

Supermarket_Sales_Unsupervised_Learning_Algorithms

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```
#Setting our working directory.  
setwd("C://Users//Revolve//Documents//Basics Practice")
```

Project Overview

Carrefour means “crossroads” in French and is a multinational retailer headquartered in France. Majid Al Futtain was the first to introduce the supermarkets in Africa, Asia and the Middle East. To date, Carrefour operates in more than 30 countries across these continents.

In Kenya, Carrefour launched its operations in 2016 and currently operates 7 stores located at Two Rivers Mall, The Hub in Karen, Thika Road Mall, The Junction Mall, Sarit Centre, Village Market store and Galleria Mall respectively.

Specifying the Research question

You are a Data analyst at Carrefour Kenya and are currently undertaking a project that will inform the marketing department on the most relevant marketing strategies that will result in the highest no. of sales (total price including tax). Your project has been divided into four parts where you’ll explore a recent marketing dataset by performing various unsupervised learning techniques and later providing recommendations based on your insights.

Defining the Metric of Success

We should be able to draw meaningful insights by performing various unsupervised learning techniques and provide effective recommendations to be used by the marketing department.

Experimental Design

- Business Understanding.
- Data Understanding
- Data Analysis
- Applying the unsupervised learning algorithms
- Conclusion

Part 1: Dimensionality Reduction

This section of the project entails reducing your dataset to a low dimensional dataset using the t-SNE algorithm or PCA. You will be required to perform your analysis and provide insights gained from your analysis.

Part 2: Feature Selection

This section requires you to perform feature selection through the use of the unsupervised learning methods learned earlier this week. You will be required to perform your analysis and provide insights on the features that contribute the most information to the dataset.

Part 3: Association Rules

This section will require that you create association rules that will allow you to identify relationships between variables in the dataset. You are provided with a separate dataset that comprises groups of items that will be associated with others. Just like in the other sections, you will also be required to provide insights for your analysis.

Part 4: Anomaly Detection

You have also been requested to check whether there are any anomalies in the given sales dataset. The objective of this task being fraud detection.

Data Understanding

Loading our dataset

```
#Dataset 1
data_1 <- read.csv('Supermarket_Dataset_1 - Sales Data.csv')
print(head(data_1, 5)) #Previewing the first five records
```

```
## 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
## 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
## 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
```

```
print(tail(data_1,5)) #Previewing the last five records
```

```
## Invoice.ID Branch Customer.type Gender Product.line Unit.price
## 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
```

```
## 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
## 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
```

#Dataset 2

```
data_2 <- read.csv('Supermarket_Sales_Dataset II.csv')
print(head(data_2, 5))#Previewing the first five records
```

```
##      shrimp  almonds  avocado  vegetables.mix green.grapes
## 1  burgers meatballs      eggs
## 2  chutney
## 3  turkey  avocado
## 4  mineral water      milk energy bar whole wheat rice  green tea
## 5 low fat yogurt
##  whole.weat.flour yams cottage.cheese energy.drink tomato.juice low.fat.yogurt
## 1
## 2
## 3
## 4
## 5
##  green.tea honey salad mineral.water salmon antioxydant.juice frozen.smoothie
## 1
## 2
## 3
## 4
## 5
##  spinach olive.oil
## 1      NA
## 2      NA
## 3      NA
## 4      NA
## 5      NA
```

```
print(tail(data_2, 5))#Previewing the last five records
```

```
##      shrimp      almonds  avocado vegetables.mix green.grapes
## 7496  butter      light mayo fresh bread
## 7497  burgers frozen vegetables      eggs  french fries  magazines
## 7498  chicken
## 7499  escalope      green tea
## 7500  eggs  frozen smoothie yogurt cake low fat yogurt
##      whole.weat.flour yams cottage.cheese energy.drink tomato.juice
## 7496
## 7497  green tea
## 7498
```

```
## 7499
## 7500
##      low.fat.yogurt green.tea honey salad mineral.water salmon
## 7496
## 7497
## 7498
## 7499
## 7500
##      antioxydant.juice frozen.smoothie spinach olive.oil
## 7496                                     NA
## 7497                                     NA
## 7498                                     NA
## 7499                                     NA
## 7500                                     NA
```

#Dataset 3

```
data_3 <- read.csv('Supermarket_Sales_Forecasting - Sales.csv')
print(head(data_3, 5)) #Previewing the first five records
```

```
##      Date      Sales
## 1  1/5/2019 548.9715
## 2  3/8/2019  80.2200
## 3  3/3/2019 340.5255
## 4 1/27/2019 489.0480
## 5  2/8/2019 634.3785
```

```
print(tail(data_3, 5)) #Previewing the last ten records
```

```
##      Date      Sales
## 996 1/29/2019  42.3675
## 997 3/2/2019 1022.4900
## 998 2/9/2019  33.4320
## 999 2/22/2019  69.1110
## 1000 2/18/2019 649.2990
```

Accessing Basic Information about our datasets

#Dataset 1

```
print(str(data_1)) #Returns column names with data types and factors
```

```
## '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" ...
## $ 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 ...
## NULL
```

Our first dataset contains sales information of the supermarket. It has 1000 observations and 16 variables, 7 of which are numerical and the rest categorical. Some of our columns have details such as the Customer type, Product line, Product Unit price, Branch, Quantity, Payment, Time, Rating and Sales Total etc. We can spot some null values in our dataset which we will take care of during our data cleaning.

```
print(str(data_2))#Returns column names with data types and factors
```

```
## 'data.frame':    7500 obs. of  20 variables:
## $ shrimp          : chr  "burgers" "chutney" "turkey" "mineral water" ...
## $ almonds         : chr  "meatballs" "" "avocado" "milk" ...
## $ avocado         : chr  "eggs" "" "" "energy bar" ...
## $ vegetables.mix  : chr  "" "" "" "whole wheat rice" ...
## $ green.grapes    : chr  "" "" "" "green tea" ...
## $ whole.wheat.flour : chr  "" "" "" "" ...
## $ yams            : chr  "" "" "" "" ...
## $ cottage.cheese  : chr  "" "" "" "" ...
## $ energy.drink    : chr  "" "" "" "" ...
## $ tomato.juice    : chr  "" "" "" "" ...
## $ low.fat.yogurt  : chr  "" "" "" "" ...
## $ green.tea       : chr  "" "" "" "" ...
## $ honey           : chr  "" "" "" "" ...
## $ salad           : chr  "" "" "" "" ...
## $ mineral.water   : chr  "" "" "" "" ...
## $ salmon          : chr  "" "" "" "" ...
## $ antioxidant.juice: chr  "" "" "" "" ...
## $ frozen.smoothie : chr  "" "" "" "" ...
## $ spinach         : chr  "" "" "" "" ...
## $ olive.oil       : logi  NA NA NA NA NA NA ...
## NULL
```

Our second dataset contains a list of product items. The variables are mostly in string form and one logical variable. There are a couple of null values which we will need to investigate further.

```
print(str(data_3))#Returns column names with data types and factors
```

```
## 'data.frame':    1000 obs. of  2 variables:
## $ Date : chr  "1/5/2019" "3/8/2019" "3/3/2019" "1/27/2019" ...
## $ Sales: num  549 80.2 340.5 489 634.4 ...
## NULL
```

The third dataframe consists of 1000 observations and 2 variables. The Date and Sales variables are in character and numerical format.

```
#Checking for unique values in ur dataset
```

```
print(sapply(data_1, function(x) length(unique(x))))#checking for number of unique values in our dataset
```

```
##      Invoice.ID      Branch      Customer.type
##      1000          3          2
##      Gender      Product.line      Unit.price
##      2          6          943
##      Quantity      Tax      Date
##      10          990          89
##      Time      Payment      cogs
##      506          3          990
## gross.margin.percentage      gross.income      Rating
##      1          990          61
##      Total
##      990
```

```
print(sapply(data_2, function(x) length(unique(x))))#checking for number of unique values in our dataset
```

```
##      shrimp      almonds      avocado      vegetables.mix
##      115          118          116          115
##      green.grapes      whole.weat.flour      yams      cottage.cheese
##      111          107          103          99
##      energy.drink      tomato.juice      low.fat.yogurt      green.tea
##      89          81          67          51
##      honey      salad      mineral.water      salmon
##      43          29          19          8
## antioxydant.juice      frozen.smoothie      spinach      olive.oil
##      3          3          3          1
```

```
print(sapply(data_3, function(x) length(unique(x))))#checking for number of unique values in our dataset
```

```
## Date Sales
##      89      990
```

```
##Data cleaning
```

We will now go through some basic data preparation operations such as identifying anomalies, missing data, duplicated data.

We will import some packages that will be useful in the process.

```
library(funModeling)
```

```
## Loading required package: Hmisc
```

```
## Loading required package: lattice
```

```
## Loading required package: survival
```

```
## Loading required package: Formula
```

```
## Loading required package: ggplot2

##
## Attaching package: 'Hmisc'

## The following objects are masked from 'package:base':
##
##     format.pval, units

## funModeling v.1.9.4 :)
## Examples and tutorials at livebook.datascienceheroes.com
## / Now in Spanish: librovivodecienciadedatos.ai
```

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:Hmisc':
##
##     src, summarize

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

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

```
library(tidyr)
library(tidyr)
library(ggplot2)
library(pander)
library(forcats)
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1.3.1 --
```

```
## v tibble 3.1.3      v purrr 0.3.4
## v readr 2.0.1      v stringr 1.4.0
```

```
## -- Conflicts ----- tidyverse_conflicts() --
```

```
## x dplyr::filter() masks stats::filter()
## x dplyr::lag() masks stats::lag()
## x dplyr::src() masks Hmisc::src()
## x dplyr::summarize() masks Hmisc::summarize()
```

Identifying Missing Values

We will profile our data set to find missing values, zeros, unique values and filter or remove where appropriate.

`df_status(data_1)` *#function can help us by showing these numbers in relative and percentage values. It a*

	variable	q_zeros	p_zeros	q_na	p_na	q_inf	p_inf	type
## 1	Invoice.ID	0	0	0	0	0	0	character
## 2	Branch	0	0	0	0	0	0	character
## 3	Customer.type	0	0	0	0	0	0	character
## 4	Gender	0	0	0	0	0	0	character
## 5	Product.line	0	0	0	0	0	0	character
## 6	Unit.price	0	0	0	0	0	0	numeric
## 7	Quantity	0	0	0	0	0	0	integer
## 8	Tax	0	0	0	0	0	0	numeric
## 9	Date	0	0	0	0	0	0	character
## 10	Time	0	0	0	0	0	0	character
## 11	Payment	0	0	0	0	0	0	character
## 12	cogs	0	0	0	0	0	0	numeric
## 13	gross.margin.percentage	0	0	0	0	0	0	numeric
## 14	gross.income	0	0	0	0	0	0	numeric
## 15	Rating	0	0	0	0	0	0	numeric
## 16	Total	0	0	0	0	0	0	numeric

##	unique
## 1	1000
## 2	3
## 3	2
## 4	2
## 5	6
## 6	943
## 7	10
## 8	990
## 9	89
## 10	506
## 11	3
## 12	990
## 13	1
## 14	990
## 15	61
## 16	990

There are no null values or zeros in our first dataset

`df_status(data_2)` *#function can help us by showing these numbers in relative and percentage values. It a*

	variable	q_zeros	p_zeros	q_na	p_na	q_inf	p_inf	type	unique
## 1	shrimp	0	0	0	0	0	0	character	115
## 2	almonds	0	0	0	0	0	0	character	118
## 3	avocado	0	0	0	0	0	0	character	116
## 4	vegetables.mix	0	0	0	0	0	0	character	115
## 5	green.grapes	0	0	0	0	0	0	character	111
## 6	whole.weat.flour	0	0	0	0	0	0	character	107
## 7	yams	0	0	0	0	0	0	character	103
## 8	cottage.cheese	0	0	0	0	0	0	character	99
## 9	energy.drink	0	0	0	0	0	0	character	89
## 10	tomato.juice	0	0	0	0	0	0	character	81


```
## 11    low.fat.yogurt      0      0      0      0      0      0 character    67
## 12      green.tea        0      0      0      0      0      0 character    51
## 13        honey         0      0      0      0      0      0 character    43
## 14        salad         0      0      0      0      0      0 character    29
## 15    mineral.water      0      0      0      0      0      0 character    19
## 16        salmon        0      0      0      0      0      0 character     8
## 17 antioxidant.juice    0      0      0      0      0      0 character     3
## 18    frozen.smoothie    0      0      0      0      0      0 character     3
## 19        spinach       0      0      0      0      0      0 character     3
## 20      olive.oil        0      0 7500  100      0      0    logical     0
```

There are 7500 null values. They seem like quite a number so we will have to investigate them fully by trying to understand the nature of the olive oil column

```
df_status(data_3)#function can help us by showing these numbers in relative and percentage values. It a
```

```
##   variable q_zeros p_zeros q_na p_na q_inf p_inf      type unique
## 1    Date         0         0     0     0     0     0 character     89
## 2    Sales         0         0     0     0     0     0   numeric    990
```

The third dataset has no null values as denoted by the 0 in q-na.

```
data_2$olive.oil #Investigating the column with null values.
```

```
##      [1] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##     [25] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##    [49] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##    [73] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##   [97] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [121] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [145] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [169] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [193] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [217] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [241] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [265] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [289] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [313] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [337] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [361] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [385] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [409] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [433] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [457] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [481] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [505] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [529] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [553] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [577] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [601] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [625] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##  [649] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

```
## [7153] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7177] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7201] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7225] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7249] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7273] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7297] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7321] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7345] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7369] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7393] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7417] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7441] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7465] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [7489] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
```

```
data_2 <- na.omit(data_2) #We will drop the null values in the data_2 dataset
```

```
sum(is.na(data_2))
```

```
## [1] 0
```

```
#data_2$olive.oil <- lapply(data_2$olive.oil, as.factor) #changing dtype of olive oil to match the rest
```

Let's then proceed to Identify duplicated records

```
print(sum(duplicated(data_1))) #Prints out the sum of duplicated records in dataset_1
```

```
## [1] 0
```

```
print(sum(duplicated(data_2))) #Prints out the sum of duplicated records in dataset_2
```

```
## [1] 0
```

```
print(sum(duplicated(data_3))) #Prints out the sum of duplicated records in dataset_3
```

```
## [1] 0
```

There are no duplicated records in our datasets.

