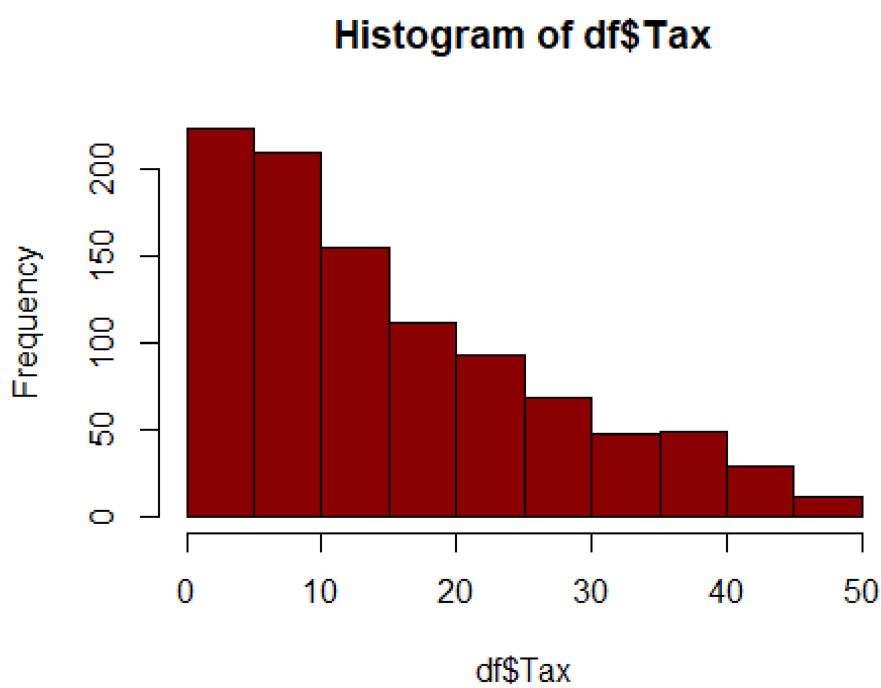
```
hist(df$Unit.price, col  = "orange")
```



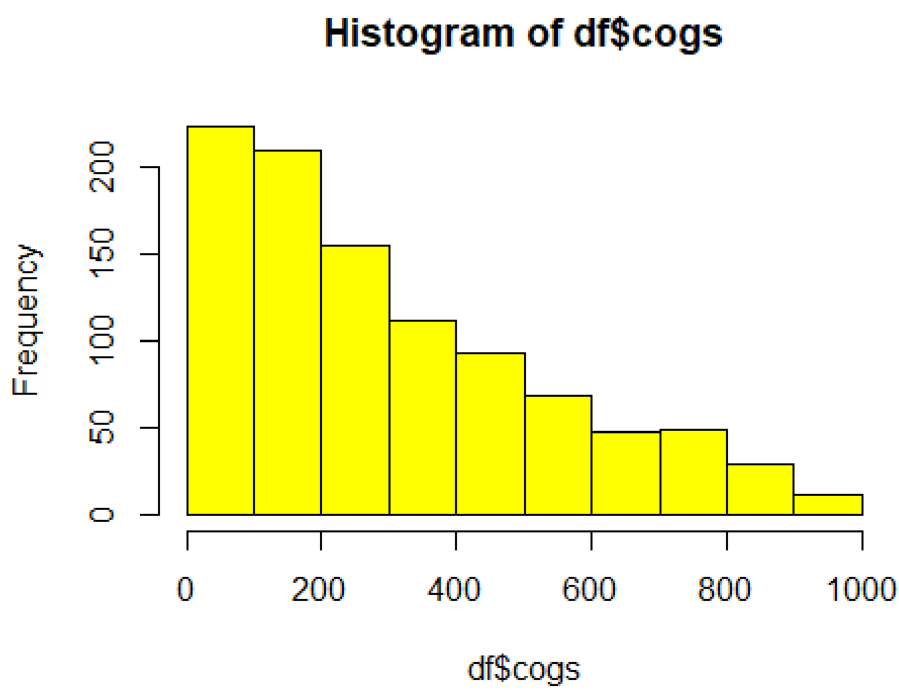
```
hist(df$Quantity, col  ="pink")
```



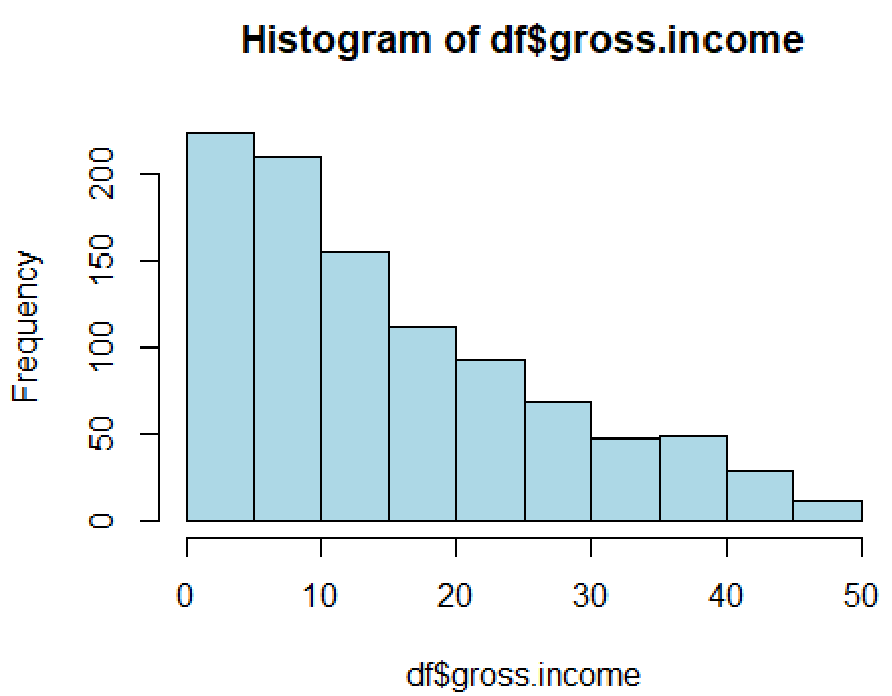

```
hist(df$Tax, col = "dark red")
```



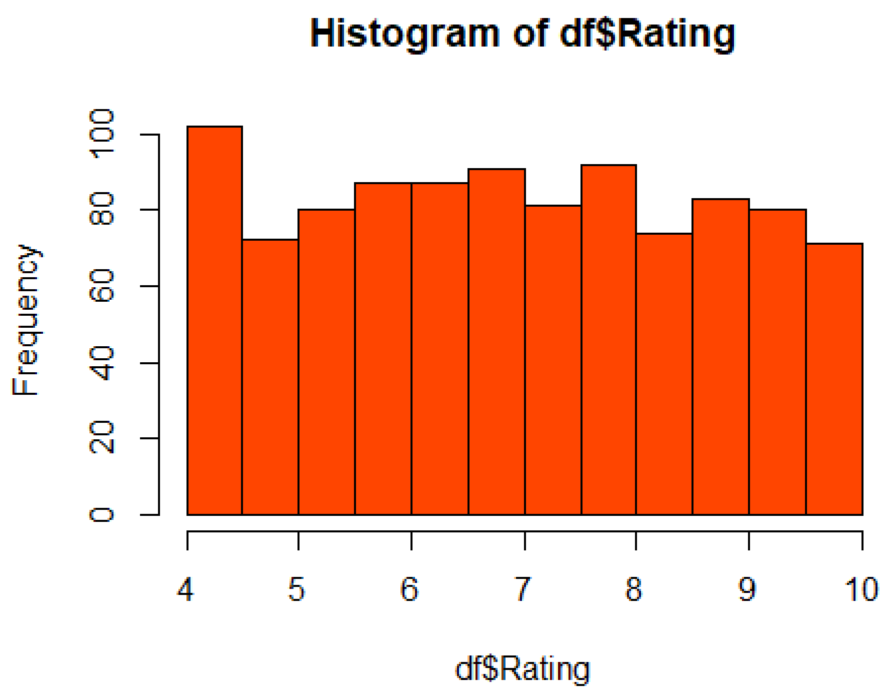
```
hist(df$cogs, col = "yellow")
```




```
hist(df$gross.income, col= "light blue")
```



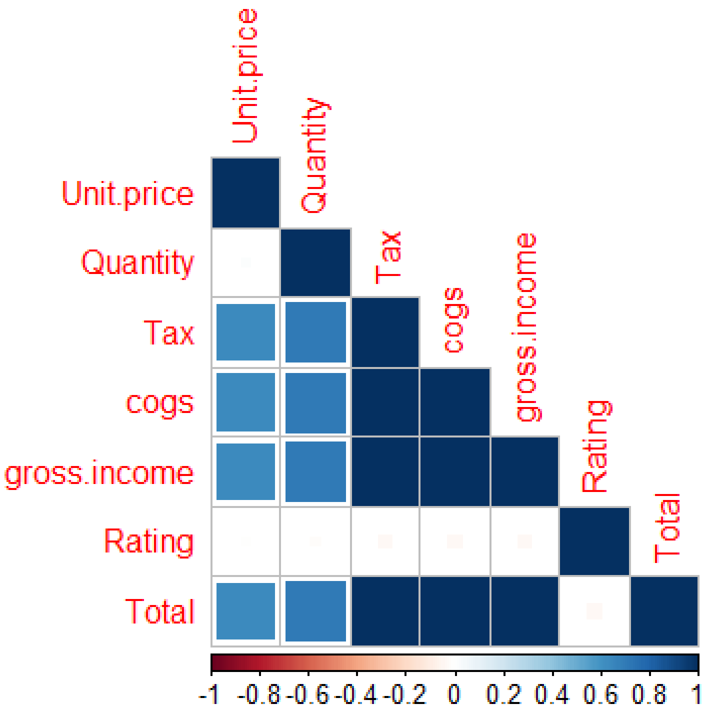
```
hist(df$Rating, col  ="orange red")
```



Bivariate Analysis

Correlation

```
library(corrplot)

## corrplot 0.90 loaded

correlation <- cor(df[,c(6,7,8,12,14,15,16)])
corrplot(correlation, method = "square", type = "lower", diag = TRUE)
```



Correlation matrix

#To understand the extent to which variables correlate with each other.

```
cor(df$Unit.price, df$Quantity)

## [1] 0.01077756

cor(df$Tax, df$Quantity)

## [1] 0.7055102

cor(df$cogs, df$gross.income)

## [1] 1

cor(df$Quantity, df$Rating)

## [1] -0.0158149

cor(df$Tax, df$gross.income)

## [1] 1
```

Dimensionality Reduction

t- Distributed Stochastic Neighbour Embedding(t-SNE)

```
library(Rtsne)
```

#Curating the database for analysis.

```
Labels <- df$Product.line
df$Product.line <- as.factor(df$Product.line)
```

#Plotting to see the dimensions.

```
colors = rainbow(length(unique(df$Product.line)))
names(colors) = unique(df$Product.line)
```

#Executing our algorithm on the curated data.

```
tsne <- Rtsne(df[,-5], dims = 2, perplexity=30, verbose=TRUE, max_iter = 500)

## Performing PCA
## Read the 1000 x 50 data matrix successfully!
## OpenMP is working. 1 threads.
## Using no_dims = 2, perplexity = 30.000000, and theta = 0.500000
## Computing input similarities...
## Building tree...
## Done in 0.28 seconds (sparsity = 0.101260)!
## Learning embedding...
## Iteration 50: error is 58.525000 (50 iterations in 0.20 seconds)
## Iteration 100: error is 52.218202 (50 iterations in 0.19 seconds)
## Iteration 150: error is 51.236579 (50 iterations in 0.18 seconds)
## Iteration 200: error is 50.929173 (50 iterations in 0.20 seconds)
## Iteration 250: error is 50.759808 (50 iterations in 0.21 seconds)
## Iteration 300: error is 0.566424 (50 iterations in 0.20 seconds)
## Iteration 350: error is 0.417109 (50 iterations in 0.17 seconds)
## Iteration 400: error is 0.388612 (50 iterations in 0.25 seconds)
## Iteration 450: error is 0.375971 (50 iterations in 0.18 seconds)
## Iteration 500: error is 0.366022 (50 iterations in 0.19 seconds)
## Fitting performed in 1.95 seconds.
```

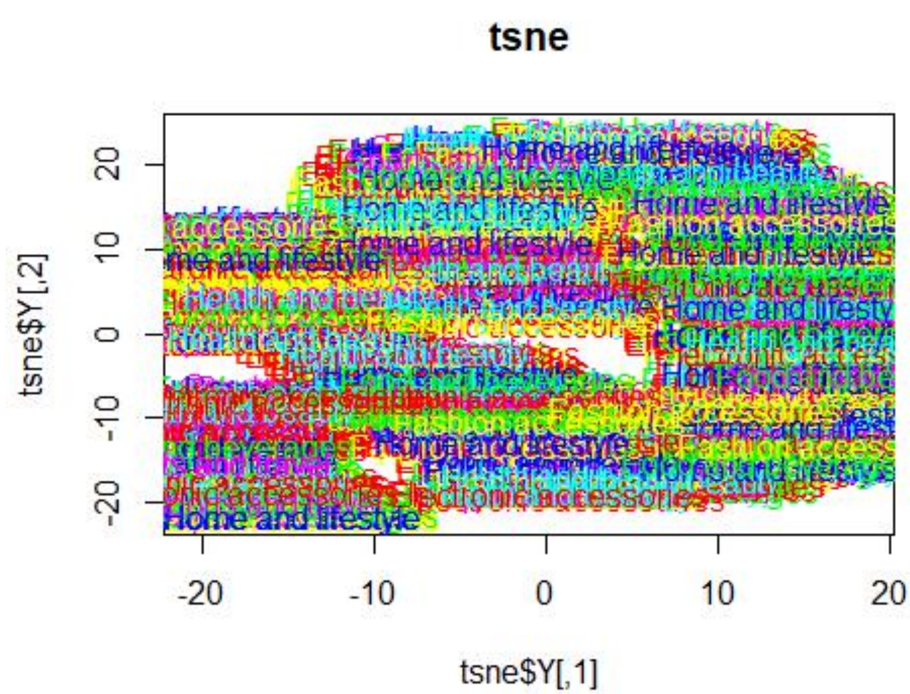
#Checking the summary of our model.

```
summary(tsne)

##                     Length Class  Mode
## N                      1   -none- numeric
## Y                   2000   -none- numeric
## costs               1000   -none- numeric
## itercosts             10   -none- numeric
## origD                  1   -none- numeric
## perplexity             1   -none- numeric
## theta                  1   -none- numeric
## max_iter               1   -none- numeric
## stop_lying_iter        1   -none- numeric
## mom_switch_iter        1   -none- numeric
## momentum               1   -none- numeric
## final_momentum         1   -none- numeric
```

```
## eta                        1   -none- numeric
## exaggeration_factor        1   -none- numeric
```

#Plotting our graph and closely examining it.

```
plot(tsne$Y, t='n', main="tsne")
text(tsne$Y, labels=df$Product.line, col=colors[df$Product.line])
```



Principal Component Analysis (PCA)

#Selecting the numerical data.

```
sales <- df[,c(6:8,12:16)]
head(sales)

##   Unit.price Quantity     Tax   cogs gross.margin.percentage gross.income
## 1      74.69        7 26.1415 522.83                4.761905      26.1415
## 2      15.28        5  3.8200  76.40                4.761905       3.8200
## 3      46.33        7 16.2155 324.31                4.761905      16.2155
## 4      58.22        8 23.2880 465.76                4.761905      23.2880
## 5      86.31        7 30.2085 604.17                4.761905      30.2085
## 6      85.39        7 29.8865 597.73                4.761905      29.8865
##   Rating    Total
## 1    9.1 548.9715
## 2    9.6  80.2200
## 3    7.4 340.5255
## 4    8.4 489.0480
```

```
## 5    5.3 634.3785
## 6    4.1 627.6165
```

#We then pass df to the prcomp(). We also set two arguments, center and scale, to be TRUE then preview our object with summary,

```
df.pca <- prcomp(df[,c(6,7,8,12,14,15,16)], center = TRUE, scale. = TRUE)
summary(df.pca)

## Importance of components:
##                           PC1    PC2    PC3     PC4       PC5       PC6
## Standard deviation     2.2185 1.0002 0.9939 0.30001 2.981e-16 1.493e-16
## Proportion of Variance 0.7031 0.1429 0.1411 0.01286 0.000e+00 0.000e+00
## Cumulative Proportion  0.7031 0.8460 0.9871 1.00000 1.000e+00 1.000e+00
##                              PC7
## Standard deviation     9.831e-17
## Proportion of Variance 0.000e+00
## Cumulative Proportion  1.000e+00
```

#As a result we obtain 7 principal components, each which explain a percentate of the total variation of the dataset. Let's call str() to have a look at our pca model.

```
str(df.pca)

## List of 5
##  $ sdev    : num [1:7] 2.22 1.00 9.94e-01 3.00e-01 2.98e-16 ...
##  $ rotation: num [1:7, 1:7] -0.292 -0.325 -0.45 -0.45 -0.45 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:7] "Unit.price" "Quantity" "Tax" "cogs" ...
##   .. ..$ : chr [1:7] "PC1" "PC2" "PC3" "PC4" ...
##  $ center  : Named num [1:7] 55.67 5.51 15.38 307.59 15.38 ...
##   ..- attr(*, "names")= chr [1:7] "Unit.price" "Quantity" "Tax" "cogs" ...
##  $ scale   : Named num [1:7] 26.49 2.92 11.71 234.18 11.71 ...
##   ..- attr(*, "names")= chr [1:7] "Unit.price" "Quantity" "Tax" "cogs" ...
##  $ x       : num [1:1000, 1:7] -2.005 2.306 -0.186 -1.504 -2.8 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : NULL
##   .. ..$ : chr [1:7] "PC1" "PC2" "PC3" "PC4" ...
##  - attr(*, "class")= chr "prcomp"
```

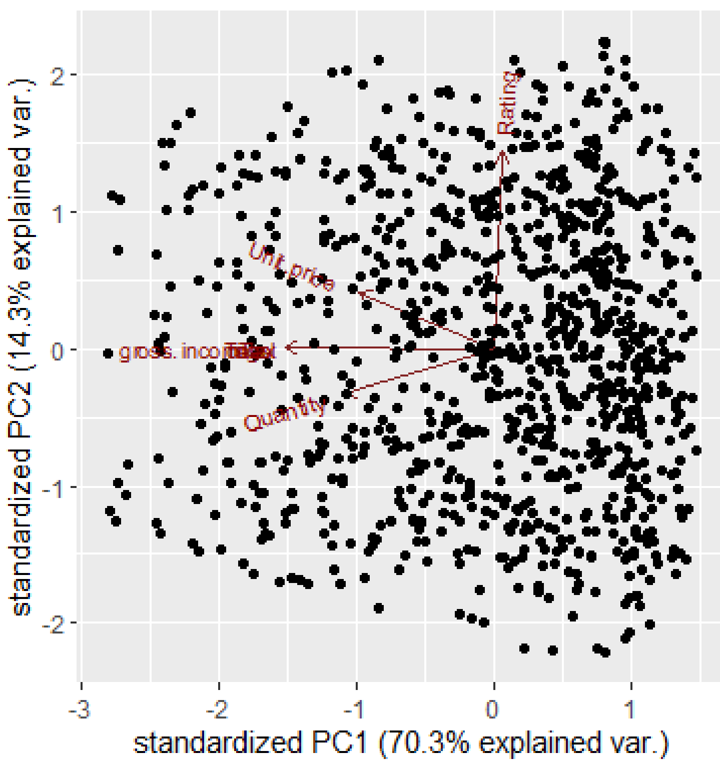
#We will now plot our pca. #Installing our ggbiplot visualization package.

```
library(devtools)

## Loading required package: usethis

install_github("vqv/ggbiplot")

## WARNING: Rtools is required to build R packages, but is not currently
installed.
##
```

```
## Please download and install Rtools 4.0 from https://cran.r-project.org/bin/windows/Rtools/.

## Skipping install of 'ggbiplot' from a github remote, the SHA1 (7325e880) has not changed since last install.
##   Use `force = TRUE` to force installation
```

#Loading our ggbiplot library

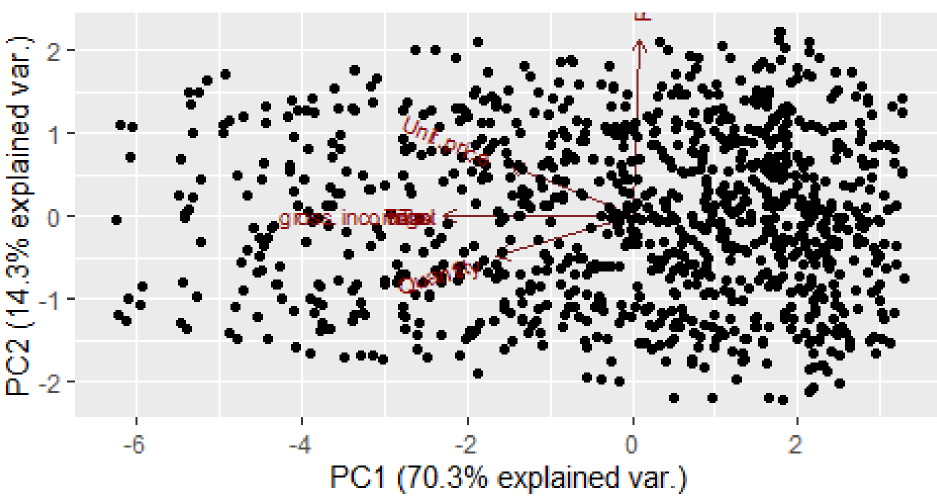
```
library(ggbiplot)

## Loading required package: ggplot2

## Loading required package: plyr

## Loading required package: scales

## Loading required package: grid

ggbiplot(df.pca)
```



#From the graph, we see that gross income, quantity,unit price and the ratings are important factors in this analysis.