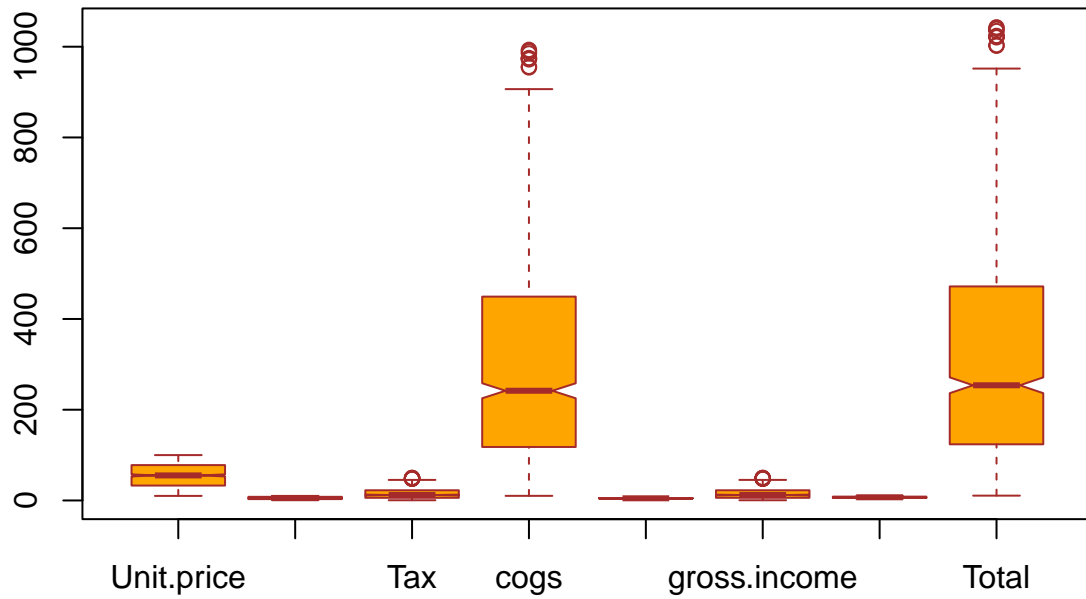
Identifying Outliers

We will use boxplots to visualize our outliers

```
#Dataset 1 outliers
```

```
num_v <- select_if(data_1, is.numeric) # We will select the numerical variables
boxplot(num_v,
  main = "Outlier Plots",
  col = "orange",
  border = "brown",
  horizontal = FALSE,
  notch = TRUE)
```

Outlier Plots

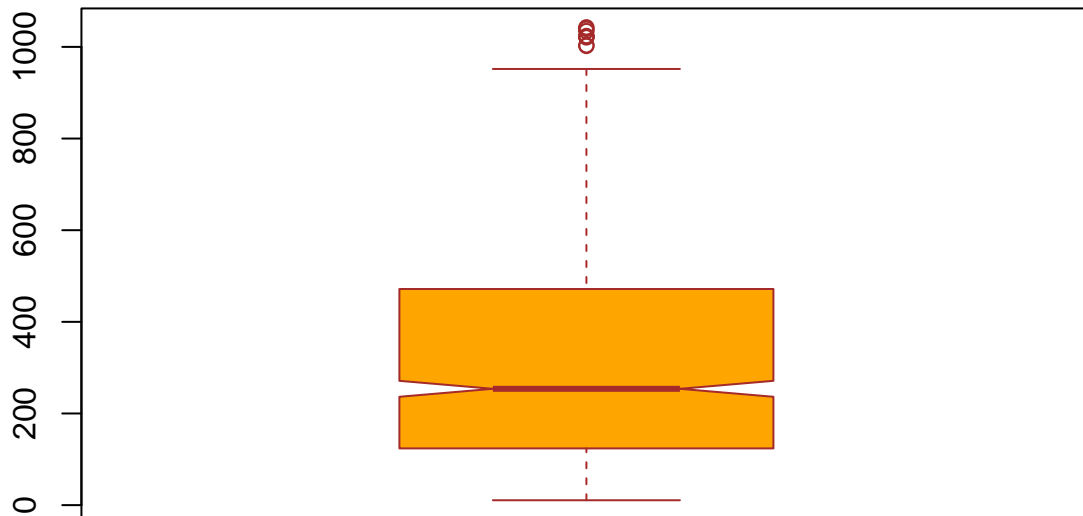


There are outliers in the cogs and total columns.

#Dataset 3 outliers

```
num_v_2 <- select_if(data_3, is.numeric) # We will select the numerical variables
boxplot(num_v_2,
  main = "Outlier Plots",
  col = "orange",
  border = "brown",
  horizontal = FALSE,
  notch = TRUE)
```


Outlier Plots



The sales column appears to have outliers. We will not be dropping these in the meantime as they might be cause variations in our analysis and might not really be outliers in supermarket sales.

Exploratory Data Analysis

Measures of Central Tendancy

```
summary(data_1) #Displays the statistical summaries of our dataset including the min.max, median, mean and
```

```
## 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
```

Measures of Dispersion

```
library(moments)

#Skewness

skewness(num_v) #On our numerical variables
```

```
##           Unit.price           Quantity           Tax
##           0.007066827           0.012921628           0.891230392
##           cogs gross.margin.percentage           gross.income
##           0.891230392           NaN           0.891230392
##           Rating           Total
##           0.008996129           0.891230392
```

```
kurtosis(num_v)
```

```
##           Unit.price           Quantity           Tax
##           1.781499           1.784528           2.912530
##           cogs gross.margin.percentage           gross.income
##           2.912530           NaN           2.912530
##           Rating           Total
##           1.848169           2.912530
```

The positive values skewness indicate that our data is skewed to the right means that the right tail is long relative to the left tail.

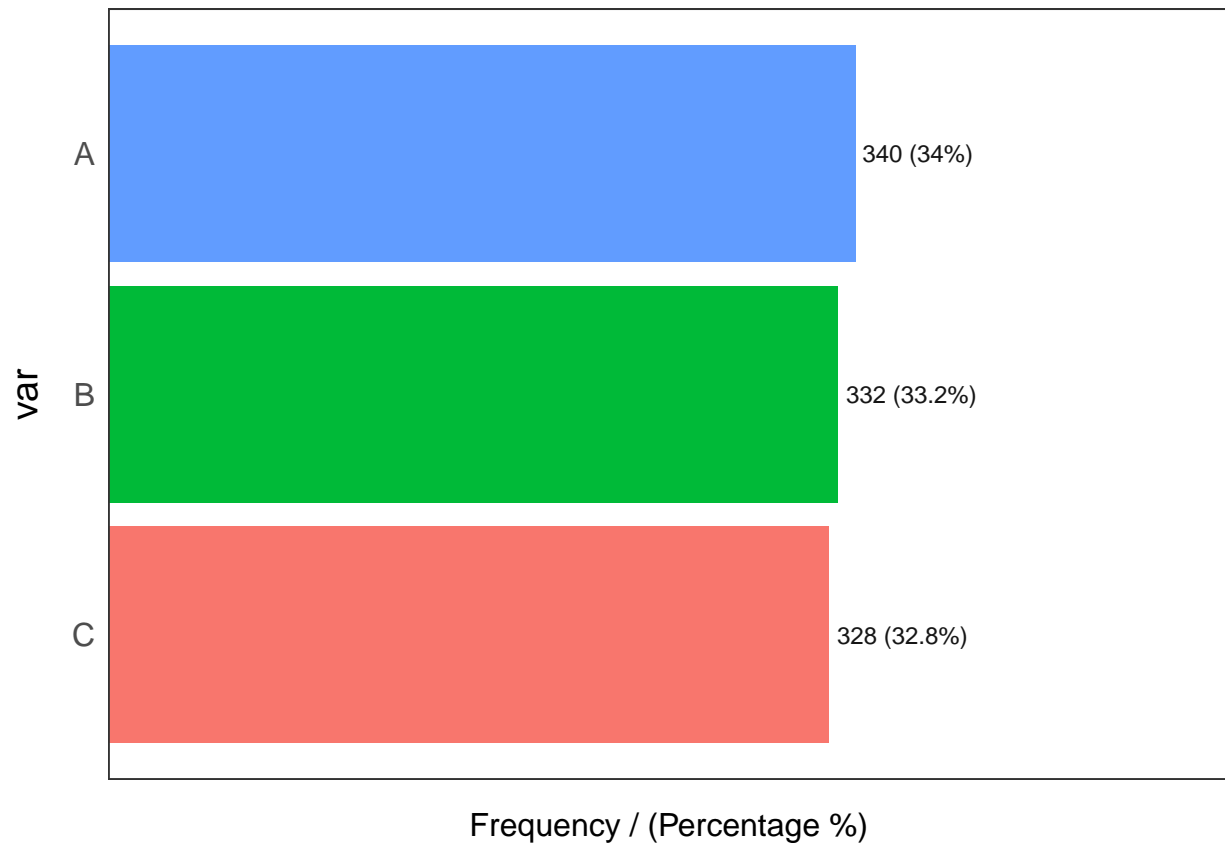
Univariate Analysis

Profiling our categorical variables

Branch

```
freq(data=data_1$Branch)
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



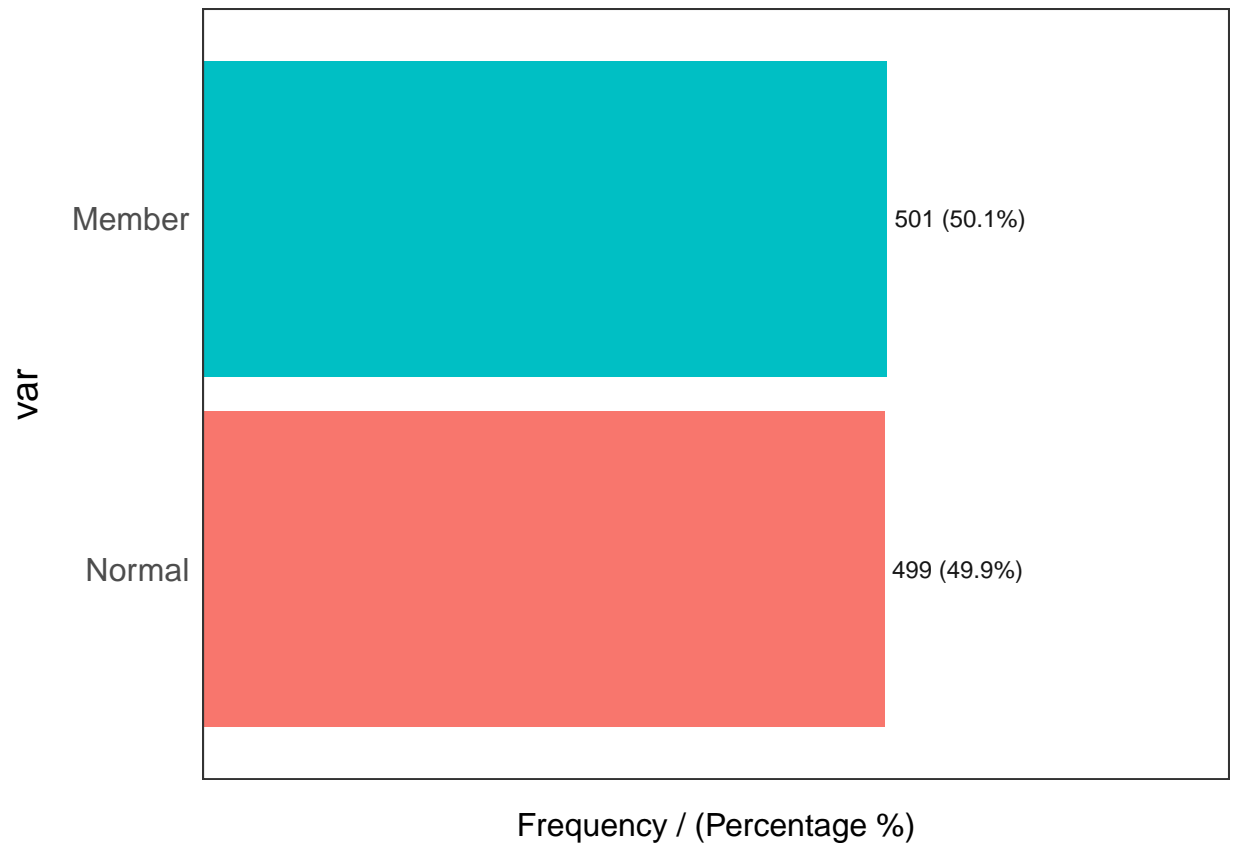
```
##   var frequency percentage cumulative_perc
## 1  A         340       34.0           34.0
## 2  B         332       33.2           67.2
## 3  C         328       32.8          100.0
```

There are three Carrefour Branches A,B and C. In the period of data collection Branch A had more customers than B and C though the difference margin is 0.8% and 0.4%.

Customer Type

```
freq(data=data_1$Customer.type)
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



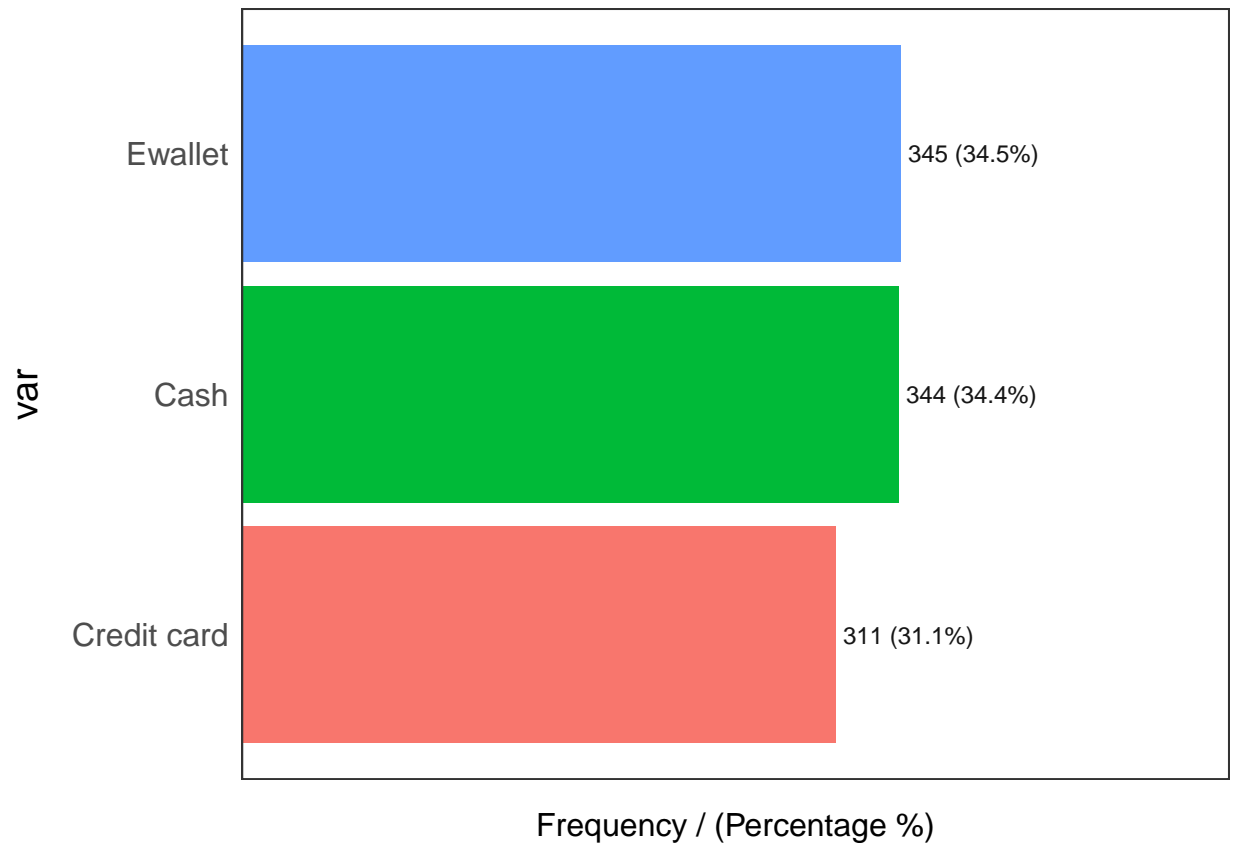
```
##      var frequency percentage cumulative_perc
## 1 Member      501      50.1          50.1
## 2 Normal      499      49.9          100.0
```

The percentage of Member and Normal customers are almost similar with “Member” customers being more at 50.1%

Payment Method

```
freq(data=data_1$Payment)
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



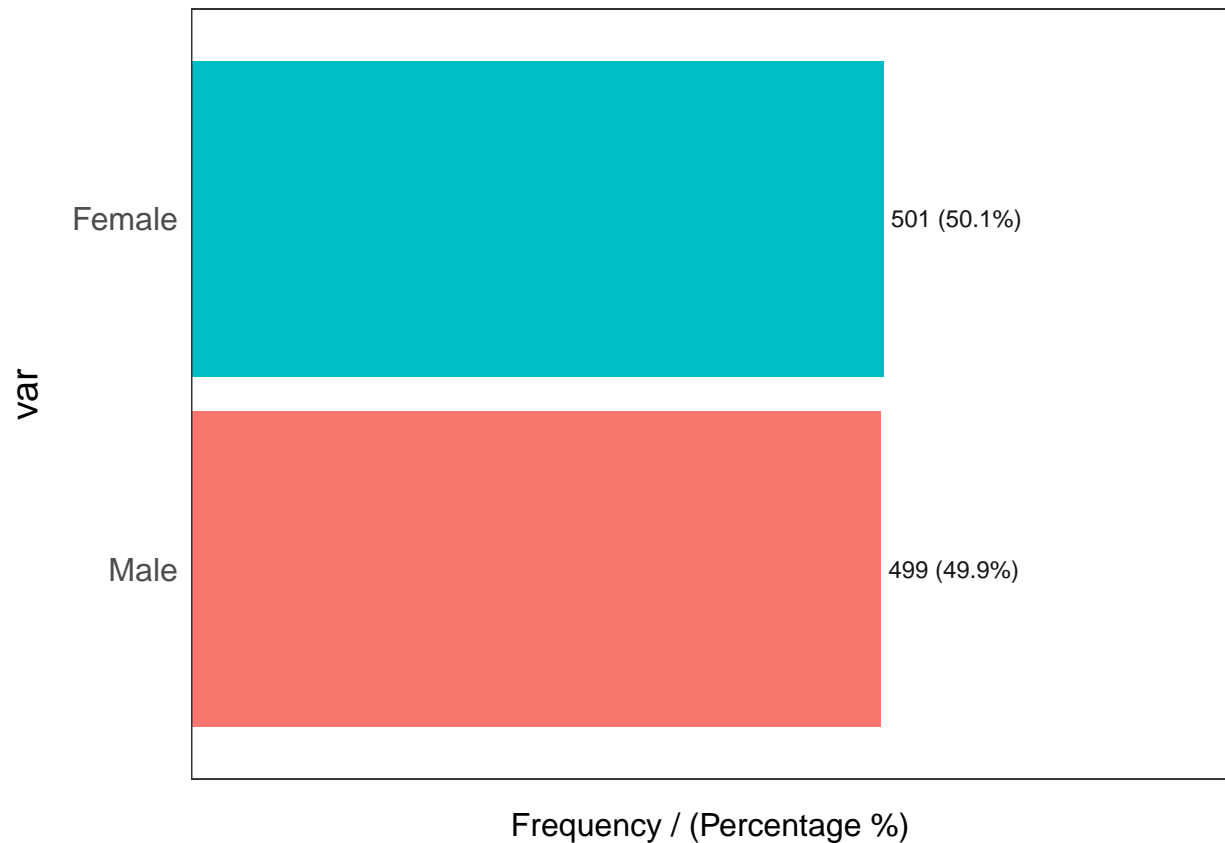
```
##           var frequency percentage cumulative_perc
## 1      Ewallet      345      34.5      34.5
## 2        Cash      344      34.4      68.9
## 3 Credit card      311      31.1     100.0
```

E wallet was the most preferred method of payment being used 34.5% of the time. Cash was used 34.4% of the time and Credit card 31.1%.

Gender

```
freq(data=data_1$Gender)
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



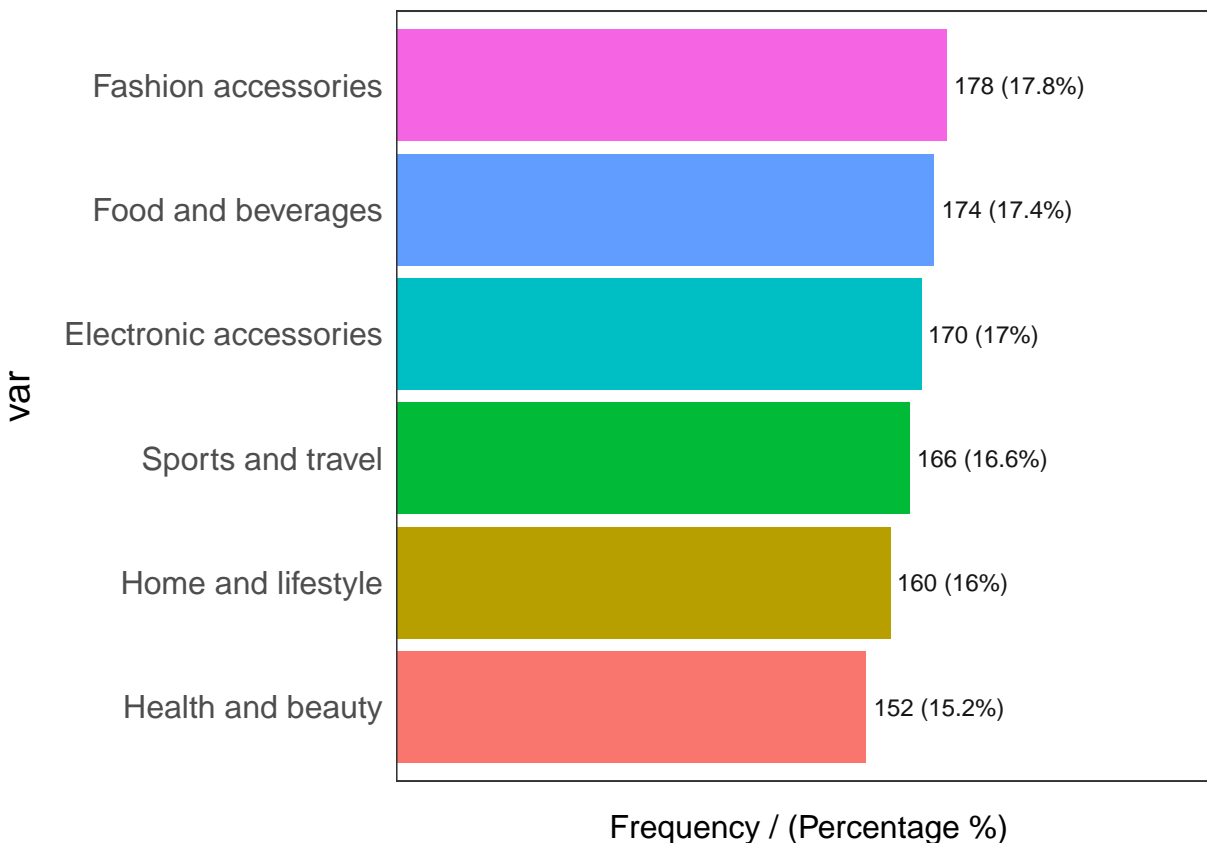
```
##      var frequency percentage cumulative_perc
## 1 Female      501      50.1          50.1
## 2  Male      499      49.9          100.0
```

Female customers form the majority of customers(50.1%) though the number does not differ greatly with male customers who are 49.9% of the customer base.

Product Line

```
freq(data=data_1$Product.line)
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



```
##           var frequency percentage cumulative_perc
## 1 Fashion accessories      178      17.8         17.8
## 2 Food and beverages      174      17.4         35.2
## 3 Electronic accessories  170      17.0         52.2
## 4 Sports and travel       166      16.6         68.8
## 5 Home and lifestyle      160      16.0         84.8
## 6 Health and beauty       152      15.2        100.0
```

The top three most popular product line are Fashion Accessories, Food and Beverages and Electronic Accessories. The least popular product is Health and Beauty products with 15.2% orders.

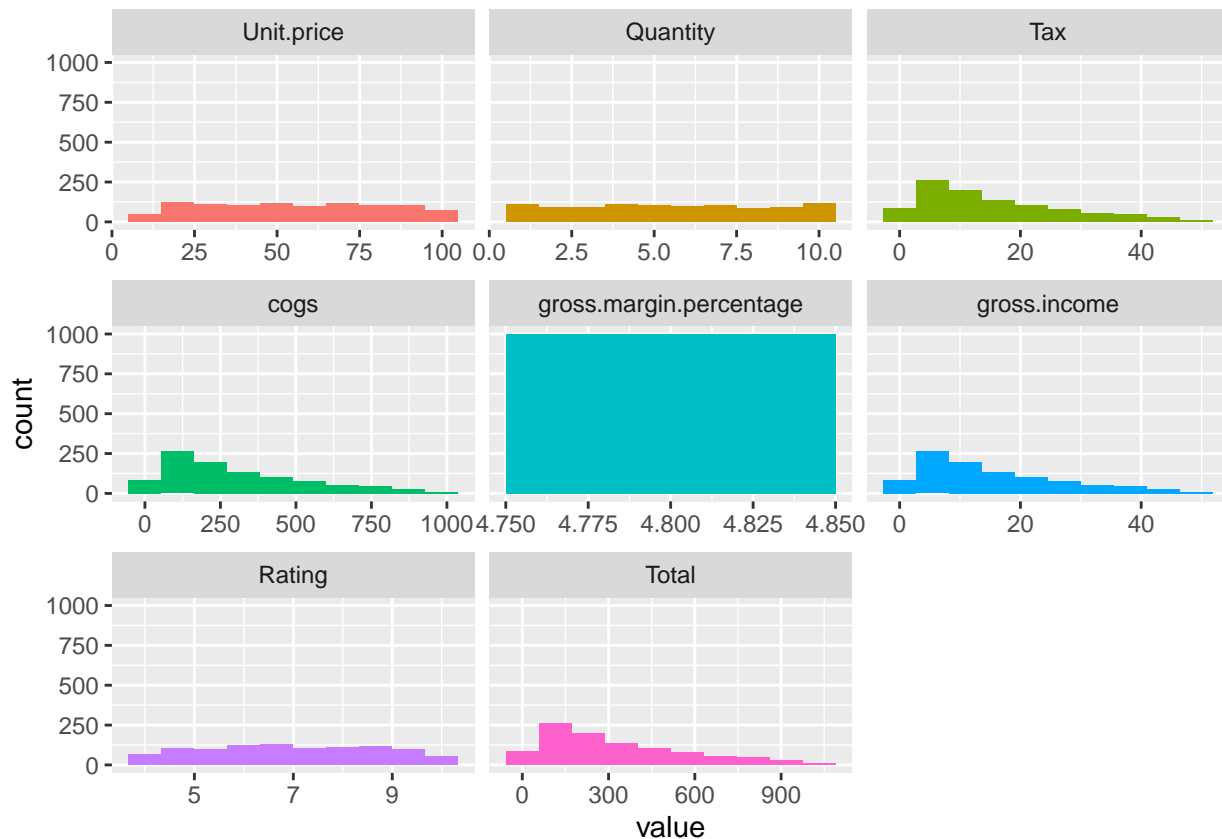
Profiling our Numerical Variables

```
#The Total and Sales Column in dataset 1 and in Dataset 3 seem similar
all(data_1$Total == data_3$Sales)
```

```
## [1] TRUE
```

```
plot_num(data_1) #This function plots the distribution of every numerical variable while automatically
```

```
## Warning: 'guides(<scale> = FALSE)' is deprecated. Please use 'guides(<scale> =
## "none")' instead.
```



Most of our data distribution is right skewed meaning that the mode is the highest peak of most of our histograms and most values fall to the right side.

Correlation and Bivariate Analysis

```
#Loading packages we might need
#install.packages("corrplot")
library(corrplot)
```

```
## corrplot 0.90 loaded
```

```
library(ggplot2)
library(dplyr)
library(lessR)
```

```
##
## lessR 4.0.2 feedback: gerbing@pdx.edu web: lessRstats.com/new
## -----
## > d <- Read("") Read text, Excel, SPSS, SAS, or R data file
## d is default data frame, data= in analysis routines optional
##
## Learn about reading, writing, and manipulating data, graphics,
## testing means and proportions, regression, factor analysis,
## customization, and descriptive statistics from pivot tables.
## Enter: browseVignettes("lessR")
##
```



```
## View changes in this new version of lessR.
##   Enter: help(package=lessR)   Click: Package NEWS

##
## Attaching package: 'lessR'

## The following object is masked from 'package:moments':
##
##      kurtosis

## The following object is masked from 'package:dplyr':
##
##      recode

## The following objects are masked from 'package:Hmisc':
##
##      label, Merge
```

```
library(reshape2)
```

```
##
## Attaching package: 'reshape2'