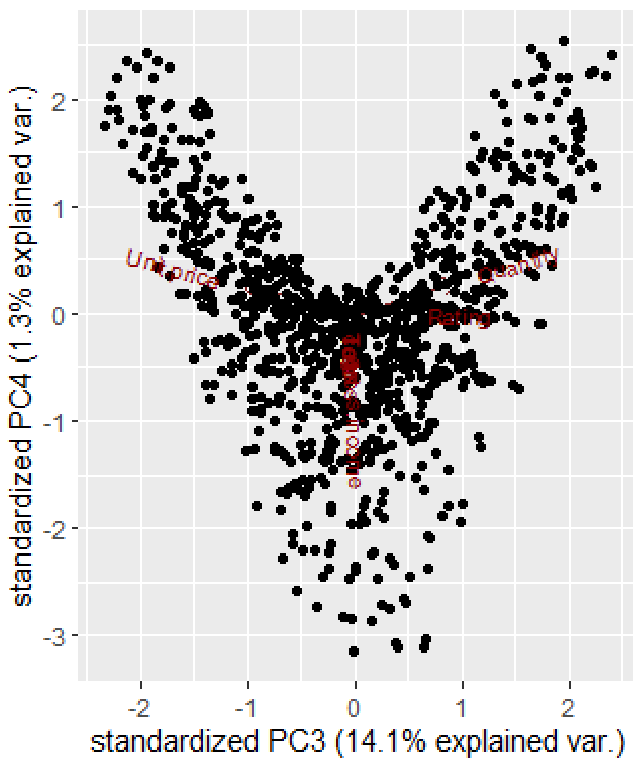
#PC1 explains 70.3% of the total variance, which means that nearly two-thirds of the information in the dataset (7 variables) can be encapsulated by just that one Principal Component. PC2 explains 14.3%% of the variance.Adding more detail to the plot, we provide arguments rownames as labels.

```
ggbiplot(df.pca, obs.scale = 1, var.scale = 1)
```



#Let's now plot PC3 and PC4.

```
ggbiplot(df.pca,ellipse=TRUE,choices=c(3,4))
```



#From the graph we see that PC3 explains 14.1% of the variance while PC4 explains 1.3% of the total variance.

#Quantity, Rating, Unit Price and Gross income are the most important features in this analysis. * PCA gives better insights over t-SNE for this kind of analysis so Carrefour should implement this algorithm when performing dimensionality reduction. * When coming up with a marketing strategy, promotions, discounts or adverts, the team should take into consideration the unit price of the commodities, their quantity, the ratings given and thecustomer's gross income to come up with their business strategies.

Part 2

Feature Selection

These methods apply a metric to assign a scoring to each feature. The features would then be ranked by the score. We will use the findCorrelation function included in the caret package to create a subset of variables. This function will allow us to remove redundancy by correlation using the given dataset. Since we are working with a correlation matrix, we'll only use the numerical variables.

```
df2 <- df[,c(6,7,8,12,14,15,16)]
head(df2)
```

```
##   Unit.price Quantity     Tax   cogs gross.income Rating    Total
## 1      74.69        7 26.1415 522.83      26.1415    9.1 548.9715
## 2      15.28        5  3.8200  76.40       3.8200    9.6  80.2200
## 3      46.33        7 16.2155 324.31      16.2155    7.4 340.5255
```

```
## 4       58.22         8 23.2880 465.76       23.2880     8.4 489.0480
## 5       86.31         7 30.2085 604.17       30.2085     5.3 634.3785
## 6       85.39         7 29.8865 597.73       29.8865     4.1 627.6165
```

Loading the caret package

```
suppressWarnings(
        suppressMessages(if
                         (!require(caret, quietly=TRUE))
                install.packages("caret")))
library(caret)
```

Installing the corrplot package for correlation.

```
suppressWarnings(
        suppressMessages(if
                         (!require(corrplot, quietly=TRUE))
                install.packages("corrplot")))
library(corrplot)
```

Getting the correlation matrix

```
corrmatrix <- cor(df2)
corrmatrix

##                 Unit.price    Quantity        Tax       cogs gross.income
## Unit.price     1.000000000  0.01077756  0.6339621  0.6339621    0.6339621
## Quantity       0.010777564  1.00000000  0.7055102  0.7055102    0.7055102
## Tax            0.633962089  0.70551019  1.0000000  1.0000000    1.0000000
## cogs           0.633962089  0.70551019  1.0000000  1.0000000    1.0000000
## gross.income   0.633962089  0.70551019  1.0000000  1.0000000    1.0000000
## Rating        -0.008777507 -0.01581490 -0.0364417 -0.0364417   -0.0364417
## Total          0.633962089  0.70551019  1.0000000  1.0000000    1.0000000
##                     Rating      Total
## Unit.price    -0.008777507  0.6339621
## Quantity      -0.015814905  0.7055102
## Tax           -0.036441705  1.0000000
## cogs          -0.036441705  1.0000000
## gross.income -0.036441705  1.0000000
## Rating         1.000000000 -0.0364417
## Total         -0.036441705  1.0000000
```

Finding variables that are highly correlated

```
highlyCorrelated <- findCorrelation(corrmatrix, cutoff=0.75)
highlyCorrelated

## [1] 4 7 3
```

Getting the names of the variables

```
names(df2[,highlyCorrelated])
```

```
## [1] "cogs"  "Total" "Tax"
```

From our output, the cogs, total and tax columns have the highest correlations.