## The following object is masked from 'package:tidyr':
##
##      smiths
```

```
library(gridExtra) # allow us to plot two plots in a row
```

```
##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##      combine
```

Correlation

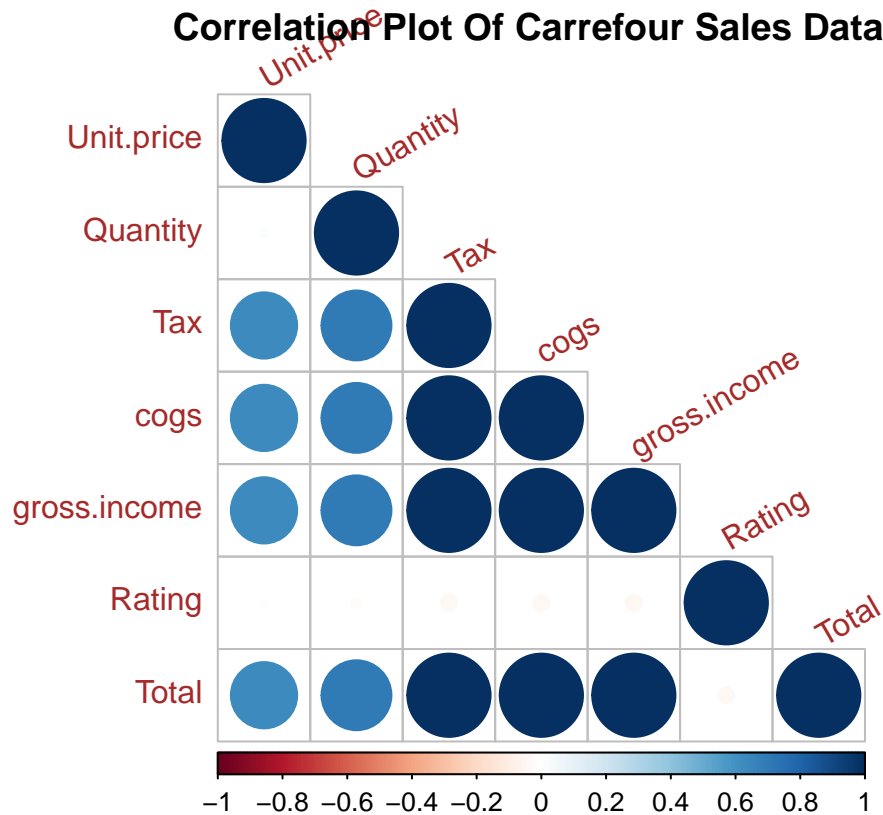
```
num_v <- subset (num_v, select = -gross.margin.percentage)

corr_tab<-cor(num_v)
```

Displaying the correlation in a matrix

```
corrplot(corr_tab, tl.col = "brown", tl.srt = 30, bg = "White",
          title = "\n\n Correlation Plot Of Carrefour Sales Data",
          type = "lower")
```

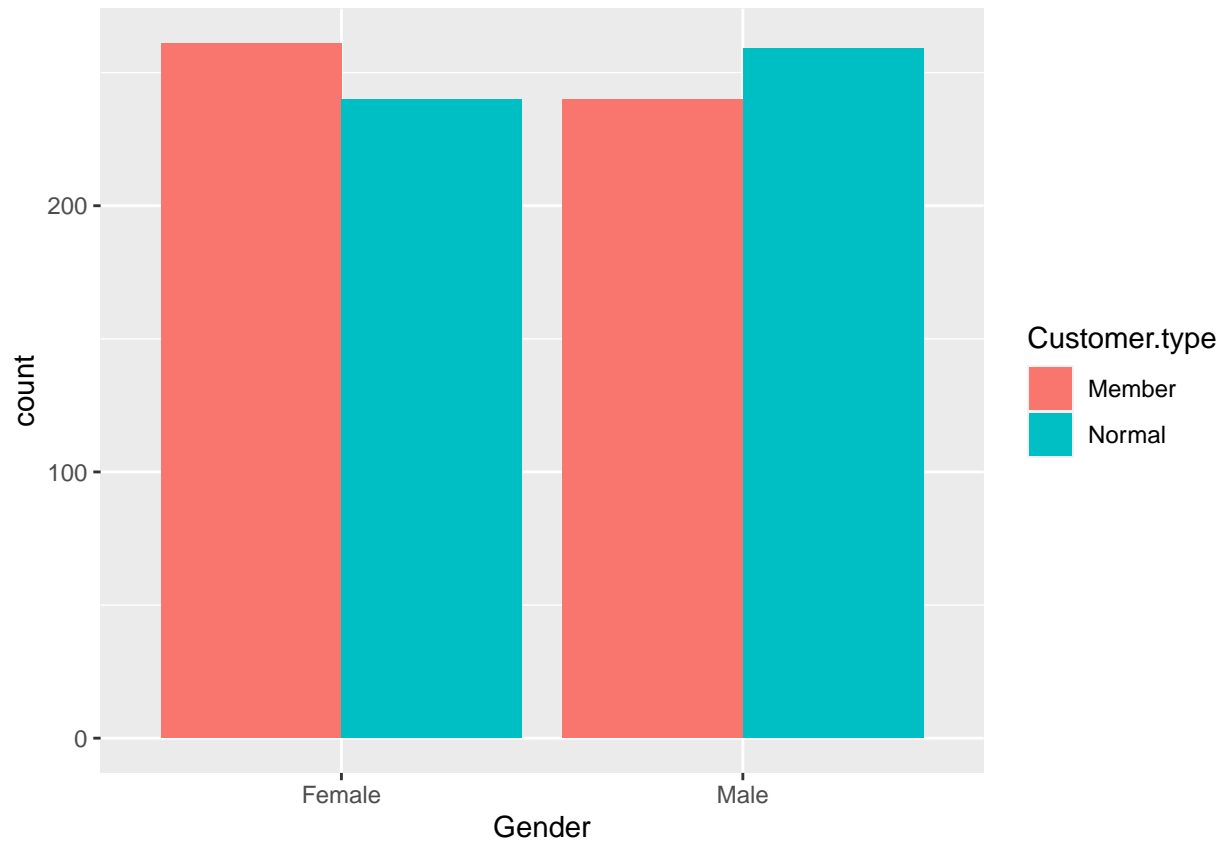
Correlation Plot Of Carrefour Sales Data



Visualizing our bivariate relationships

Gender and Customer Type

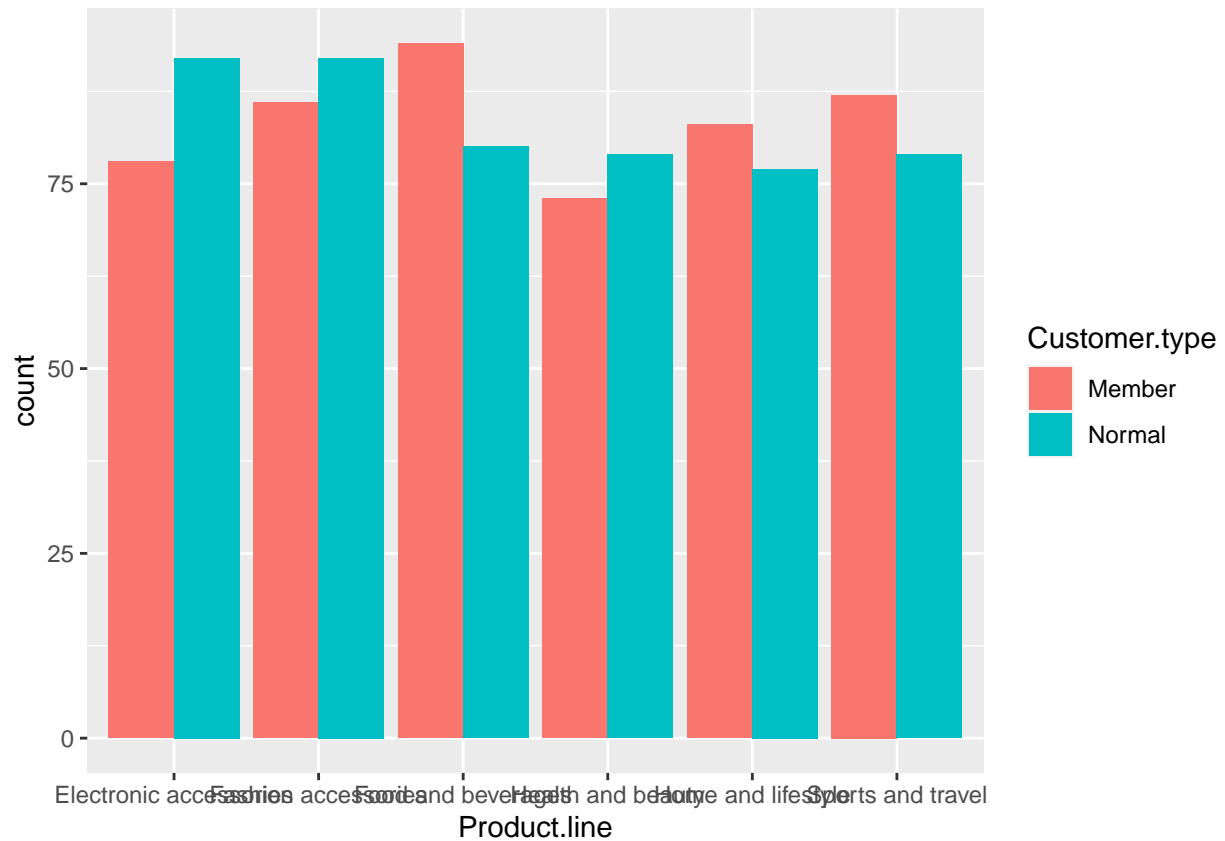
```
# bar chart
ggplot(data_1,
       aes(x = Gender,
           fill = Customer.type)) +
  geom_bar(position = "dodge")
```



Females make up majority of the members while Males form majority of the Normal customer pool

Product Line and Customer Type

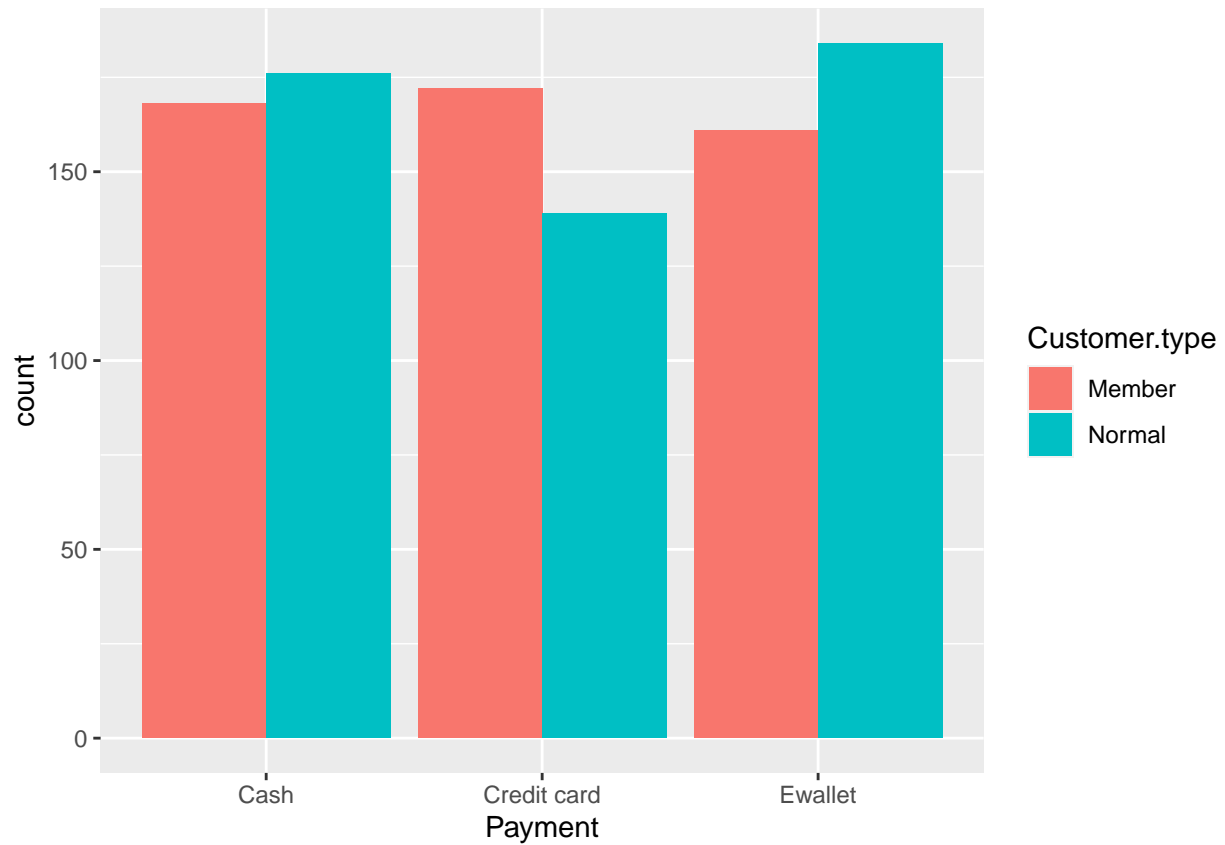
```
ggplot(data_1,  
  aes(x = Product.line,  
      fill = Customer.type)) +  
  geom_bar(position = "dodge")
```



Most members buy Food and Beverages while regular customers buy Fashion accessories and Electronic Accessories.

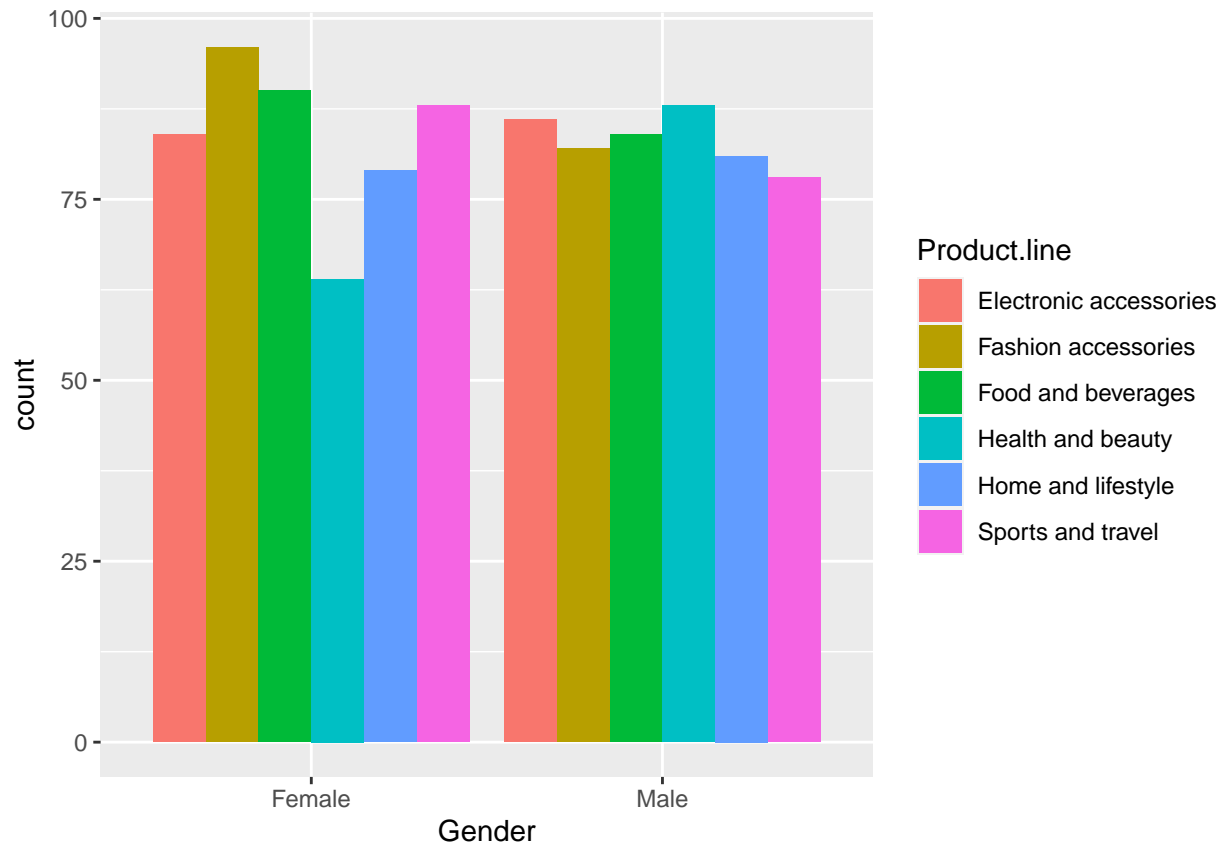
Payment and Customer Type

```
ggplot(data_1,
  aes(x = Payment,
    fill = Customer.type)) +
  geom_bar(position = "dodge")
```



Normal customers are more prone to paying using E-wallet than customers with membership. Customers with membership tend to pay more frequently using Credit Card.