Removing redundant features

```
df3<-df2[-highlyCorrelated]
df3
```

```
##      Unit.price Quantity gross.income Rating
## 1         74.69        7      26.1415    9.1
## 2         15.28        5       3.8200    9.6
## 3         46.33        7      16.2155    7.4
## 4         58.22        8      23.2880    8.4
## 5         86.31        7      30.2085    5.3
## 6         85.39        7      29.8865    4.1
## 7         68.84        6      20.6520    5.8
## 8         73.56       10      36.7800    8.0
## 9         36.26        2       3.6260    7.2
## 10        54.84        3       8.2260    5.9
## 11        14.48        4       2.8960    4.5
## 12        25.51        4       5.1020    6.8
## 13        46.95        5      11.7375    7.1
## 14        43.19       10      21.5950    8.2
## 15        71.38       10      35.6900    5.7
## 16        93.72        6      28.1160    4.5
## 17        68.93        7      24.1255    4.6
## 18        72.61        6      21.7830    6.9
## 19        54.67        3       8.2005    8.6
## 20        40.30        2       4.0300    4.4
## 21        86.04        5      21.5100    4.8
## 22        87.98        3      13.1970    5.1
## 23        33.20        2       3.3200    4.4
## 24        34.56        5       8.6400    9.9
## 25        88.63        3      13.2945    6.0
## 26        52.59        8      21.0360    8.5
## 27        33.52        1       1.6760    6.7
## 28        87.67        2       8.7670    7.7
## 29        88.36        5      22.0900    9.6
## 30        24.89        9      11.2005    7.4
## 31        94.13        5      23.5325    4.8
## 32        78.07        9      35.1315    4.5
## 33        83.78        8      33.5120    5.1
## 34        96.58        2       9.6580    5.1
## 35        99.42        4      19.8840    7.5
## 36        68.12        1       3.4060    6.8
## 37        62.62        5      15.6550    7.0
## 38        60.88        9      27.3960    4.7
## 39        54.92        8      21.9680    7.6
## 40        30.12        8      12.0480    7.7
## 41        86.72        1       4.3360    7.9
```

```
## 42         56.11         2        5.6110    6.3
## 43         69.12         6       20.7360    5.6
## 44         98.70         8       39.4800    7.6
## 45         15.37         2        1.5370    7.2
## 46         93.96         4       18.7920    9.5
## 47         56.69         9       25.5105    8.4
## 48         20.01         9        9.0045    4.1
## 49         18.93         6        5.6790    8.1
## 50         82.63        10       41.3150    7.9
## 51         91.40         7       31.9900    9.5
## 52         44.59         5       11.1475    8.5
## 53         17.87         4        3.5740    6.5
## 54         15.43         1        0.7715    6.1
## 55         16.16         2        1.6160    6.5
## 56         85.98         8       34.3920    8.2
## 57         44.34         2        4.4340    5.8
## 58         89.60         8       35.8400    6.6
## 59         72.35        10       36.1750    5.4
## 60         30.61         6        9.1830    9.3
## 61         24.74         3        3.7110   10.0
## 62         55.73         6       16.7190    7.0
## 63         55.07         9       24.7815   10.0
## 64         15.81        10        7.9050    8.6
## 65         75.74         4       15.1480    7.6
## 66         15.87        10        7.9350    5.8
## 67         33.47         2        3.3470    6.7
## 68         97.61         6       29.2830    9.9
## 69         78.77        10       39.3850    6.4
## 70         18.33         1        0.9165    4.3
## 71         89.48        10       44.7400    9.6
## 72         62.12        10       31.0600    5.9
## 73         48.52         3        7.2780    4.0
## 74         75.91         6       22.7730    8.7
## 75         74.67         9       33.6015    9.4
## 76         41.65        10       20.8250    5.4
## 77         49.04         9       22.0680    8.6
## 78         20.01         9        9.0045    5.7
## 79         78.31        10       39.1550    6.6
## 80         20.38         5        5.0950    6.0
## 81         99.19         6       29.7570    5.5
## 82         96.68         3       14.5020    6.4
## 83         19.25         8        7.7000    6.6
## 84         80.36         4       16.0720    8.3
## 85         48.91         5       12.2275    6.6
## 86         83.06         7       29.0710    4.0
## 87         76.52         5       19.1300    9.9
## 88         49.38         7       17.2830    7.3
## 89         42.47         1        2.1235    5.7
## 90         76.99         6       23.0970    6.1
## 91         47.38         4        9.4760    7.1
```

```
## 92         44.86        10       22.4300    8.2
## 93         21.98         7        7.6930    5.1
## 94         64.36         9       28.9620    8.6
## 95         89.75         1        4.4875    6.6
## 96         97.16         1        4.8580    7.2
## 97         87.87        10       43.9350    5.1
## 98         12.45         6        3.7350    4.1
## 99         52.75         3        7.9125    9.3
## 100        82.70         6       24.8100    7.4
## 101        48.71         1        2.4355    4.1
## 102        78.55         9       35.3475    7.2
## 103        23.07         9       10.3815    4.9
## 104        58.26         6       17.4780    9.9
## 105        30.35         7       10.6225    8.0
## 106        88.67        10       44.3350    7.3
## 107        27.38         6        8.2140    7.9
## 108        62.13         6       18.6390    7.4
## 109        33.98         9       15.2910    4.2
## 110        81.97        10       40.9850    9.2
## 111        16.49         2        1.6490    4.6
## 112        98.21         3       14.7315    7.8
## 113        72.84         7       25.4940    8.4
## 114        58.07         9       26.1315    4.3
## 115        80.79         9       36.3555    9.5
## 116        27.02         3        4.0530    7.1
## 117        21.94         5        5.4850    5.3
## 118        51.36         1        2.5680    5.2
## 119        10.96        10        5.4800    6.0
## 120        53.44         2        5.3440    4.1
## 121        99.56         8       39.8240    5.2
## 122        57.12         7       19.9920    6.5
## 123        99.96         9       44.9820    4.2
## 124        63.91         8       25.5640    4.6
## 125        56.47         8       22.5880    7.3
## 126        93.69         7       32.7915    4.5
## 127        32.25         5        8.0625    9.0
## 128        31.73         9       14.2785    5.9
## 129        68.54         8       27.4160    8.5
## 130        90.28         9       40.6260    7.2
## 131        39.62         7       13.8670    7.5
## 132        92.13         6       27.6390    8.3
## 133        34.84         4        6.9680    7.4
## 134        87.45         6       26.2350    8.8
## 135        81.30         6       24.3900    5.3
## 136        90.22         3       13.5330    6.2
## 137        26.31         5        6.5775    8.8
## 138        34.42         6       10.3260    9.8
## 139        51.91        10       25.9550    8.2
## 140        72.50         8       29.0000    9.2
## 141        89.80        10       44.9000    5.4
```

```
## 142        90.50        10       45.2500    8.1
## 143        68.60        10       34.3000    9.1
## 144        30.41         1        1.5205    8.4
## 145        77.95         6       23.3850    8.0
## 146        46.26         6       13.8780    9.5
## 147        30.14        10       15.0700    9.2
## 148        66.14         4       13.2280    5.6
## 149        71.86         8       28.7440    6.2
## 150        32.46         8       12.9840    4.9
## 151        91.54         4       18.3080    4.8
## 152        34.56         7       12.0960    7.3
## 153        83.24         9       37.4580    7.4
## 154        16.48         6        4.9440    9.9
## 155        80.97         8       32.3880    9.3
## 156        92.29         5       23.0725    9.0
## 157        72.17         1        3.6085    6.1
## 158        50.28         5       12.5700    9.7
## 159        97.22         9       43.7490    6.0
## 160        93.39         6       28.0170   10.0
## 161        43.18         8       17.2720    8.3
## 162        63.69         1        3.1845    6.0
## 163        45.79         7       16.0265    7.0
## 164        76.40         2        7.6400    6.5
## 165        39.90        10       19.9500    5.9
## 166        42.57         8       17.0280    5.6
## 167        95.58        10       47.7900    4.8
## 168        98.98        10       49.4900    8.7
## 169        51.28         6       15.3840    6.5
## 170        69.52         7       24.3320    8.5
## 171        70.01         5       17.5025    5.5
## 172        80.05         5       20.0125    9.4
## 173        20.85         8        8.3400    6.3
## 174        52.89         6       15.8670    9.8
## 175        19.79         8        7.9160    8.7
## 176        33.84         9       15.2280    8.8
## 177        22.17         8        8.8680    9.6
## 178        22.51         7        7.8785    4.8
## 179        73.88         6       22.1640    4.4
## 180        86.80         3       13.0200    9.9
## 181        64.26         7       22.4910    5.7
## 182        38.47         8       15.3880    7.7
## 183        15.50        10        7.7500    8.0
## 184        34.31         8       13.7240    5.7
## 185        12.34         7        4.3190    6.7
## 186        18.08         3        2.7120    8.0
## 187        94.49         8       37.7960    7.5
## 188        46.47         4        9.2940    7.0
## 189        74.07         1        3.7035    9.9
## 190        69.81         4       13.9620    5.9
## 191        77.04         3       11.5560    7.2
```

```
## 192        73.52          2        7.3520    4.6
## 193        87.80          9       39.5100    9.2
## 194        25.55          4        5.1100    5.7
## 195        32.71          5        8.1775    9.9
## 196        74.29          1        3.7145    5.0
## 197        43.70          2        4.3700    4.9
## 198        25.29          1        1.2645    6.1
## 199        41.50          4        8.3000    8.2
## 200        71.39          5       17.8475    5.5
## 201        19.15          6        5.7450    6.8
## 202        57.49          4       11.4980    6.6
## 203        61.41          7       21.4935    9.8
## 204        25.90         10       12.9500    8.7
## 205        17.77          5        4.4425    5.4
## 206        23.03          9       10.3635    7.9
## 207        66.65          9       29.9925    9.7
## 208        28.53         10       14.2650    7.8
## 209        30.37          3        4.5555    5.1
## 210        99.73          9       44.8785    6.5
## 211        26.23          9       11.8035    5.9
## 212        93.26          9       41.9670    8.8
## 213        92.36          5       23.0900    4.9
## 214        46.42          3        6.9630    4.4
## 215        29.61          7       10.3635    6.5
## 216        18.28          1        0.9140    8.3
## 217        24.77          5        6.1925    8.5
## 218        94.64          3       14.1960    5.5
## 219        94.87          8       37.9480    8.7
## 220        57.34          3        8.6010    7.9
## 221        45.35          6       13.6050    6.1
## 222        62.08          7       21.7280    5.4
## 223        11.81          5        2.9525    9.4
## 224        12.54          1        0.6270    8.2
## 225        43.25          2        4.3250    6.2
## 226        87.16          2        8.7160    9.7
## 227        69.37          9       31.2165    4.0
## 228        37.06          4        7.4120    9.7
## 229        90.70          6       27.2100    5.3
## 230        63.42          8       25.3680    7.4
## 231        81.37          2        8.1370    6.5
## 232        10.59          3        1.5885    8.7
## 233        84.09          9       37.8405    8.0
## 234        73.82          4       14.7640    6.7
## 235        51.94         10       25.9700    6.5
## 236        93.14          2        9.3140    4.1
## 237        17.41          5        4.3525    4.9
## 238        44.22          5       11.0550    8.6
## 239        13.22          5        3.3050    4.3
## 240        89.69          1        4.4845    4.9
## 241        24.94          9       11.2230    5.6
```

```
## 242        59.77         2        5.9770    5.8
## 243        93.20         2        9.3200    6.0
## 244        62.65         4       12.5300    4.2
## 245        93.87         8       37.5480    8.3
## 246        47.59         8       19.0360    5.7
## 247        81.40         3       12.2100    4.8
## 248        17.94         5        4.4850    6.8
## 249        77.72         4       15.5440    8.8
## 250        73.06         7       25.5710    4.2
## 251        46.55         9       20.9475    6.4
## 252        35.19        10       17.5950    8.4
## 253        14.39         2        1.4390    7.2
## 254        23.75         4        4.7500    5.2
## 255        58.90         8       23.5600    8.9
## 256        32.62         4        6.5240    9.0
## 257        66.35         1        3.3175    9.7
## 258        25.91         6        7.7730    8.7
## 259        32.25         4        6.4500    6.5
## 260        65.94         4       13.1880    6.9
## 261        75.06         9       33.7770    6.2
## 262        16.45         4        3.2900    5.6
## 263        38.30         4        7.6600    5.7
## 264        22.24        10       11.1200    4.2
## 265        54.45         1        2.7225    7.9
## 266        98.40         7       34.4400    8.7
## 267        35.47         4        7.0940    6.9
## 268        74.60        10       37.3000    9.5
## 269        70.74         4       14.1480    4.4
## 270        35.54        10       17.7700    7.0
## 271        67.43         5       16.8575    6.3
## 272        21.12         2        2.1120    9.7
## 273        21.54         9        9.6930    8.8
## 274        12.03         2        1.2030    5.1
## 275        99.71         6       29.9130    7.9
## 276        47.97         7       16.7895    6.2
## 277        21.82        10       10.9100    7.1
## 278        95.42         4       19.0840    6.4
## 279        70.99        10       35.4950    5.7
## 280        44.02        10       22.0100    9.6
## 281        69.96         8       27.9840    6.4
## 282        37.00         1        1.8500    7.9
## 283        15.34         1        0.7670    6.5
## 284        99.83         6       29.9490    8.5
## 285        47.67         4        9.5340    9.1
## 286        66.68         5       16.6700    7.6
## 287        74.86         1        3.7430    6.9
## 288        23.75         9       10.6875    9.5
## 289        48.51         7       16.9785    5.2
## 290        94.88         7       33.2080    4.2
## 291        40.30        10       20.1500    7.0
```

```
## 292        27.85         7        9.7475    6.0
## 293        62.48         1        3.1240    4.7
## 294        36.36         2        3.6360    7.1
## 295        18.11        10        9.0550    5.9
## 296        51.92         5       12.9800    7.5
## 297        28.84         4        5.7680    6.4
## 298        78.38         6       23.5140    5.8
## 299        60.01         4       12.0020    4.5
## 300        88.61         1        4.4305    7.7
## 301        99.82         2        9.9820    6.7
## 302        39.01         1        1.9505    4.7
## 303        48.61         1        2.4305    4.4
## 304        51.19         4       10.2380    4.7
## 305        14.96         8        5.9840    8.6
## 306        72.20         7       25.2700    4.3
## 307        40.23         7       14.0805    9.6
## 308        88.79         8       35.5160    4.1
## 309        26.48         3        3.9720    4.7
## 310        81.91         2        8.1910    7.8
## 311        79.93         6       23.9790    5.5
## 312        69.33         2        6.9330    9.7
## 313        14.23         5        3.5575    4.4
## 314        15.55         9        6.9975    5.0
## 315        78.13        10       39.0650    4.4
## 316        99.37         2        9.9370    5.2
## 317        21.08         3        3.1620    7.3
## 318        74.79         5       18.6975    4.9
## 319        29.67         7       10.3845    8.1
## 320        44.07         4        8.8140    8.4
## 321        22.93         9       10.3185    5.5
## 322        39.42         1        1.9710    8.4
## 323        15.26         6        4.5780    9.8
## 324        61.77         5       15.4425    6.7
## 325        21.52         6        6.4560    9.4
## 326        97.74         4       19.5480    6.4
## 327        99.78         5       24.9450    5.4
## 328        94.26         4       18.8520    8.6
## 329        51.13         4       10.2260    4.0
## 330        36.36         4        7.2720    7.6
## 331        22.02         9        9.9090    6.8
## 332        32.90         3        4.9350    9.1
## 333        77.02         5       19.2550    5.5
## 334        23.48         2        2.3480    7.9
## 335        14.70         5        3.6750    8.5
## 336        28.45         5        7.1125    9.1
## 337        76.40         9       34.3800    7.5
## 338        57.95         6       17.3850    5.2
## 339        47.65         3        7.1475    9.5
## 340        42.82         9       19.2690    8.9
## 341        48.09         3        7.2135    7.8
```

```
## 342        55.97        7      19.5895    8.9
## 343        76.90        7      26.9150    7.7
## 344        97.03        5      24.2575    9.3
## 345        44.65        3       6.6975    6.2
## 346        77.93        9      35.0685    7.6
## 347        71.95        1       3.5975    7.3
## 348        89.25        8      35.7000    4.7
## 349        26.02        7       9.1070    5.1
## 350        13.50       10       6.7500    4.8
## 351        99.30       10      49.6500    6.6
## 352        51.69        7      18.0915    5.5
## 353        54.73        7      19.1555    8.5
## 354        27.00        9      12.1500    4.8
## 355        30.24        1       1.5120    8.4
## 356        89.14        4      17.8280    7.8
## 357        37.55       10      18.7750    9.3
## 358        95.44       10      47.7200    5.2
## 359        27.50        3       4.1250    6.5
## 360        74.97        1       3.7485    5.6
## 361        80.96        8      32.3840    7.4
## 362        94.47        8      37.7880    9.1
## 363        99.79        2       9.9790    8.0
## 364        73.22        6      21.9660    7.2
## 365        41.24        4       8.2480    7.1
## 366        81.68        4      16.3360    9.1
## 367        51.32        9      23.0940    5.6
## 368        65.94        4      13.1880    6.0
## 369        14.36       10       7.1800    5.4
## 370        21.50        9       9.6750    7.8
## 371        26.26        7       9.1910    9.9
## 372        60.96        2       6.0960    4.9
## 373        70.11        6      21.0330    5.2
## 374        42.08        6      12.6240    8.9
## 375        67.09        5      16.7725    9.1
## 376        96.70        5      24.1750    7.0
## 377        35.38        9      15.9210    9.6
## 378        95.49        7      33.4215    8.7
## 379        96.98        4      19.3960    9.4
## 380        23.65        4       4.7300    4.0
## 381        82.33        4      16.4660    7.5
## 382        26.61        2       2.6610    4.2
## 383        99.69        5      24.9225    9.9
## 384        74.89        4      14.9780    4.2
## 385        40.94        5      10.2350    9.9
## 386        75.82        1       3.7910    5.8
## 387        46.77        6      14.0310    6.0
## 388        32.32       10      16.1600   10.0
## 389        54.07        9      24.3315    9.5
## 390        18.22        7       6.3770    6.6
## 391        80.48        3      12.0720    8.1
```

```
## 392       37.95       10      18.9750    9.7
## 393       76.82        1       3.8410    7.2
## 394       52.26       10      26.1300    6.2
## 395       79.74        1       3.9870    7.3
## 396       77.50        5      19.3750    4.3
## 397       54.27        5      13.5675    4.6
## 398       13.59        9       6.1155    5.8
## 399       41.06        6      12.3180    8.3
## 400       19.24        9       8.6580    8.0
## 401       39.43        6      11.8290    9.4
## 402       46.22        4       9.2440    6.2
## 403       13.98        1       0.6990    9.8
## 404       39.75        5       9.9375    9.6
## 405       97.79        7      34.2265    4.9
## 406       67.26        4      13.4520    8.0
## 407       13.79        5       3.4475    7.8
## 408       68.71        4      13.7420    4.1
## 409       56.53        4      11.3060    5.5
## 410       23.82        5       5.9550    5.4
## 411       34.21       10      17.1050    5.1
## 412       21.87        2       2.1870    6.9
## 413       20.97        5       5.2425    7.8
## 414       25.84        3       3.8760    6.6
## 415       50.93        8      20.3720    9.2
## 416       96.11        1       4.8055    7.8
## 417       45.38        4       9.0760    8.7
## 418       81.51        1       4.0755    9.2
## 419       57.22        2       5.7220    8.3
## 420       25.22        7       8.8270    8.2
## 421       38.60        3       5.7900    7.5
## 422       84.05        3      12.6075    9.8
## 423       97.21       10      48.6050    8.7
## 424       25.42        8      10.1680    6.7
## 425       16.28        1       0.8140    5.0
## 426       40.61        9      18.2745    7.0
## 427       53.17        7      18.6095    8.9
## 428       20.87        3       3.1305    8.0
## 429       67.27        5      16.8175    6.9
## 430       90.65       10      45.3250    7.3
## 431       69.08        2       6.9080    6.9
## 432       43.27        2       4.3270    5.7
## 433       23.46        6       7.0380    6.4
## 434       95.54        7      33.4390    9.6
## 435       47.44        1       2.3720    6.8
## 436       99.24        9      44.6580    9.0
## 437       82.93        4      16.5860    9.6
## 438       33.99        6      10.1970    7.7
## 439       17.04        4       3.4080    7.0
## 440       40.86        8      16.3440    6.5
## 441       17.44        5       4.3600    8.1
```

```
## 442         88.43          8       35.3720    4.3
## 443         89.21          9       40.1445    6.5
## 444         12.78          1        0.6390    9.5
## 445         19.10          7        6.6850    9.7
## 446         19.15          1        0.9575    9.5
## 447         27.66         10       13.8300    8.9
## 448         45.74          3        6.8610    6.5
## 449         27.07          1        1.3535    5.3
## 450         39.12          1        1.9560    9.6
## 451         74.71          6       22.4130    6.7
## 452         22.01          6        6.6030    7.6
## 453         63.61          5       15.9025    4.8
## 454         25.00          1        1.2500    5.5
## 455         20.77          4        4.1540    4.7
## 456         29.56          5        7.3900    6.9
## 457         77.40          9       34.8300    4.5
## 458         79.39         10       39.6950    6.2
## 459         46.57         10       23.2850    7.6
## 460         35.89          1        1.7945    7.9
## 461         40.52          5       10.1300    4.5
## 462         73.05         10       36.5250    8.7
## 463         73.95          4       14.7900    6.1
## 464         22.62          1        1.1310    6.4
## 465         51.34          5       12.8350    9.1
## 466         54.55         10       27.2750    7.1
## 467         37.15          7       13.0025    7.7
## 468         37.02          6       11.1060    4.5
## 469         21.58          1        1.0790    7.2
## 470         98.84          1        4.9420    8.4
## 471         83.77          6       25.1310    5.4
## 472         40.05          4        8.0100    9.7
## 473         43.13         10       21.5650    5.5
## 474         72.57          8       29.0280    4.6
## 475         64.44          5       16.1100    6.6
## 476         65.18          3        9.7770    6.3
## 477         33.26          5        8.3150    4.2
## 478         84.07          4       16.8140    4.4
## 479         34.37         10       17.1850    6.7
## 480         38.60          1        1.9300    6.7
## 481         65.97          8       26.3880    8.4
## 482         32.80         10       16.4000    6.2
## 483         37.14          5        9.2850    5.0
## 484         60.38         10       30.1900    6.0
## 485         36.98         10       18.4900    7.0
## 486         49.49          4        9.8980    6.6
## 487         41.09         10       20.5450    7.3
## 488         37.15          4        7.4300    8.3
## 489         22.96          1        1.1480    4.3
## 490         77.68          9       34.9560    9.8
## 491         34.70          2        3.4700    8.2
```

```
## 492        19.66       10       9.8300    7.2
## 493        25.32        8      10.1280    8.7
## 494        12.12       10       6.0600    8.4
## 495        99.89        2       9.9890    7.1
## 496        75.92        8      30.3680    5.5
## 497        63.22        2       6.3220    8.5
## 498        90.24        6      27.0720    6.2
## 499        98.13        1       4.9065    8.9
## 500        51.52        8      20.6080    9.6
## 501        73.97        1       3.6985    5.4
## 502        31.90        1       1.5950    9.1
## 503        69.40        2       6.9400    9.0
## 504        93.31        2       9.3310    6.3
## 505        88.45        1       4.4225    9.5
## 506        24.18        8       9.6720    9.8
## 507        48.50        3       7.2750    6.7
## 508        84.05        6      25.2150    7.7
## 509        61.29        5      15.3225    7.0
## 510        15.95        6       4.7850    5.1
## 511        90.74        7      31.7590    6.2
## 512        42.91        5      10.7275    6.1
## 513        54.28        7      18.9980    9.3
## 514        99.55        7      34.8425    7.6
## 515        58.39        7      20.4365    8.2
## 516        51.47        1       2.5735    8.5
## 517        54.86        5      13.7150    9.8
## 518        39.39        5       9.8475    8.7
## 519        34.73        2       3.4730    9.7
## 520        71.92        5      17.9800    4.3
## 521        45.71        3       6.8565    7.7
## 522        83.17        6      24.9510    7.3
## 523        37.44        6      11.2320    5.9
## 524        62.87        2       6.2870    5.0
## 525        81.71        6      24.5130    8.0
## 526        91.41        5      22.8525    7.1
## 527        39.21        4       7.8420    9.0
## 528        59.86        2       5.9860    6.7
## 529        54.36       10      27.1800    6.1
## 530        98.09        9      44.1405    9.3
## 531        25.43        6       7.6290    7.0
## 532        86.68        8      34.6720    7.2
## 533        22.95       10      11.4750    8.2
## 534        16.31        9       7.3395    8.4
## 535        28.32        5       7.0800    6.2
## 536        16.67        7       5.8345    7.4
## 537        73.96        1       3.6980    5.0
## 538        97.94        1       4.8970    6.9
## 539        73.05        4      14.6100    4.9
## 540        87.48        6      26.2440    5.1
## 541        30.68        3       4.6020    9.1
```

```
## 542        75.88         1        3.7940    7.1
## 543        20.18         4        4.0360    5.0
## 544        18.77         6        5.6310    5.5
## 545        71.20         1        3.5600    9.2
## 546        38.81         4        7.7620    4.9
## 547        29.42        10       14.7100    8.9
## 548        60.95         9       27.4275    6.0
## 549        51.54         5       12.8850    4.2
## 550        66.06         6       19.8180    7.3
## 551        57.27         3        8.5905    6.5
## 552        54.31         9       24.4395    8.9
## 553        58.24         9       26.2080    9.7
## 554        22.21         6        6.6630    8.6
## 555        19.32         7        6.7620    6.9
## 556        37.48         3        5.6220    7.7
## 557        72.04         2        7.2040    9.5
## 558        98.52        10       49.2600    4.5
## 559        41.66         6       12.4980    5.6
## 560        72.42         3       10.8630    8.2
## 561        21.58         9        9.7110    7.3
## 562        89.20        10       44.6000    4.4
## 563        42.42         8       16.9680    5.7
## 564        74.51         6       22.3530    5.0
## 565        99.25         2        9.9250    9.0
## 566        81.21        10       40.6050    6.3
## 567        49.33        10       24.6650    9.4
## 568        65.74         9       29.5830    7.7
## 569        79.86         7       27.9510    5.5
## 570        73.98         7       25.8930    4.1
## 571        82.04         5       20.5100    7.6
## 572        26.67        10       13.3350    8.6
## 573        10.13         7        3.5455    8.3
## 574        72.39         2        7.2390    8.1
## 575        85.91         5       21.4775    8.6
## 576        81.31         7       28.4585    6.3
## 577        60.30         4       12.0600    5.8
## 578        31.77         4        6.3540    6.2
## 579        64.27         4       12.8540    7.7
## 580        69.51         2        6.9510    8.1
## 581        27.22         3        4.0830    7.3
## 582        77.68         4       15.5360    8.4
## 583        92.98         2        9.2980    8.0
## 584        18.08         4        3.6160    9.5
## 585        63.06         3        9.4590    7.0
## 586        51.71         4       10.3420    9.8
## 587        52.34         3        7.8510    9.2
## 588        43.06         5       10.7650    7.7
## 589        59.61        10       29.8050    5.3
## 590        14.62         5        3.6550    4.4
## 591        46.53         6       13.9590    4.3
```