```
ggplot(data_1,
  aes(x = Gender,
    fill = Product.line)) +
  geom_bar(position = "dodge")
```

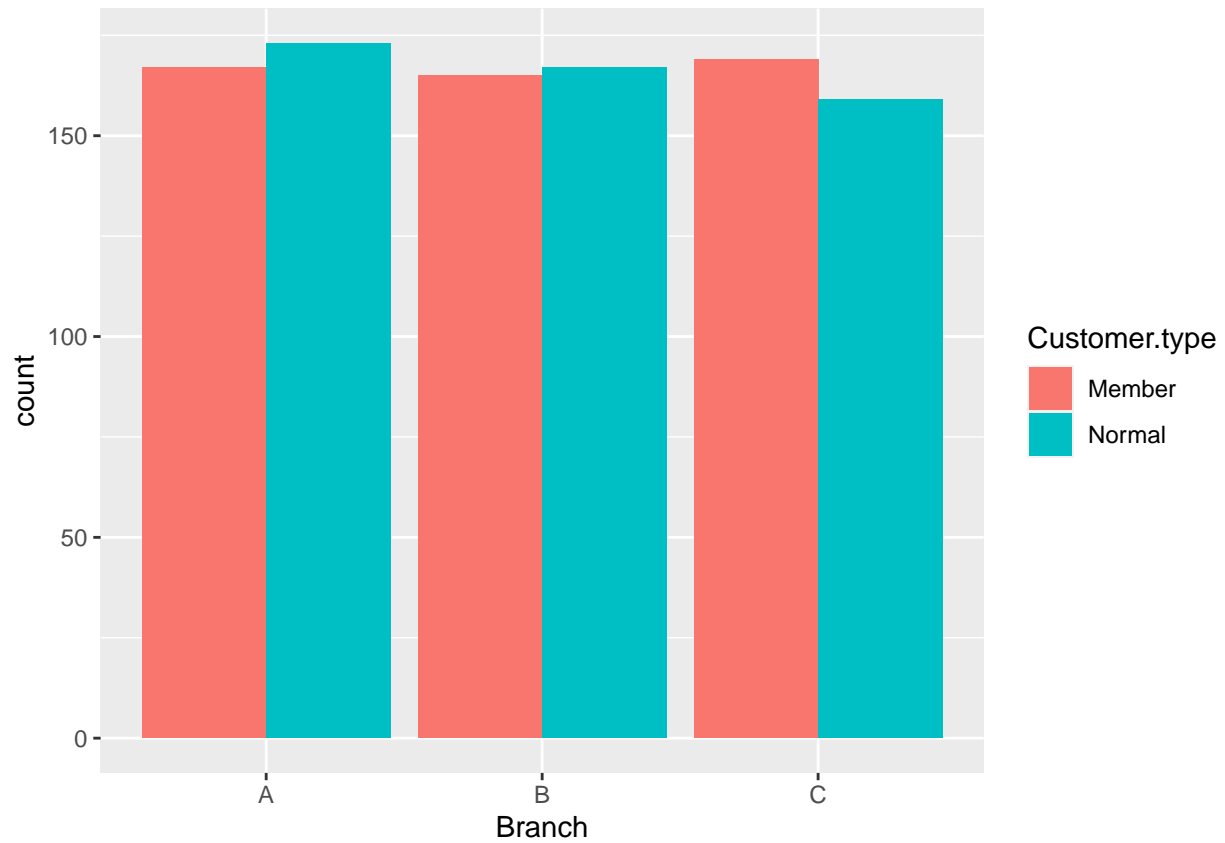


Female shoppers tend to buy fashion accessories the most, followed by food and beverages with the least sales in Health and Beauty in the data collection period.

Male customers have bought products in health and beauty line followed by electronic accessories the most.

Branch and Member

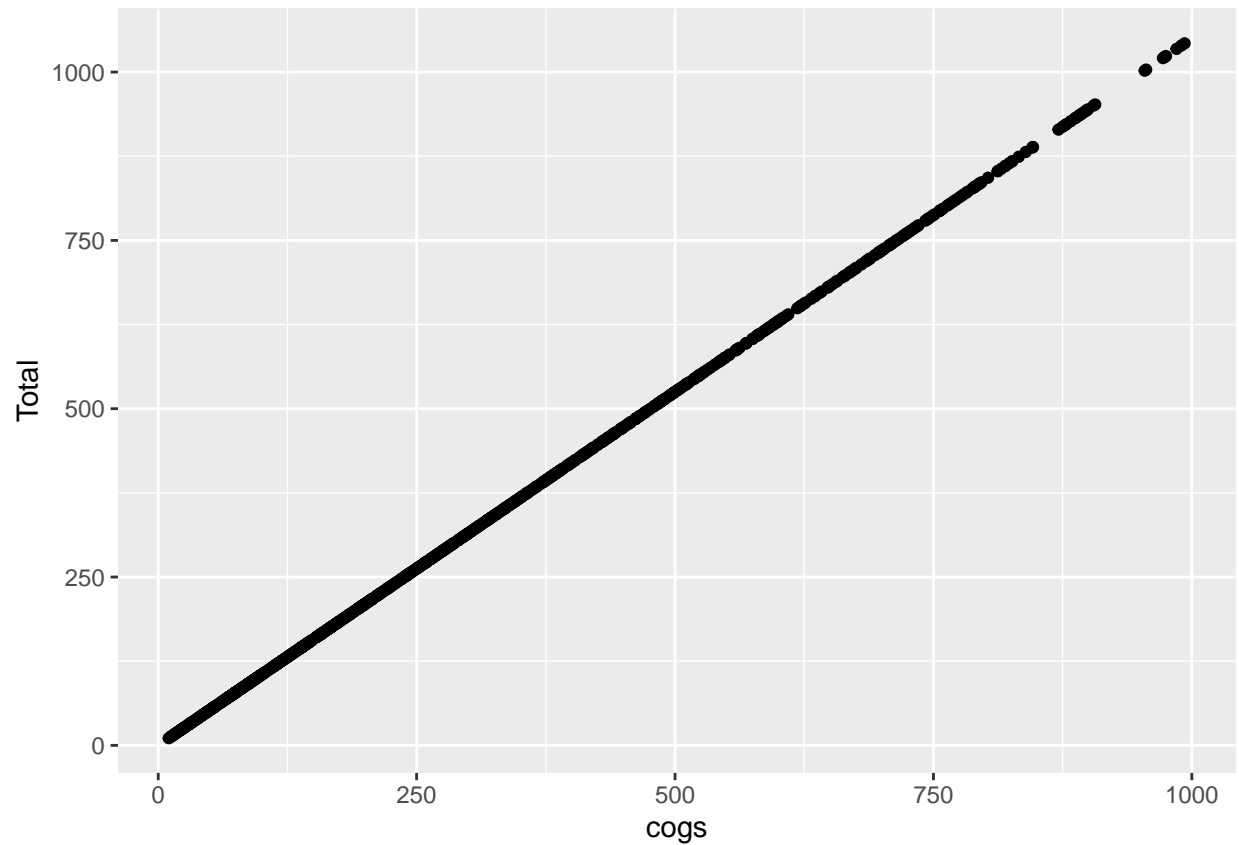
```
ggplot(data_1,
  aes(x = Branch,
    fill = Customer.type)) +
  geom_bar(position = "dodge")
```



Branch “c” has the most customers with memberships and “A” the most regular customers.

Cogs and Total

```
# simple scatterplot visualization of Cogs and Total
ggplot(data_1,
  aes(x = cogs,
    y = Total)) +
  geom_point()
```



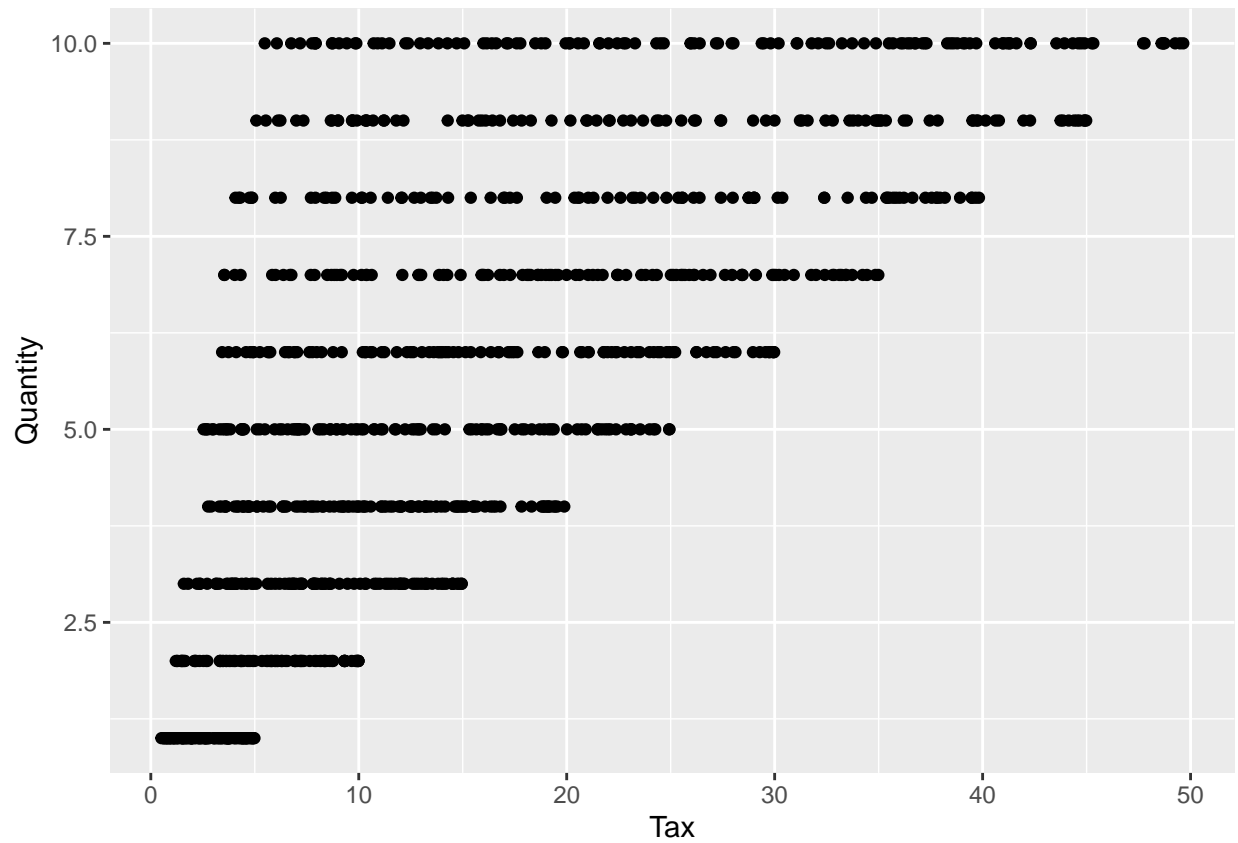
```
cor(data_1$cogs, data_1$Total, method="pearson")
```

```
## [1] 1
```

Cost of goods sold (COGS) refers to the direct costs of producing the goods sold by a company. This amount includes the cost of the materials and labor directly used to create the good. It excludes indirect expenses, such as distribution costs and sales force costs. The total column represents the total sales unit of a product. The visualization above shows that cogs and the total sales are highly correlated.

Tax and Quantity

```
ggplot(data_1,  
  aes(x = Tax,  
       y = Quantity)) +  
  geom_point()
```

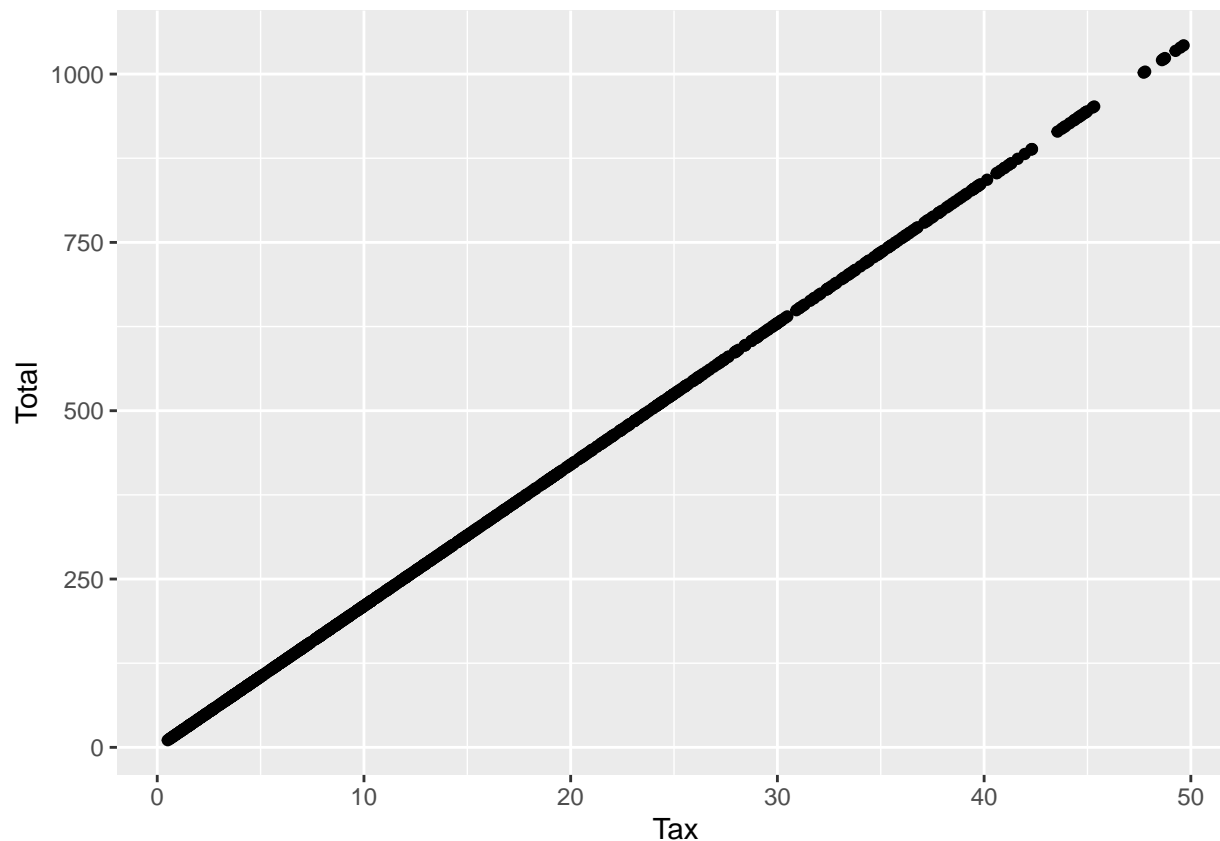
```
cor(data_1$Tax, data_1$Quantity, method="pearson")
```

```
## [1] 0.7055102
```

The tax paid for a product is correlated to the quantity of products sold

Tax and Total Sales

```
ggplot(data_1,
       aes(x = Tax,
           y = Total)) +
  geom_point()
```



```
cor(data_1$Tax, data_1$Total, method="pearson")
```

```
## [1] 1
```

The tax paid for a product is correlated with the total sales.

#Principal Component Analysis (PCA)

PCA is a type of linear transformation on a given data set that has values for a certain number of variables (coordinates) for a certain amount of spaces. This linear transformation fits this dataset to a new coordinate system in such a way that the most significant variance is found on the first coordinate, and each subsequent coordinate is orthogonal to the last and has a lesser variance. In this way, you transform a set of x correlated variables over y samples to a set of p uncorrelated principal components over the same samples.

#Since PCA works well with numerical variables, we will use the subset of numerical variables we made.