```
## 592        24.24        7       8.4840    9.4
## 593        45.58        1       2.2790    9.8
## 594        75.20        3      11.2800    4.8
## 595        96.80        3      14.5200    5.3
## 596        14.82        3       2.2230    8.7
## 597        52.20        3       7.8300    9.5
## 598        46.66        9      20.9970    5.3
## 599        36.85        5       9.2125    9.2
## 600        70.32        2       7.0320    9.6
## 601        83.08        1       4.1540    6.4
## 602        64.99        1       3.2495    4.5
## 603        77.56       10      38.7800    6.9
## 604        54.51        6      16.3530    7.8
## 605        51.89        7      18.1615    4.5
## 606        31.75        4       6.3500    8.6
## 607        53.65        7      18.7775    5.2
## 608        49.79        4       9.9580    6.4
## 609        30.61        1       1.5305    5.2
## 610        57.89        2       5.7890    8.9
## 611        28.96        1       1.4480    6.2
## 612        98.97        9      44.5365    6.7
## 613        93.22        3      13.9830    7.2
## 614        80.93        1       4.0465    9.0
## 615        67.45       10      33.7250    4.2
## 616        38.72        9      17.4240    4.2
## 617        72.60        6      21.7800    6.9
## 618        87.91        5      21.9775    4.4
## 619        98.53        6      29.5590    4.0
## 620        43.46        6      13.0380    8.5
## 621        71.68        3      10.7520    9.2
## 622        91.61        1       4.5805    9.8
## 623        94.59        7      33.1065    4.9
## 624        83.25       10      41.6250    4.4
## 625        91.35        1       4.5675    6.8
## 626        78.88        2       7.8880    9.1
## 627        60.87        2       6.0870    8.7
## 628        82.58       10      41.2900    5.0
## 629        53.30        3       7.9950    7.5
## 630        12.09        1       0.6045    8.2
## 631        64.19       10      32.0950    6.7
## 632        78.31        3      11.7465    5.4
## 633        83.77        2       8.3770    7.0
## 634        99.70        3      14.9550    4.7
## 635        79.91        3      11.9865    5.0
## 636        66.47       10      33.2350    5.0
## 637        28.95        7      10.1325    6.0
## 638        46.20        1       2.3100    6.3
## 639        17.63        5       4.4075    8.5
## 640        52.42        3       7.8630    7.5
## 641        98.79        3      14.8185    6.4
```

```
## 642        88.55         8      35.4200    4.7
## 643        55.67         2       5.5670    6.0
## 644        72.52         8      29.0080    4.0
## 645        12.05         5       3.0125    5.5
## 646        19.36         9       8.7120    8.7
## 647        70.21         6      21.0630    7.4
## 648        33.63         1       1.6815    5.6
## 649        15.49         2       1.5490    6.3
## 650        24.74        10      12.3700    7.1
## 651        75.66         5      18.9150    7.8
## 652        55.81         6      16.7430    9.9
## 653        72.78        10      36.3900    7.3
## 654        37.32         9      16.7940    5.1
## 655        60.18         4      12.0360    9.4
## 656        15.69         3       2.3535    5.8
## 657        99.69         1       4.9845    8.0
## 658        88.15         3      13.2225    7.9
## 659        27.93         5       6.9825    5.9
## 660        55.45         1       2.7725    4.9
## 661        42.97         3       6.4455    9.3
## 662        17.14         7       5.9990    7.9
## 663        58.75         6      17.6250    5.9
## 664        87.10        10      43.5500    9.9
## 665        98.80         2       9.8800    7.7
## 666        48.63         4       9.7260    7.6
## 667        57.74         3       8.6610    7.7
## 668        17.97         4       3.5940    6.4
## 669        47.71         6      14.3130    4.4
## 670        40.62         2       4.0620    4.1
## 671        56.04        10      28.0200    4.4
## 672        93.40         2       9.3400    5.5
## 673        73.41         3      11.0115    4.0
## 674        33.64         8      13.4560    9.3
## 675        45.48        10      22.7400    4.8
## 676        83.77         2       8.3770    4.6
## 677        64.08         7      22.4280    7.3
## 678        73.47         4      14.6940    6.0
## 679        58.95        10      29.4750    8.1
## 680        48.50         6      14.5500    9.4
## 681        39.48         1       1.9740    6.5
## 682        34.81         1       1.7405    7.0
## 683        49.32         6      14.7960    7.1
## 684        21.48         2       2.1480    6.6
## 685        23.08         6       6.9240    4.9
## 686        49.10         2       4.9100    6.4
## 687        64.83         2       6.4830    8.0
## 688        63.56        10      31.7800    4.3
## 689        72.88         2       7.2880    6.1
## 690        67.10         3      10.0650    7.5
## 691        70.19         9      31.5855    6.7
```

```
## 692        55.04        7      19.2640     5.2
## 693        48.63       10      24.3150     8.8
## 694        73.38        7      25.6830     9.5
## 695        52.60        9      23.6700     7.6
## 696        87.37        5      21.8425     6.6
## 697        27.04        4       5.4080     6.9
## 698        62.19        4      12.4380     4.3
## 699        69.58        9      31.3110     7.8
## 700        97.50       10      48.7500     8.0
## 701        60.41        8      24.1640     9.6
## 702        32.32        3       4.8480     4.3
## 703        19.77       10       9.8850     5.0
## 704        80.47        9      36.2115     9.2
## 705        88.39        9      39.7755     6.3
## 706        71.77        7      25.1195     8.9
## 707        43.00        4       8.6000     7.6
## 708        68.98        1       3.4490     4.8
## 709        15.62        8       6.2480     9.1
## 710        25.70        3       3.8550     6.1
## 711        80.62        6      24.1860     9.1
## 712        75.53        4      15.1060     8.3
## 713        77.63        9      34.9335     7.2
## 714        13.85        9       6.2325     6.0
## 715        98.70        8      39.4800     8.5
## 716        35.68        5       8.9200     6.6
## 717        71.46        7      25.0110     4.5
## 718        11.94        3       1.7910     8.1
## 719        45.38        3       6.8070     7.2
## 720        17.48        6       5.2440     6.1
## 721        25.56        7       8.9460     7.1
## 722        90.63        9      40.7835     5.1
## 723        44.12        3       6.6180     7.9
## 724        36.77        7      12.8695     7.4
## 725        23.34        4       4.6680     7.4
## 726        28.50        8      11.4000     6.6
## 727        55.57        3       8.3355     5.9
## 728        69.74       10      34.8700     8.9
## 729        97.26        4      19.4520     6.8
## 730        52.18        7      18.2630     9.3
## 731        22.32        4       4.4640     4.4
## 732        56.00        3       8.4000     4.8
## 733        19.70        1       0.9850     9.5
## 734        75.88        7      26.5580     8.9
## 735        53.72        1       2.6860     6.4
## 736        81.95       10      40.9750     6.0
## 737        81.20        7      28.4200     8.1
## 738        58.76       10      29.3800     9.0
## 739        91.56        8      36.6240     6.0
## 740        93.96        9      42.2820     9.8
## 741        55.61        7      19.4635     8.5
```

```
## 742        84.83         1       4.2415    8.8
## 743        71.63         2       7.1630    8.8
## 744        37.69         2       3.7690    9.5
## 745        31.67         8      12.6680    5.6
## 746        38.42         1       1.9210    8.6
## 747        65.23        10      32.6150    5.2
## 748        10.53         5       2.6325    5.8
## 749        12.29         9       5.5305    8.0
## 750        81.23         7      28.4305    9.0
## 751        22.32         4       4.4640    4.1
## 752        27.28         5       6.8200    8.6
## 753        17.42        10       8.7100    7.0
## 754        73.28         5      18.3200    8.4
## 755        84.87         3      12.7305    7.4
## 756        97.29         8      38.9160    6.2
## 757        35.74         8      14.2960    4.9
## 758        96.52         6      28.9560    4.5
## 759        18.85        10       9.4250    5.6
## 760        55.39         4      11.0780    8.0
## 761        77.20        10      38.6000    5.6
## 762        72.13        10      36.0650    4.2
## 763        63.88         8      25.5520    9.9
## 764        10.69         5       2.6725    7.6
## 765        55.50         4      11.1000    6.6
## 766        95.46         8      38.1840    4.7
## 767        76.06         3      11.4090    9.8
## 768        13.69         6       4.1070    6.3
## 769        95.64         4      19.1280    7.9
## 770        11.43         6       3.4290    7.7
## 771        95.54         4      19.1080    4.5
## 772        85.87         7      30.0545    8.0
## 773        67.99         7      23.7965    5.7
## 774        52.42         1       2.6210    6.3
## 775        65.65         2       6.5650    6.0
## 776        28.86         5       7.2150    8.0
## 777        65.31         7      22.8585    4.2
## 778        93.38         1       4.6690    9.6
## 779        25.25         5       6.3125    6.1
## 780        87.87         9      39.5415    5.6
## 781        21.80         8       8.7200    8.3
## 782        94.76         4      18.9520    7.8
## 783        30.62         1       1.5310    4.1
## 784        44.01         8      17.6040    8.8
## 785        10.16         5       2.5400    4.1
## 786        74.58         7      26.1030    9.0
## 787        71.89         8      28.7560    5.5
## 788        10.99         5       2.7475    9.3
## 789        60.47         3       9.0705    5.6
## 790        58.91         7      20.6185    9.7
## 791        46.41         1       2.3205    4.0
```

```
## 792         68.55          4       13.7100    9.2
## 793         97.37         10       48.6850    4.9
## 794         92.60          7       32.4100    9.3
## 795         46.61          2        4.6610    6.6
## 796         27.18          2        2.7180    4.3
## 797         60.87          1        3.0435    5.5
## 798         24.49         10       12.2450    8.1
## 799         92.78          1        4.6390    9.8
## 800         86.69          5       21.6725    9.4
## 801         23.01          6        6.9030    7.9
## 802         30.20          8       12.0800    5.1
## 803         67.39          7       23.5865    6.9
## 804         48.96          9       22.0320    8.0
## 805         75.59          9       34.0155    8.0
## 806         77.47          4       15.4940    4.2
## 807         93.18          2        9.3180    8.5
## 808         50.23          4       10.0460    9.0
## 809         17.75          1        0.8875    8.6
## 810         62.18         10       31.0900    6.0
## 811         10.75          8        4.3000    6.2
## 812         40.26         10       20.1300    5.0
## 813         64.97          5       16.2425    6.5
## 814         95.15          1        4.7575    6.0
## 815         48.62          8       19.4480    5.0
## 816         53.21          8       21.2840    5.0
## 817         45.44          7       15.9040    9.2
## 818         33.88          8       13.5520    9.6
## 819         96.16          4       19.2320    8.4
## 820         47.16          5       11.7900    6.0
## 821         52.89          4       10.5780    6.7
## 822         47.68          2        4.7680    4.1
## 823         10.17          1        0.5085    5.9
## 824         68.71          3       10.3065    8.7
## 825         60.08          7       21.0280    4.5
## 826         22.01          4        4.4020    6.6
## 827         72.11          9       32.4495    7.7
## 828         41.28          3        6.1920    8.5
## 829         64.95         10       32.4750    5.2
## 830         74.22         10       37.1100    4.3
## 831         10.56          8        4.2240    7.6
## 832         62.57          4       12.5140    9.5
## 833         11.85          8        4.7400    4.1
## 834         91.30          1        4.5650    9.2
## 835         40.73          7       14.2555    5.4
## 836         52.38          1        2.6190    5.8
## 837         38.54          5        9.6350    5.6
## 838         44.63          6       13.3890    5.1
## 839         55.87         10       27.9350    5.8
## 840         29.22          6        8.7660    5.0
## 841         51.94          3        7.7910    7.9
```

```
## 842       60.30        1     3.0150    6.0
## 843       39.47        2     3.9470    5.0
## 844       14.87        2     1.4870    8.9
## 845       21.32        1     1.0660    5.9
## 846       93.78        3    14.0670    5.9
## 847       73.26        1     3.6630    9.7
## 848       22.38        1     1.1190    8.6
## 849       72.88        9    32.7960    4.0
## 850       99.10        6    29.7300    4.2
## 851       74.10        1     3.7050    9.2
## 852       98.48        2     9.8480    9.2
## 853       53.19        7    18.6165    5.0
## 854       52.79       10    26.3950   10.0
## 855       95.95        5    23.9875    8.8
## 856       36.51        9    16.4295    4.2
## 857       21.12        8     8.4480    6.3
## 858       28.31        4     5.6620    8.2
## 859       57.59        6    17.2770    5.1
## 860       47.63        9    21.4335    5.0
## 861       86.27        1     4.3135    7.0
## 862       12.76        2     1.2760    7.8
## 863       11.28        9     5.0760    4.3
## 864       51.07        7    17.8745    7.0
## 865       79.59        3    11.9385    6.6
## 866       33.81        3     5.0715    7.3
## 867       90.53        8    36.2120    6.5
## 868       62.82        2     6.2820    4.9
## 869       24.31        3     3.6465    4.3
## 870       64.59        4    12.9180    9.3
## 871       24.82        7     8.6870    7.1
## 872       56.50        1     2.8250    9.6
## 873       21.43       10    10.7150    6.2
## 874       89.06        6    26.7180    9.9
## 875       23.29        4     4.6580    5.9
## 876       65.26        8    26.1040    6.3
## 877       52.35        1     2.6175    4.0
## 878       39.75        1     1.9875    6.1
## 879       90.02        8    36.0080    4.5
## 880       12.10        8     4.8400    8.6
## 881       33.21       10    16.6050    6.0
## 882       10.18        8     4.0720    9.5
## 883       31.99       10    15.9950    9.9
## 884       34.42        6    10.3260    7.5
## 885       83.34        2     8.3340    7.6
## 886       45.58        7    15.9530    5.0
## 887       87.90        1     4.3950    6.7
## 888       73.47       10    36.7350    9.5
## 889       12.19        8     4.8760    6.8
## 890       76.92       10    38.4600    5.6
## 891       83.66        5    20.9150    7.2
```

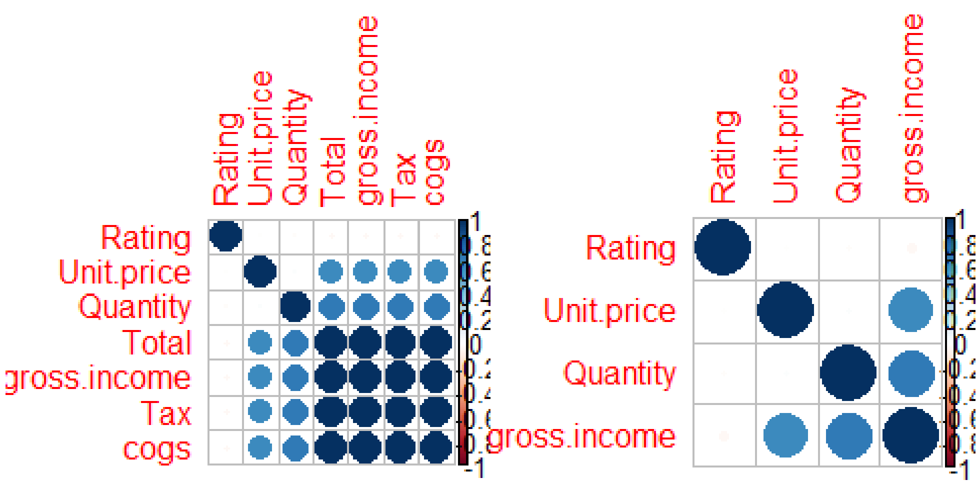
```
## 892        57.91          8       23.1640    8.1
## 893        92.49          5       23.1225    8.6
## 894        28.38          5        7.0950    9.4
## 895        50.45          6       15.1350    8.9
## 896        99.16          8       39.6640    4.2
## 897        60.74          7       21.2590    5.0
## 898        47.27          6       14.1810    8.8
## 899        85.60          7       29.9600    5.3
## 900        35.04          9       15.7680    4.6
## 901        44.84          9       20.1780    7.5
## 902        45.97          4        9.1940    5.1
## 903        27.73          5        6.9325    4.2
## 904        11.53          7        4.0355    8.1
## 905        58.32          2        5.8320    6.0
## 906        78.38          4       15.6760    7.9
## 907        84.61         10       42.3050    8.8
## 908        82.88          5       20.7200    6.6
## 909        79.54          2        7.9540    6.2
## 910        49.01         10       24.5050    4.2
## 911        29.15          3        4.3725    7.3
## 912        56.13          4       11.2260    8.6
## 913        93.12          8       37.2480    6.8
## 914        51.34          8       20.5360    7.6
## 915        99.60          3       14.9400    5.8
## 916        35.49          6       10.6470    4.1
## 917        42.85          1        2.1425    9.3
## 918        94.67          4       18.9340    6.8
## 919        68.97          3       10.3455    8.7
## 920        26.26          3        3.9390    6.3
## 921        35.79          9       16.1055    5.1
## 922        16.37          6        4.9110    7.0
## 923        12.73          2        1.2730    5.2
## 924        83.14          7       29.0990    6.6
## 925        35.22          6       10.5660    6.5
## 926        13.78          4        2.7560    9.0
## 927        88.31          1        4.4155    5.2
## 928        39.62          9       17.8290    6.8
## 929        88.25          9       39.7125    7.6
## 930        25.31          2        2.5310    7.2
## 931        99.92          6       29.9760    7.1
## 932        83.35          2        8.3350    9.5
## 933        74.44         10       37.2200    5.1
## 934        64.08          7       22.4280    7.6
## 935        63.15          6       18.9450    9.8
## 936        85.72          3       12.8580    5.1
## 937        78.89          7       27.6115    7.5
## 938        89.48          5       22.3700    7.4
## 939        92.09          3       13.8135    4.2
## 940        57.29          6       17.1870    5.9
## 941        66.52          4       13.3040    6.9
```

```
## 942         99.82          9       44.9190    6.6
## 943         45.68         10       22.8400    5.7
## 944         50.79          5       12.6975    5.3
## 945         10.08          7        3.5280    4.2
## 946         93.88          7       32.8580    7.3
## 947         84.25          2        8.4250    5.3
## 948         53.78          1        2.6890    4.7
## 949         35.81          5        8.9525    7.9
## 950         26.43          8       10.5720    8.9
## 951         39.91          3        5.9865    9.3
## 952         21.90          3        3.2850    4.7
## 953         62.85          4       12.5700    8.7
## 954         21.04          4        4.2080    7.6
## 955         65.91          6       19.7730    5.7
## 956         42.57          7       14.8995    6.8
## 957         50.49          9       22.7205    5.4
## 958         46.02          6       13.8060    7.1
## 959         15.80         10        7.9000    7.8
## 960         98.66          9       44.3970    8.4
## 961         91.98          1        4.5990    9.8
## 962         20.89          2        2.0890    9.8
## 963         15.50          1        0.7750    7.4
## 964         96.82          3       14.5230    6.7
## 965         33.33          2        3.3330    6.4
## 966         38.27          2        3.8270    5.8
## 967         33.30          9       14.9850    7.2
## 968         81.01          3       12.1515    9.3
## 969         15.80          3        2.3700    9.5
## 970         34.49          5        8.6225    9.0
## 971         84.63         10       42.3150    9.0
## 972         36.91          7       12.9185    6.7
## 973         87.08          7       30.4780    5.5
## 974         80.08          3       12.0120    5.4
## 975         86.13          2        8.6130    8.2
## 976         49.92          2        4.9920    7.0
## 977         74.66          4       14.9320    8.5
## 978         26.60          6        7.9800    4.9
## 979         25.45          1        1.2725    5.1
## 980         67.77          1        3.3885    6.5
## 981         59.59          4       11.9180    9.8
## 982         58.15          4       11.6300    8.4
## 983         97.48          9       43.8660    7.4
## 984         99.96          7       34.9860    6.1
## 985         96.37          7       33.7295    6.0
## 986         63.71          5       15.9275    8.5
## 987         14.76          2        1.4760    4.3
## 988         62.00          8       24.8000    6.2
## 989         82.34         10       41.1700    4.3
## 990         75.37          8       30.1480    8.4
## 991         56.56          5       14.1400    4.5
```

```
## 992        76.60        10      38.3000    6.0
## 993        58.03         2       5.8030    8.8
## 994        17.49        10       8.7450    6.6
## 995        60.95         1       3.0475    5.9
## 996        40.35         1       2.0175    6.2
## 997        97.38        10      48.6900    4.4
## 998        31.84         1       1.5920    7.7
## 999        65.82         1       3.2910    4.1
## 1000       88.34         7      30.9190    6.6
```