```
num_v
```

	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
## 7	68.84	6	20.6520	413.04	20.6520	5.8	433.6920

## 8	73.56	10	36.7800	735.60	36.7800	8.0	772.3800
## 9	36.26	2	3.6260	72.52	3.6260	7.2	76.1460
## 10	54.84	3	8.2260	164.52	8.2260	5.9	172.7460
## 11	14.48	4	2.8960	57.92	2.8960	4.5	60.8160
## 12	25.51	4	5.1020	102.04	5.1020	6.8	107.1420
## 13	46.95	5	11.7375	234.75	11.7375	7.1	246.4875
## 14	43.19	10	21.5950	431.90	21.5950	8.2	453.4950
## 15	71.38	10	35.6900	713.80	35.6900	5.7	749.4900
## 16	93.72	6	28.1160	562.32	28.1160	4.5	590.4360
## 17	68.93	7	24.1255	482.51	24.1255	4.6	506.6355
## 18	72.61	6	21.7830	435.66	21.7830	6.9	457.4430
## 19	54.67	3	8.2005	164.01	8.2005	8.6	172.2105
## 20	40.30	2	4.0300	80.60	4.0300	4.4	84.6300
## 21	86.04	5	21.5100	430.20	21.5100	4.8	451.7100
## 22	87.98	3	13.1970	263.94	13.1970	5.1	277.1370
## 23	33.20	2	3.3200	66.40	3.3200	4.4	69.7200
## 24	34.56	5	8.6400	172.80	8.6400	9.9	181.4400
## 25	88.63	3	13.2945	265.89	13.2945	6.0	279.1845
## 26	52.59	8	21.0360	420.72	21.0360	8.5	441.7560
## 27	33.52	1	1.6760	33.52	1.6760	6.7	35.1960
## 28	87.67	2	8.7670	175.34	8.7670	7.7	184.1070
## 29	88.36	5	22.0900	441.80	22.0900	9.6	463.8900
## 30	24.89	9	11.2005	224.01	11.2005	7.4	235.2105
## 31	94.13	5	23.5325	470.65	23.5325	4.8	494.1825
## 32	78.07	9	35.1315	702.63	35.1315	4.5	737.7615
## 33	83.78	8	33.5120	670.24	33.5120	5.1	703.7520
## 34	96.58	2	9.6580	193.16	9.6580	5.1	202.8180
## 35	99.42	4	19.8840	397.68	19.8840	7.5	417.5640
## 36	68.12	1	3.4060	68.12	3.4060	6.8	71.5260
## 37	62.62	5	15.6550	313.10	15.6550	7.0	328.7550
## 38	60.88	9	27.3960	547.92	27.3960	4.7	575.3160
## 39	54.92	8	21.9680	439.36	21.9680	7.6	461.3280
## 40	30.12	8	12.0480	240.96	12.0480	7.7	253.0080
## 41	86.72	1	4.3360	86.72	4.3360	7.9	91.0560
## 42	56.11	2	5.6110	112.22	5.6110	6.3	117.8310
## 43	69.12	6	20.7360	414.72	20.7360	5.6	435.4560
## 44	98.70	8	39.4800	789.60	39.4800	7.6	829.0800
## 45	15.37	2	1.5370	30.74	1.5370	7.2	32.2770
## 46	93.96	4	18.7920	375.84	18.7920	9.5	394.6320
## 47	56.69	9	25.5105	510.21	25.5105	8.4	535.7205
## 48	20.01	9	9.0045	180.09	9.0045	4.1	189.0945
## 49	18.93	6	5.6790	113.58	5.6790	8.1	119.2590
## 50	82.63	10	41.3150	826.30	41.3150	7.9	867.6150
## 51	91.40	7	31.9900	639.80	31.9900	9.5	671.7900
## 52	44.59	5	11.1475	222.95	11.1475	8.5	234.0975
## 53	17.87	4	3.5740	71.48	3.5740	6.5	75.0540
## 54	15.43	1	0.7715	15.43	0.7715	6.1	16.2015
## 55	16.16	2	1.6160	32.32	1.6160	6.5	33.9360
## 56	85.98	8	34.3920	687.84	34.3920	8.2	722.2320
## 57	44.34	2	4.4340	88.68	4.4340	5.8	93.1140
## 58	89.60	8	35.8400	716.80	35.8400	6.6	752.6400
## 59	72.35	10	36.1750	723.50	36.1750	5.4	759.6750
## 60	30.61	6	9.1830	183.66	9.1830	9.3	192.8430
## 61	24.74	3	3.7110	74.22	3.7110	10.0	77.9310

## 62	55.73	6	16.7190	334.38	16.7190	7.0	351.0990
## 63	55.07	9	24.7815	495.63	24.7815	10.0	520.4115
## 64	15.81	10	7.9050	158.10	7.9050	8.6	166.0050
## 65	75.74	4	15.1480	302.96	15.1480	7.6	318.1080
## 66	15.87	10	7.9350	158.70	7.9350	5.8	166.6350
## 67	33.47	2	3.3470	66.94	3.3470	6.7	70.2870
## 68	97.61	6	29.2830	585.66	29.2830	9.9	614.9430
## 69	78.77	10	39.3850	787.70	39.3850	6.4	827.0850
## 70	18.33	1	0.9165	18.33	0.9165	4.3	19.2465
## 71	89.48	10	44.7400	894.80	44.7400	9.6	939.5400
## 72	62.12	10	31.0600	621.20	31.0600	5.9	652.2600
## 73	48.52	3	7.2780	145.56	7.2780	4.0	152.8380
## 74	75.91	6	22.7730	455.46	22.7730	8.7	478.2330
## 75	74.67	9	33.6015	672.03	33.6015	9.4	705.6315
## 76	41.65	10	20.8250	416.50	20.8250	5.4	437.3250
## 77	49.04	9	22.0680	441.36	22.0680	8.6	463.4280
## 78	20.01	9	9.0045	180.09	9.0045	5.7	189.0945
## 79	78.31	10	39.1550	783.10	39.1550	6.6	822.2550
## 80	20.38	5	5.0950	101.90	5.0950	6.0	106.9950
## 81	99.19	6	29.7570	595.14	29.7570	5.5	624.8970
## 82	96.68	3	14.5020	290.04	14.5020	6.4	304.5420
## 83	19.25	8	7.7000	154.00	7.7000	6.6	161.7000
## 84	80.36	4	16.0720	321.44	16.0720	8.3	337.5120
## 85	48.91	5	12.2275	244.55	12.2275	6.6	256.7775
## 86	83.06	7	29.0710	581.42	29.0710	4.0	610.4910
## 87	76.52	5	19.1300	382.60	19.1300	9.9	401.7300
## 88	49.38	7	17.2830	345.66	17.2830	7.3	362.9430
## 89	42.47	1	2.1235	42.47	2.1235	5.7	44.5935
## 90	76.99	6	23.0970	461.94	23.0970	6.1	485.0370
## 91	47.38	4	9.4760	189.52	9.4760	7.1	198.9960
## 92	44.86	10	22.4300	448.60	22.4300	8.2	471.0300
## 93	21.98	7	7.6930	153.86	7.6930	5.1	161.5530
## 94	64.36	9	28.9620	579.24	28.9620	8.6	608.2020
## 95	89.75	1	4.4875	89.75	4.4875	6.6	94.2375
## 96	97.16	1	4.8580	97.16	4.8580	7.2	102.0180
## 97	87.87	10	43.9350	878.70	43.9350	5.1	922.6350
## 98	12.45	6	3.7350	74.70	3.7350	4.1	78.4350
## 99	52.75	3	7.9125	158.25	7.9125	9.3	166.1625
## 100	82.70	6	24.8100	496.20	24.8100	7.4	521.0100
## 101	48.71	1	2.4355	48.71	2.4355	4.1	51.1455
## 102	78.55	9	35.3475	706.95	35.3475	7.2	742.2975
## 103	23.07	9	10.3815	207.63	10.3815	4.9	218.0115
## 104	58.26	6	17.4780	349.56	17.4780	9.9	367.0380
## 105	30.35	7	10.6225	212.45	10.6225	8.0	223.0725
## 106	88.67	10	44.3350	886.70	44.3350	7.3	931.0350
## 107	27.38	6	8.2140	164.28	8.2140	7.9	172.4940
## 108	62.13	6	18.6390	372.78	18.6390	7.4	391.4190
## 109	33.98	9	15.2910	305.82	15.2910	4.2	321.1110
## 110	81.97	10	40.9850	819.70	40.9850	9.2	860.6850
## 111	16.49	2	1.6490	32.98	1.6490	4.6	34.6290
## 112	98.21	3	14.7315	294.63	14.7315	7.8	309.3615
## 113	72.84	7	25.4940	509.88	25.4940	8.4	535.3740
## 114	58.07	9	26.1315	522.63	26.1315	4.3	548.7615
## 115	80.79	9	36.3555	727.11	36.3555	9.5	763.4655

## 116	27.02	3	4.0530	81.06	4.0530	7.1	85.1130
## 117	21.94	5	5.4850	109.70	5.4850	5.3	115.1850
## 118	51.36	1	2.5680	51.36	2.5680	5.2	53.9280
## 119	10.96	10	5.4800	109.60	5.4800	6.0	115.0800
## 120	53.44	2	5.3440	106.88	5.3440	4.1	112.2240
## 121	99.56	8	39.8240	796.48	39.8240	5.2	836.3040
## 122	57.12	7	19.9920	399.84	19.9920	6.5	419.8320
## 123	99.96	9	44.9820	899.64	44.9820	4.2	944.6220
## 124	63.91	8	25.5640	511.28	25.5640	4.6	536.8440
## 125	56.47	8	22.5880	451.76	22.5880	7.3	474.3480
## 126	93.69	7	32.7915	655.83	32.7915	4.5	688.6215
## 127	32.25	5	8.0625	161.25	8.0625	9.0	169.3125
## 128	31.73	9	14.2785	285.57	14.2785	5.9	299.8485
## 129	68.54	8	27.4160	548.32	27.4160	8.5	575.7360
## 130	90.28	9	40.6260	812.52	40.6260	7.2	853.1460
## 131	39.62	7	13.8670	277.34	13.8670	7.5	291.2070
## 132	92.13	6	27.6390	552.78	27.6390	8.3	580.4190
## 133	34.84	4	6.9680	139.36	6.9680	7.4	146.3280
## 134	87.45	6	26.2350	524.70	26.2350	8.8	550.9350
## 135	81.30	6	24.3900	487.80	24.3900	5.3	512.1900
## 136	90.22	3	13.5330	270.66	13.5330	6.2	284.1930
## 137	26.31	5	6.5775	131.55	6.5775	8.8	138.1275
## 138	34.42	6	10.3260	206.52	10.3260	9.8	216.8460
## 139	51.91	10	25.9550	519.10	25.9550	8.2	545.0550
## 140	72.50	8	29.0000	580.00	29.0000	9.2	609.0000
## 141	89.80	10	44.9000	898.00	44.9000	5.4	942.9000
## 142	90.50	10	45.2500	905.00	45.2500	8.1	950.2500
## 143	68.60	10	34.3000	686.00	34.3000	9.1	720.3000
## 144	30.41	1	1.5205	30.41	1.5205	8.4	31.9305
## 145	77.95	6	23.3850	467.70	23.3850	8.0	491.0850
## 146	46.26	6	13.8780	277.56	13.8780	9.5	291.4380
## 147	30.14	10	15.0700	301.40	15.0700	9.2	316.4700
## 148	66.14	4	13.2280	264.56	13.2280	5.6	277.7880
## 149	71.86	8	28.7440	574.88	28.7440	6.2	603.6240
## 150	32.46	8	12.9840	259.68	12.9840	4.9	272.6640
## 151	91.54	4	18.3080	366.16	18.3080	4.8	384.4680
## 152	34.56	7	12.0960	241.92	12.0960	7.3	254.0160
## 153	83.24	9	37.4580	749.16	37.4580	7.4	786.6180
## 154	16.48	6	4.9440	98.88	4.9440	9.9	103.8240
## 155	80.97	8	32.3880	647.76	32.3880	9.3	680.1480
## 156	92.29	5	23.0725	461.45	23.0725	9.0	484.5225
## 157	72.17	1	3.6085	72.17	3.6085	6.1	75.7785
## 158	50.28	5	12.5700	251.40	12.5700	9.7	263.9700
## 159	97.22	9	43.7490	874.98	43.7490	6.0	918.7290
## 160	93.39	6	28.0170	560.34	28.0170	10.0	588.3570
## 161	43.18	8	17.2720	345.44	17.2720	8.3	362.7120
## 162	63.69	1	3.1845	63.69	3.1845	6.0	66.8745
## 163	45.79	7	16.0265	320.53	16.0265	7.0	336.5565
## 164	76.40	2	7.6400	152.80	7.6400	6.5	160.4400
## 165	39.90	10	19.9500	399.00	19.9500	5.9	418.9500
## 166	42.57	8	17.0280	340.56	17.0280	5.6	357.5880
## 167	95.58	10	47.7900	955.80	47.7900	4.8	1003.5900
## 168	98.98	10	49.4900	989.80	49.4900	8.7	1039.2900
## 169	51.28	6	15.3840	307.68	15.3840	6.5	323.0640

## 170	69.52	7	24.3320	486.64	24.3320	8.5	510.9720
## 171	70.01	5	17.5025	350.05	17.5025	5.5	367.5525
## 172	80.05	5	20.0125	400.25	20.0125	9.4	420.2625
## 173	20.85	8	8.3400	166.80	8.3400	6.3	175.1400
## 174	52.89	6	15.8670	317.34	15.8670	9.8	333.2070
## 175	19.79	8	7.9160	158.32	7.9160	8.7	166.2360
## 176	33.84	9	15.2280	304.56	15.2280	8.8	319.7880
## 177	22.17	8	8.8680	177.36	8.8680	9.6	186.2280
## 178	22.51	7	7.8785	157.57	7.8785	4.8	165.4485
## 179	73.88	6	22.1640	443.28	22.1640	4.4	465.4440
## 180	86.80	3	13.0200	260.40	13.0200	9.9	273.4200
## 181	64.26	7	22.4910	449.82	22.4910	5.7	472.3110
## 182	38.47	8	15.3880	307.76	15.3880	7.7	323.1480
## 183	15.50	10	7.7500	155.00	7.7500	8.0	162.7500
## 184	34.31	8	13.7240	274.48	13.7240	5.7	288.2040
## 185	12.34	7	4.3190	86.38	4.3190	6.7	90.6990
## 186	18.08	3	2.7120	54.24	2.7120	8.0	56.9520
## 187	94.49	8	37.7960	755.92	37.7960	7.5	793.7160
## 188	46.47	4	9.2940	185.88	9.2940	7.0	195.1740
## 189	74.07	1	3.7035	74.07	3.7035	9.9	77.7735
## 190	69.81	4	13.9620	279.24	13.9620	5.9	293.2020
## 191	77.04	3	11.5560	231.12	11.5560	7.2	242.6760
## 192	73.52	2	7.3520	147.04	7.3520	4.6	154.3920
## 193	87.80	9	39.5100	790.20	39.5100	9.2	829.7100
## 194	25.55	4	5.1100	102.20	5.1100	5.7	107.3100
## 195	32.71	5	8.1775	163.55	8.1775	9.9	171.7275
## 196	74.29	1	3.7145	74.29	3.7145	5.0	78.0045
## 197	43.70	2	4.3700	87.40	4.3700	4.9	91.7700
## 198	25.29	1	1.2645	25.29	1.2645	6.1	26.5545
## 199	41.50	4	8.3000	166.00	8.3000	8.2	174.3000
## 200	71.39	5	17.8475	356.95	17.8475	5.5	374.7975
## 201	19.15	6	5.7450	114.90	5.7450	6.8	120.6450
## 202	57.49	4	11.4980	229.96	11.4980	6.6	241.4580
## 203	61.41	7	21.4935	429.87	21.4935	9.8	451.3635
## 204	25.90	10	12.9500	259.00	12.9500	8.7	271.9500
## 205	17.77	5	4.4425	88.85	4.4425	5.4	93.2925
## 206	23.03	9	10.3635	207.27	10.3635	7.9	217.6335
## 207	66.65	9	29.9925	599.85	29.9925	9.7	629.8425
## 208	28.53	10	14.2650	285.30	14.2650	7.8	299.5650
## 209	30.37	3	4.5555	91.11	4.5555	5.1	95.6655
## 210	99.73	9	44.8785	897.57	44.8785	6.5	942.4485
## 211	26.23	9	11.8035	236.07	11.8035	5.9	247.8735
## 212	93.26	9	41.9670	839.34	41.9670	8.8	881.3070
## 213	92.36	5	23.0900	461.80	23.0900	4.9	484.8900
## 214	46.42	3	6.9630	139.26	6.9630	4.4	146.2230
## 215	29.61	7	10.3635	207.27	10.3635	6.5	217.6335
## 216	18.28	1	0.9140	18.28	0.9140	8.3	19.1940
## 217	24.77	5	6.1925	123.85	6.1925	8.5	130.0425
## 218	94.64	3	14.1960	283.92	14.1960	5.5	298.1160
## 219	94.87	8	37.9480	758.96	37.9480	8.7	796.9080
## 220	57.34	3	8.6010	172.02	8.6010	7.9	180.6210
## 221	45.35	6	13.6050	272.10	13.6050	6.1	285.7050
## 222	62.08	7	21.7280	434.56	21.7280	5.4	456.2880
## 223	11.81	5	2.9525	59.05	2.9525	9.4	62.0025

## 224	12.54	1	0.6270	12.54	0.6270	8.2	13.1670
## 225	43.25	2	4.3250	86.50	4.3250	6.2	90.8250
## 226	87.16	2	8.7160	174.32	8.7160	9.7	183.0360
## 227	69.37	9	31.2165	624.33	31.2165	4.0	655.5465
## 228	37.06	4	7.4120	148.24	7.4120	9.7	155.6520
## 229	90.70	6	27.2100	544.20	27.2100	5.3	571.4100
## 230	63.42	8	25.3680	507.36	25.3680	7.4	532.7280
## 231	81.37	2	8.1370	162.74	8.1370	6.5	170.8770
## 232	10.59	3	1.5885	31.77	1.5885	8.7	33.3585
## 233	84.09	9	37.8405	756.81	37.8405	8.0	794.6505
## 234	73.82	4	14.7640	295.28	14.7640	6.7	310.0440
## 235	51.94	10	25.9700	519.40	25.9700	6.5	545.3700
## 236	93.14	2	9.3140	186.28	9.3140	4.1	195.5940
## 237	17.41	5	4.3525	87.05	4.3525	4.9	91.4025
## 238	44.22	5	11.0550	221.10	11.0550	8.6	232.1550
## 239	13.22	5	3.3050	66.10	3.3050	4.3	69.4050
## 240	89.69	1	4.4845	89.69	4.4845	4.9	94.1745
## 241	24.94	9	11.2230	224.46	11.2230	5.6	235.6830
## 242	59.77	2	5.9770	119.54	5.9770	5.8	125.5170
## 243	93.20	2	9.3200	186.40	9.3200	6.0	195.7200
## 244	62.65	4	12.5300	250.60	12.5300	4.2	263.1300
## 245	93.87	8	37.5480	750.96	37.5480	8.3	788.5080
## 246	47.59	8	19.0360	380.72	19.0360	5.7	399.7560
## 247	81.40	3	12.2100	244.20	12.2100	4.8	256.4100
## 248	17.94	5	4.4850	89.70	4.4850	6.8	94.1850
## 249	77.72	4	15.5440	310.88	15.5440	8.8	326.4240
## 250	73.06	7	25.5710	511.42	25.5710	4.2	536.9910
## 251	46.55	9	20.9475	418.95	20.9475	6.4	439.8975
## 252	35.19	10	17.5950	351.90	17.5950	8.4	369.4950
## 253	14.39	2	1.4390	28.78	1.4390	7.2	30.2190
## 254	23.75	4	4.7500	95.00	4.7500	5.2	99.7500
## 255	58.90	8	23.5600	471.20	23.5600	8.9	494.7600
## 256	32.62	4	6.5240	130.48	6.5240	9.0	137.0040
## 257	66.35	1	3.3175	66.35	3.3175	9.7	69.6675
## 258	25.91	6	7.7730	155.46	7.7730	8.7	163.2330
## 259	32.25	4	6.4500	129.00	6.4500	6.5	135.4500
## 260	65.94	4	13.1880	263.76	13.1880	6.9	276.9480
## 261	75.06	9	33.7770	675.54	33.7770	6.2	709.3170
## 262	16.45	4	3.2900	65.80	3.2900	5.6	69.0900
## 263	38.30	4	7.6600	153.20	7.6600	5.7	160.8600
## 264	22.24	10	11.1200	222.40	11.1200	4.2	233.5200
## 265	54.45	1	2.7225	54.45	2.7225	7.9	57.1725
## 266	98.40	7	34.4400	688.80	34.4400	8.7	723.2400
## 267	35.47	4	7.0940	141.88	7.0940	6.9	148.9740
## 268	74.60	10	37.3000	746.00	37.3000	9.5	783.3000
## 269	70.74	4	14.1480	282.96	14.1480	4.4	297.1080
## 270	35.54	10	17.7700	355.40	17.7700	7.0	373.1700
## 271	67.43	5	16.8575	337.15	16.8575	6.3	354.0075
## 272	21.12	2	2.1120	42.24	2.1120	9.7	44.3520
## 273	21.54	9	9.6930	193.86	9.6930	8.8	203.5530
## 274	12.03	2	1.2030	24.06	1.2030	5.1	25.2630
## 275	99.71	6	29.9130	598.26	29.9130	7.9	628.1730
## 276	47.97	7	16.7895	335.79	16.7895	6.2	352.5795
## 277	21.82	10	10.9100	218.20	10.9100	7.1	229.1100

## 278	95.42	4	19.0840	381.68	19.0840	6.4	400.7640
## 279	70.99	10	35.4950	709.90	35.4950	5.7	745.3950
## 280	44.02	10	22.0100	440.20	22.0100	9.6	462.2100
## 281	69.96	8	27.9840	559.68	27.9840	6.4	587.6640
## 282	37.00	1	1.8500	37.00	1.8500	7.9	38.8500
## 283	15.34	1	0.7670	15.34	0.7670	6.5	16.1070
## 284	99.83	6	29.9490	598.98	29.9490	8.5	628.9290
## 285	47.67	4	9.5340	190.68	9.5340	9.1	200.2140
## 286	66.68	5	16.6700	333.40	16.6700	7.6	350.0700
## 287	74.86	1	3.7430	74.86	3.7430	6.9	78.6030
## 288	23.75	9	10.6875	213.75	10.6875	9.5	224.4375
## 289	48.51	7	16.9785	339.57	16.9785	5.2	356.5485
## 290	94.88	7	33.2080	664.16	33.2080	4.2	697.3680
## 291	40.30	10	20.1500	403.00	20.1500	7.0	423.1500
## 292	27.85	7	9.7475	194.95	9.7475	6.0	204.6975
## 293	62.48	1	3.1240	62.48	3.1240	4.7	65.6040
## 294	36.36	2	3.6360	72.72	3.6360	7.1	76.3560
## 295	18.11	10	9.0550	181.10	9.0550	5.9	190.1550
## 296	51.92	5	12.9800	259.60	12.9800	7.5	272.5800
## 297	28.84	4	5.7680	115.36	5.7680	6.4	121.1280
## 298	78.38	6	23.5140	470.28	23.5140	5.8	493.7940
## 299	60.01	4	12.0020	240.04	12.0020	4.5	252.0420
## 300	88.61	1	4.4305	88.61	4.4305	7.7	93.0405
## 301	99.82	2	9.9820	199.64	9.9820	6.7	209.6220
## 302	39.01	1	1.9505	39.01	1.9505	4.7	40.9605
## 303	48.61	1	2.4305	48.61	2.4305	4.4	51.0405
## 304	51.19	4	10.2380	204.76	10.2380	4.7	214.9980
## 305	14.96	8	5.9840	119.68	5.9840	8.6	125.6640
## 306	72.20	7	25.2700	505.40	25.2700	4.3	530.6700
## 307	40.23	7	14.0805	281.61	14.0805	9.6	295.6905
## 308	88.79	8	35.5160	710.32	35.5160	4.1	745.8360
## 309	26.48	3	3.9720	79.44	3.9720	4.7	83.4120
## 310	81.91	2	8.1910	163.82	8.1910	7.8	172.0110
## 311	79.93	6	23.9790	479.58	23.9790	5.5	503.5590
## 312	69.33	2	6.9330	138.66	6.9330	9.7	145.5930
## 313	14.23	5	3.5575	71.15	3.5575	4.4	74.7075
## 314	15.55	9	6.9975	139.95	6.9975	5.0	146.9475
## 315	78.13	10	39.0650	781.30	39.0650	4.4	820.3650
## 316	99.37	2	9.9370	198.74	9.9370	5.2	208.6770
## 317	21.08	3	3.1620	63.24	3.1620	7.3	66.4020
## 318	74.79	5	18.6975	373.95	18.6975	4.9	392.6475
## 319	29.67	7	10.3845	207.69	10.3845	8.1	218.0745
## 320	44.07	4	8.8140	176.28	8.8140	8.4	185.0940
## 321	22.93	9	10.3185	206.37	10.3185	5.5	216.6885
## 322	39.42	1	1.9710	39.42	1.9710	8.4	41.3910
## 323	15.26	6	4.5780	91.56	4.5780	9.8	96.1380
## 324	61.77	5	15.4425	308.85	15.4425	6.7	324.2925
## 325	21.52	6	6.4560	129.12	6.4560	9.4	135.5760
## 326	97.74	4	19.5480	390.96	19.5480	6.4	410.5080
## 327	99.78	5	24.9450	498.90	24.9450	5.4	523.8450
## 328	94.26	4	18.8520	377.04	18.8520	8.6	395.8920
## 329	51.13	4	10.2260	204.52	10.2260	4.0	214.7460
## 330	36.36	4	7.2720	145.44	7.2720	7.6	152.7120
## 331	22.02	9	9.9090	198.18	9.9090	6.8	208.0890

## 332	32.90	3	4.9350	98.70	4.9350	9.1	103.6350
## 333	77.02	5	19.2550	385.10	19.2550	5.5	404.3550
## 334	23.48	2	2.3480	46.96	2.3480	7.9	49.3080
## 335	14.70	5	3.6750	73.50	3.6750	8.5	77.1750
## 336	28.45	5	7.1125	142.25	7.1125	9.1	149.3625
## 337	76.40	9	34.3800	687.60	34.3800	7.5	721.9800
## 338	57.95	6	17.3850	347.70	17.3850	5.2	365.0850
## 339	47.65	3	7.1475	142.95	7.1475	9.5	150.0975
## 340	42.82	9	19.2690	385.38	19.2690	8.9	404.6490
## 341	48.09	3	7.2135	144.27	7.2135	7.8	151.4835
## 342	55.97	7	19.5895	391.79	19.5895	8.9	411.3795
## 343	76.90	7	26.9150	538.30	26.9150	7.7	565.2150
## 344	97.03	5	24.2575	485.15	24.2575	9.3	509.4075
## 345	44.65	3	6.6975	133.95	6.6975	6.2	140.6475
## 346	77.93	9	35.0685	701.37	35.0685	7.6	736.4385
## 347	71.95	1	3.5975	71.95	3.5975	7.3	75.5475
## 348	89.25	8	35.7000	714.00	35.7000	4.7	749.7000
## 349	26.02	7	9.1070	182.14	9.1070	5.1	191.2470
## 350	13.50	10	6.7500	135.00	6.7500	4.8	141.7500
## 351	99.30	10	49.6500	993.00	49.6500	6.6	1042.6500
## 352	51.69	7	18.0915	361.83	18.0915	5.5	379.9215
## 353	54.73	7	19.1555	383.11	19.1555	8.5	402.2655
## 354	27.00	9	12.1500	243.00	12.1500	4.8	255.1500
## 355	30.24	1	1.5120	30.24	1.5120	8.4	31.7520
## 356	89.14	4	17.8280	356.56	17.8280	7.8	374.3880
## 357	37.55	10	18.7750	375.50	18.7750	9.3	394.2750
## 358	95.44	10	47.7200	954.40	47.7200	5.2	1002.1200
## 359	27.50	3	4.1250	82.50	4.1250	6.5	86.6250
## 360	74.97	1	3.7485	74.97	3.7485	5.6	78.7185
## 361	80.96	8	32.3840	647.68	32.3840	7.4	680.0640
## 362	94.47	8	37.7880	755.76	37.7880	9.1	793.5480
## 363	99.79	2	9.9790	199.58	9.9790	8.0	209.5590
## 364	73.22	6	21.9660	439.32	21.9660	7.2	461.2860
## 365	41.24	4	8.2480	164.96	8.2480	7.1	173.2080
## 366	81.68	4	16.3360	326.72	16.3360	9.1	343.0560
## 367	51.32	9	23.0940	461.88	23.0940	5.6	484.9740
## 368	65.94	4	13.1880	263.76	13.1880	6.0	276.9480
## 369	14.36	10	7.1800	143.60	7.1800	5.4	150.7800
## 370	21.50	9	9.6750	193.50	9.6750	7.8	203.1750
## 371	26.26	7	9.1910	183.82	9.1910	9.9	193.0110
## 372	60.96	2	6.0960	121.92	6.0960	4.9	128.0160
## 373	70.11	6	21.0330	420.66	21.0330	5.2	441.6930
## 374	42.08	6	12.6240	252.48	12.6240	8.9	265.1040
## 375	67.09	5	16.7725	335.45	16.7725	9.1	352.2225
## 376	96.70	5	24.1750	483.50	24.1750	7.0	507.6750
## 377	35.38	9	15.9210	318.42	15.9210	9.6	334.3410
## 378	95.49	7	33.4215	668.43	33.4215	8.7	701.8515
## 379	96.98	4	19.3960	387.92	19.3960	9.4	407.3160
## 380	23.65	4	4.7300	94.60	4.7300	4.0	99.3300
## 381	82.33	4	16.4660	329.32	16.4660	7.5	345.7860
## 382	26.61	2	2.6610	53.22	2.6610	4.2	55.8810
## 383	99.69	5	24.9225	498.45	24.9225	9.9	523.3725
## 384	74.89	4	14.9780	299.56	14.9780	4.2	314.5380
## 385	40.94	5	10.2350	204.70	