Graphical comparison.

```r
par(mfrow = c(1, 2))
corrplot(corrmatrix, order = "hclust")
corrplot(cor(df3), order = "hclust")
```



Embedded Methods

We will use the ewkm function from the wskm package. This is a weighted subspace clustering algorithm that is well suited to very high dimensional data.

Loading our wskm package.

```r
#Installing and Loading our wskm and cluster package
suppressWarnings(
        suppressMessages(if
                         (!require(wskm, quietly=TRUE))
                install.packages("wskm")))
```

```
library(wskm)
suppressWarnings(
        suppressMessages(if
                         (!require(cluster, quietly=TRUE))
                install.packages("cluster")))
library("cluster")

#Deploying the function
set.seed(23)
model <- ewkm(df2, 3, lambda=2, maxiter=1000)
model
```

```
## K-means clustering with 3 clusters of sizes 587, 230, 183
##
## Cluster means:
##   Unit.price Quantity       Tax      cogs gross.income   Rating     Total
## 1   66.22920 6.936968 22.451185 449.02370    22.451185 6.933220 471.47488
## 2   38.24948 2.469565  3.249196  64.98391     3.249196 6.796087  68.23311
## 3   43.70607 4.754098  7.941030 158.82060     7.941030 7.321311 166.76163
##
## Clustering vector:
##    [1] 1 2 1 1 1 1 1 1 2 3 2 2 1 1 1 1 1 1 3 2 1 1 2 3 1 1 2 3 1 1 1 1 1 3
1 2 1
##   [38] 1 1 1 2 1 1 1 2 1 1 3 1 1 1 1 2 2 2 1 2 1 1 3 2 1 1 3 1 3 2 1 1 2 1
1 3 1
##   [75] 1 1 1 3 1 2 1 1 3 1 1 1 1 1 2 1 1 1 3 1 2 2 1 2 3 1 2 1 1 1 1 1 3 1
1 1 2
##  [112] 1 1 1 1 2 2 2 1 2 1 1 1 1 1 1 3 1 1 1 1 1 3 1 1 1 3 3 1 1 1 1 1 2 1
1 1 1
##  [149] 1 1 1 1 1 2 1 1 2 1 1 1 1 2 1 3 1 1 1 1 1 1 1 1 3 1 3 1 3 3 1 1 1 1
3 1 2
##  [186] 2 1 3 2 1 1 3 1 2 3 2 2 2 3 1 1 1 1 1 2 1 1 1 2 1 1 1 1 3 1 2 3 1 1
3 1 1
##  [223] 2 2 2 3 1 3 1 1 3 2 1 1 1 3 2 1 2 2 1 3 3 1 1 1 1 2 1 1 1 1 2 2 1 3
2 3 3
##  [260] 1 1 2 3 1 2 1 3 1 1 1 1 2 3 2 1 1 1 1 1 1 1 2 1 1 3 1 2 3 1 1 1 1 2
2 3 1
##  [297] 1 1 1 2 1 2 2 3 3 1 1 1 2 3 1 3 2 3 1 3 2 1 1 3 1 2 2 1 3 1 1 1 3 3
1 2 1
##  [334] 2 2 3 1 1 3 1 3 1 1 1 3 1 2 1 3 3 1 1 1 1 2 1 1 1 2 2 1 1 1 1 3 1 1
1 3 1
##  [371] 3 3 1 1 1 1 1 1 1 2 1 2 1 1 3 2 1 1 1 3 1 1 2 1 2 1 1 3 1 3 1 3 2 3
1 1 2
##  [408] 1 1 3 1 2 2 2 1 2 3 2 3 3 1 1 1 1 2 1 1 2 1 1 3 2 3 1 2 1 1 1 2 1 2
1 1 2
##  [445] 3 2 1 3 2 2 1 3 1 2 2 3 1 1 1 2 3 1 1 2 1 1 1 1 2 2 1 3 1 1 1 1 3 1
1 2 1
##  [482] 1 3 1 1 1 1 3 2 1 2 1 3 3 1 1 3 1 2 1 2 2 3 3 2 3 3 1 1 2 1 1 1 1 1
2 1 3
##  [519] 2 1 3 1 1 3 1 1 3 1 1 1 3 1 1 3 3 1 2 2 1 1 2 2 2 3 2 3 1 1 1 1 3 1
```

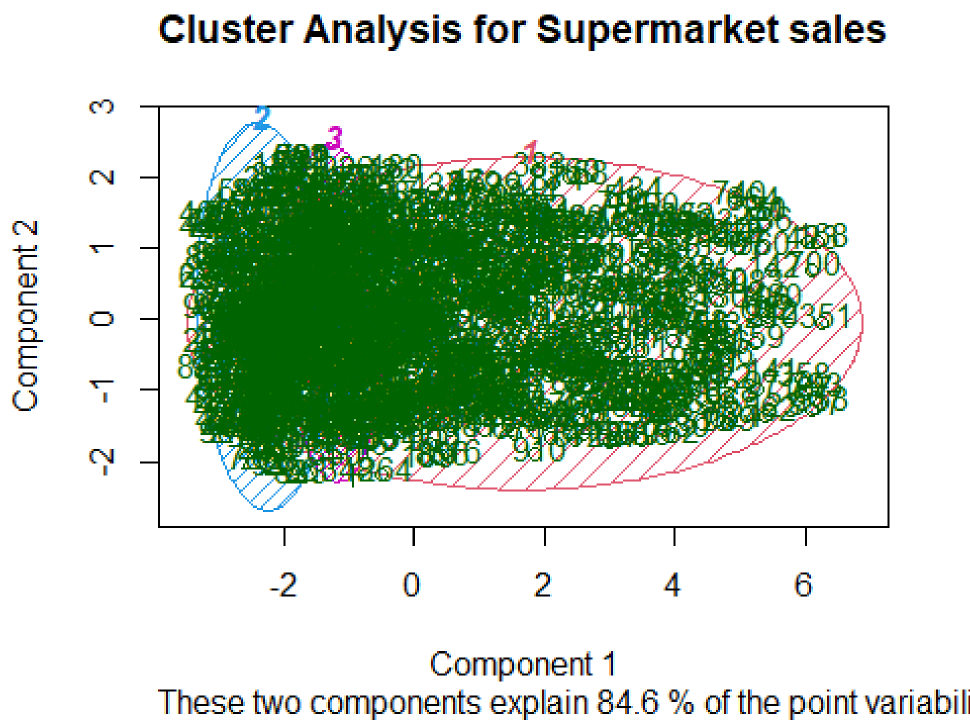
```
1 3 3
##  [556] 1 3 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 2 3 1 1 1 3 1 3 2 1 3 2 1 3 3 1 1
2 1 3
##  [593] 2 1 1 2 3 1 3 3 2 2 1 1 1 3 1 1 2 3 2 1 1 2 1 1 1 1 1 1 1 2 1 1 2 3
3 1 3
##  [630] 2 1 1 3 1 1 1 1 2 2 3 1 1 1 1 2 3 1 2 2 1 1 1 1 1 1 2 2 1 3 2 3 3 1
1 1 1
##  [667] 3 2 1 2 1 3 3 1 1 3 1 1 1 1 2 2 1 2 3 2 3 1 3 1 1 1 1 1 1 1 1 1 1 1
1 2 3
##  [704] 1 1 1 3 2 3 2 1 1 1 3 1 3 1 2 3 2 3 1 3 1 2 1 3 1 1 1 2 3 2 1 2 1 1
1 1 1
##  [741] 1 2 3 2 1 2 1 2 1 1 2 3 3 1 1 1 1 1 3 1 1 1 1 2 1 1 1 2 1 2 1 1 1 2
3 3 1
##  [778] 2 3 1 3 1 2 1 2 1 1 2 3 1 2 1 1 1 2 2 2 1 2 1 3 1 1 1 1 1 3 3 2 1 2
1 1 2
##  [815] 1 1 1 1 1 1 1 2 1 1 1 2 1 3 1 1 2 1 2 2 1 2 3 1 1 3 3 2 2 2 2 1 2 2
1 1 2
##  [852] 3 1 1 1 1 3 1 1 1 2 2 2 1 1 2 1 3 2 1 3 2 1 1 2 1 2 2 1 2 1 2 1 1 3
1 2 1
##  [889] 2 1 1 1 1 3 1 1 1 1 1 1 1 3 3 2 1 1 1 1 3 1 2 1 1 1 1 3 2 1 1 2 1 2
2 1 1
##  [926] 2 2 1 1 2 1 3 1 1 1 1 1 1 1 1 1 1 1 1 2 1 3 2 3 1 3 2 1 2 1 1 1 1 3
1 2 2
##  [963] 1 1 2 2 1 1 2 3 1 1 1 1 3 2 1 3 2 2 1 1 1 1 1 1 2 1 1 1 1 1 3 3 2 2
1 2 2
## [1000] 1
##
## Within cluster sum of squares by cluster:
## [1] 53385220.1   464864.0   342620.4
##  (between_SS / total_SS =  53.4 %)
##
## Available components:
##
##  [1] "cluster"          "centers"          "totss"            "withinss"
##  [5] "tot.withinss"     "betweenss"        "size"             "iterations"
##  [9] "total.iterations" "restarts"         "weights"
```

Loading the cluster package.

```
suppressWarnings(
        suppressMessages(if
                         (!require(cluster, quietly=TRUE))
                install.packages("cluster")))
library("cluster")
```

cluster plot against the 1st 2 principal components.

```
clusplot(df2, model$cluster, color=TRUE, shade=TRUE,
         labels=2, lines=1,main='Cluster Analysis for Supermarket sales')
```



From our plot, we see that the first 2 components explain 84.6 % of the point variability. Weights are calculated for each variable and cluster. They are a measure of the relative importance of each variable with regards to the membership of the observations to that cluster. The weights are incorporated into the distance function, typically reducing the distance for more important variables. Weights remain stored in the model and we can check them as follows:

```
round(model$weights*100,2)

##   Unit.price Quantity Tax cogs gross.income Rating Total
## 1          0        0   0    0            0  99.99     0
## 2          0        0  50    0           50   0.00     0
## 3          0        0  50    0           50   0.00     0
```

Feature Ranking

We will use the FSelector Package. This is a package containing functions for selecting attributes from a given dataset.

Loading the required package.`

##3 Conclusion

The most important variables or features are the tax, cogs, gross income, quantity and unit price in determining the sales in the supermarket. * When coming up with a marketing strategy, promotions, discounts or adverts, the team should take into consideration the tax, unit price of the commodities, their quantity, the ratings given and the customer’s gross income to implement the strategies.