10.2350	9.9	214.9350

## 386	75.82	1	3.7910	75.82	3.7910	5.8	79.6110
## 387	46.77	6	14.0310	280.62	14.0310	6.0	294.6510
## 388	32.32	10	16.1600	323.20	16.1600	10.0	339.3600
## 389	54.07	9	24.3315	486.63	24.3315	9.5	510.9615
## 390	18.22	7	6.3770	127.54	6.3770	6.6	133.9170
## 391	80.48	3	12.0720	241.44	12.0720	8.1	253.5120
## 392	37.95	10	18.9750	379.50	18.9750	9.7	398.4750
## 393	76.82	1	3.8410	76.82	3.8410	7.2	80.6610
## 394	52.26	10	26.1300	522.60	26.1300	6.2	548.7300
## 395	79.74	1	3.9870	79.74	3.9870	7.3	83.7270
## 396	77.50	5	19.3750	387.50	19.3750	4.3	406.8750
## 397	54.27	5	13.5675	271.35	13.5675	4.6	284.9175
## 398	13.59	9	6.1155	122.31	6.1155	5.8	128.4255
## 399	41.06	6	12.3180	246.36	12.3180	8.3	258.6780
## 400	19.24	9	8.6580	173.16	8.6580	8.0	181.8180
## 401	39.43	6	11.8290	236.58	11.8290	9.4	248.4090
## 402	46.22	4	9.2440	184.88	9.2440	6.2	194.1240
## 403	13.98	1	0.6990	13.98	0.6990	9.8	14.6790
## 404	39.75	5	9.9375	198.75	9.9375	9.6	208.6875
## 405	97.79	7	34.2265	684.53	34.2265	4.9	718.7565
## 406	67.26	4	13.4520	269.04	13.4520	8.0	282.4920
## 407	13.79	5	3.4475	68.95	3.4475	7.8	72.3975
## 408	68.71	4	13.7420	274.84	13.7420	4.1	288.5820
## 409	56.53	4	11.3060	226.12	11.3060	5.5	237.4260
## 410	23.82	5	5.9550	119.10	5.9550	5.4	125.0550
## 411	34.21	10	17.1050	342.10	17.1050	5.1	359.2050
## 412	21.87	2	2.1870	43.74	2.1870	6.9	45.9270
## 413	20.97	5	5.2425	104.85	5.2425	7.8	110.0925
## 414	25.84	3	3.8760	77.52	3.8760	6.6	81.3960
## 415	50.93	8	20.3720	407.44	20.3720	9.2	427.8120
## 416	96.11	1	4.8055	96.11	4.8055	7.8	100.9155
## 417	45.38	4	9.0760	181.52	9.0760	8.7	190.5960
## 418	81.51	1	4.0755	81.51	4.0755	9.2	85.5855
## 419	57.22	2	5.7220	114.44	5.7220	8.3	120.1620
## 420	25.22	7	8.8270	176.54	8.8270	8.2	185.3670
## 421	38.60	3	5.7900	115.80	5.7900	7.5	121.5900
## 422	84.05	3	12.6075	252.15	12.6075	9.8	264.7575
## 423	97.21	10	48.6050	972.10	48.6050	8.7	1020.7050
## 424	25.42	8	10.1680	203.36	10.1680	6.7	213.5280
## 425	16.28	1	0.8140	16.28	0.8140	5.0	17.0940
## 426	40.61	9	18.2745	365.49	18.2745	7.0	383.7645
## 427	53.17	7	18.6095	372.19	18.6095	8.9	390.7995
## 428	20.87	3	3.1305	62.61	3.1305	8.0	65.7405
## 429	67.27	5	16.8175	336.35	16.8175	6.9	353.1675
## 430	90.65	10	45.3250	906.50	45.3250	7.3	951.8250
## 431	69.08	2	6.9080	138.16	6.9080	6.9	145.0680
## 432	43.27	2	4.3270	86.54	4.3270	5.7	90.8670
## 433	23.46	6	7.0380	140.76	7.0380	6.4	147.7980
## 434	95.54	7	33.4390	668.78	33.4390	9.6	702.2190
## 435	47.44	1	2.3720	47.44	2.3720	6.8	49.8120
## 436	99.24	9	44.6580	893.16	44.6580	9.0	937.8180
## 437	82.93	4	16.5860	331.72	16.5860	9.6	348.3060
## 438	33.99	6	10.1970	203.94	10.1970	7.7	214.1370
## 439	17.04	4	3.4080	68.16	3.4080	7.0	71.5680

## 440	40.86	8	16.3440	326.88	16.3440	6.5	343.2240
## 441	17.44	5	4.3600	87.20	4.3600	8.1	91.5600
## 442	88.43	8	35.3720	707.44	35.3720	4.3	742.8120
## 443	89.21	9	40.1445	802.89	40.1445	6.5	843.0345
## 444	12.78	1	0.6390	12.78	0.6390	9.5	13.4190
## 445	19.10	7	6.6850	133.70	6.6850	9.7	140.3850
## 446	19.15	1	0.9575	19.15	0.9575	9.5	20.1075
## 447	27.66	10	13.8300	276.60	13.8300	8.9	290.4300
## 448	45.74	3	6.8610	137.22	6.8610	6.5	144.0810
## 449	27.07	1	1.3535	27.07	1.3535	5.3	28.4235
## 450	39.12	1	1.9560	39.12	1.9560	9.6	41.0760
## 451	74.71	6	22.4130	448.26	22.4130	6.7	470.6730
## 452	22.01	6	6.6030	132.06	6.6030	7.6	138.6630
## 453	63.61	5	15.9025	318.05	15.9025	4.8	333.9525
## 454	25.00	1	1.2500	25.00	1.2500	5.5	26.2500
## 455	20.77	4	4.1540	83.08	4.1540	4.7	87.2340
## 456	29.56	5	7.3900	147.80	7.3900	6.9	155.1900
## 457	77.40	9	34.8300	696.60	34.8300	4.5	731.4300
## 458	79.39	10	39.6950	793.90	39.6950	6.2	833.5950
## 459	46.57	10	23.2850	465.70	23.2850	7.6	488.9850
## 460	35.89	1	1.7945	35.89	1.7945	7.9	37.6845
## 461	40.52	5	10.1300	202.60	10.1300	4.5	212.7300
## 462	73.05	10	36.5250	730.50	36.5250	8.7	767.0250
## 463	73.95	4	14.7900	295.80	14.7900	6.1	310.5900
## 464	22.62	1	1.1310	22.62	1.1310	6.4	23.7510
## 465	51.34	5	12.8350	256.70	12.8350	9.1	269.5350
## 466	54.55	10	27.2750	545.50	27.2750	7.1	572.7750
## 467	37.15	7	13.0025	260.05	13.0025	7.7	273.0525
## 468	37.02	6	11.1060	222.12	11.1060	4.5	233.2260
## 469	21.58	1	1.0790	21.58	1.0790	7.2	22.6590
## 470	98.84	1	4.9420	98.84	4.9420	8.4	103.7820
## 471	83.77	6	25.1310	502.62	25.1310	5.4	527.7510
## 472	40.05	4	8.0100	160.20	8.0100	9.7	168.2100
## 473	43.13	10	21.5650	431.30	21.5650	5.5	452.8650
## 474	72.57	8	29.0280	580.56	29.0280	4.6	609.5880
## 475	64.44	5	16.1100	322.20	16.1100	6.6	338.3100
## 476	65.18	3	9.7770	195.54	9.7770	6.3	205.3170
## 477	33.26	5	8.3150	166.30	8.3150	4.2	174.6150
## 478	84.07	4	16.8140	336.28	16.8140	4.4	353.0940
## 479	34.37	10	17.1850	343.70	17.1850	6.7	360.8850
## 480	38.60	1	1.9300	38.60	1.9300	6.7	40.5300
## 481	65.97	8	26.3880	527.76	26.3880	8.4	554.1480
## 482	32.80	10	16.4000	328.00	16.4000	6.2	344.4000
## 483	37.14	5	9.2850	185.70	9.2850	5.0	194.9850
## 484	60.38	10	30.1900	603.80	30.1900	6.0	633.9900
## 485	36.98	10	18.4900	369.80	18.4900	7.0	388.2900
## 486	49.49	4	9.8980	197.96	9.8980	6.6	207.8580
## 487	41.09	10	20.5450	410.90	20.5450	7.3	431.4450
## 488	37.15	4	7.4300	148.60	7.4300	8.3	156.0300
## 489	22.96	1	1.1480	22.96	1.1480	4.3	24.1080
## 490	77.68	9	34.9560	699.12	34.9560	9.8	734.0760
## 491	34.70	2	3.4700	69.40	3.4700	8.2	72.8700
## 492	19.66	10	9.8300	196.60	9.8300	7.2	206.4300
## 493	25.32	8	10.1280	202.56	10.1280	8.7	212.6880

## 494	12.12	10	6.0600	121.20	6.0600	8.4	127.2600
## 495	99.89	2	9.9890	199.78	9.9890	7.1	209.7690
## 496	75.92	8	30.3680	607.36	30.3680	5.5	637.7280
## 497	63.22	2	6.3220	126.44	6.3220	8.5	132.7620
## 498	90.24	6	27.0720	541.44	27.0720	6.2	568.5120
## 499	98.13	1	4.9065	98.13	4.9065	8.9	103.0365
## 500	51.52	8	20.6080	412.16	20.6080	9.6	432.7680
## 501	73.97	1	3.6985	73.97	3.6985	5.4	77.6685
## 502	31.90	1	1.5950	31.90	1.5950	9.1	33.4950
## 503	69.40	2	6.9400	138.80	6.9400	9.0	145.7400
## 504	93.31	2	9.3310	186.62	9.3310	6.3	195.9510
## 505	88.45	1	4.4225	88.45	4.4225	9.5	92.8725
## 506	24.18	8	9.6720	193.44	9.6720	9.8	203.1120
## 507	48.50	3	7.2750	145.50	7.2750	6.7	152.7750
## 508	84.05	6	25.2150	504.30	25.2150	7.7	529.5150
## 509	61.29	5	15.3225	306.45	15.3225	7.0	321.7725
## 510	15.95	6	4.7850	95.70	4.7850	5.1	100.4850
## 511	90.74	7	31.7590	635.18	31.7590	6.2	666.9390
## 512	42.91	5	10.7275	214.55	10.7275	6.1	225.2775
## 513	54.28	7	18.9980	379.96	18.9980	9.3	398.9580
## 514	99.55	7	34.8425	696.85	34.8425	7.6	731.6925
## 515	58.39	7	20.4365	408.73	20.4365	8.2	429.1665
## 516	51.47	1	2.5735	51.47	2.5735	8.5	54.0435
## 517	54.86	5	13.7150	274.30	13.7150	9.8	288.0150
## 518	39.39	5	9.8475	196.95	9.8475	8.7	206.7975
## 519	34.73	2	3.4730	69.46	3.4730	9.7	72.9330
## 520	71.92	5	17.9800	359.60	17.9800	4.3	377.5800
## 521	45.71	3	6.8565	137.13	6.8565	7.7	143.9865
## 522	83.17	6	24.9510	499.02	24.9510	7.3	523.9710
## 523	37.44	6	11.2320	224.64	11.2320	5.9	235.8720
## 524	62.87	2	6.2870	125.74	6.2870	5.0	132.0270
## 525	81.71	6	24.5130	490.26	24.5130	8.0	514.7730
## 526	91.41	5	22.8525	457.05	22.8525	7.1	479.9025
## 527	39.21	4	7.8420	156.84	7.8420	9.0	164.6820
## 528	59.86	2	5.9860	119.72	5.9860	6.7	125.7060
## 529	54.36	10	27.1800	543.60	27.1800	6.1	570.7800
## 530	98.09	9	44.1405	882.81	44.1405	9.3	926.9505
## 531	25.43	6	7.6290	152.58	7.6290	7.0	160.2090
## 532	86.68	8	34.6720	693.44	34.6720	7.2	728.1120
## 533	22.95	10	11.4750	229.50	11.4750	8.2	240.9750
## 534	16.31	9	7.3395	146.79	7.3395	8.4	154.1295
## 535	28.32	5	7.0800	141.60	7.0800	6.2	148.6800
## 536	16.67	7	5.8345	116.69	5.8345	7.4	122.5245
## 537	73.96	1	3.6980	73.96	3.6980	5.0	77.6580
## 538	97.94	1	4.8970	97.94	4.8970	6.9	102.8370
## 539	73.05	4	14.6100	292.20	14.6100	4.9	306.8100
## 540	87.48	6	26.2440	524.88	26.2440	5.1	551.1240
## 541	30.68	3	4.6020	92.04	4.6020	9.1	96.6420
## 542	75.88	1	3.7940	75.88	3.7940	7.1	79.6740
## 543	20.18	4	4.0360	80.72	4.0360	5.0	84.7560
## 544	18.77	6	5.6310	112.62	5.6310	5.5	118.2510
## 545	71.20	1	3.5600	71.20	3.5600	9.2	74.7600
## 546	38.81	4	7.7620	155.24	7.7620	4.9	163.0020
## 547	29.42	10	14.7100	294.20	14.7100	8.9	308.9100

## 548	60.95	9	27.4275	548.55	27.4275	6.0	575.9775
## 549	51.54	5	12.8850	257.70	12.8850	4.2	270.5850
## 550	66.06	6	19.8180	396.36	19.8180	7.3	416.1780
## 551	57.27	3	8.5905	171.81	8.5905	6.5	180.4005
## 552	54.31	9	24.4395	488.79	24.4395	8.9	513.2295
## 553	58.24	9	26.2080	524.16	26.2080	9.7	550.3680
## 554	22.21	6	6.6630	133.26	6.6630	8.6	139.9230
## 555	19.32	7	6.7620	135.24	6.7620	6.9	142.0020
## 556	37.48	3	5.6220	112.44	5.6220	7.7	118.0620
## 557	72.04	2	7.2040	144.08	7.2040	9.5	151.2840
## 558	98.52	10	49.2600	985.20	49.2600	4.5	1034.4600
## 559	41.66	6	12.4980	249.96	12.4980	5.6	262.4580
## 560	72.42	3	10.8630	217.26	10.8630	8.2	228.1230
## 561	21.58	9	9.7110	194.22	9.7110	7.3	203.9310
## 562	89.20	10	44.6000	892.00	44.6000	4.4	936.6000
## 563	42.42	8	16.9680	339.36	16.9680	5.7	356.3280
## 564	74.51	6	22.3530	447.06	22.3530	5.0	469.4130
## 565	99.25	2	9.9250	198.50	9.9250	9.0	208.4250
## 566	81.21	10	40.6050	812.10	40.6050	6.3	852.7050
## 567	49.33	10	24.6650	493.30	24.6650	9.4	517.9650
## 568	65.74	9	29.5830	591.66	29.5830	7.7	621.2430
## 569	79.86	7	27.9510	559.02	27.9510	5.5	586.9710
## 570	73.98	7	25.8930	517.86	25.8930	4.1	543.7530
## 571	82.04	5	20.5100	410.20	20.5100	7.6	430.7100
## 572	26.67	10	13.3350	266.70	13.3350	8.6	280.0350
## 573	10.13	7	3.5455	70.91	3.5455	8.3	74.4555
## 574	72.39	2	7.2390	144.78	7.2390	8.1	152.0190
## 575	85.91	5	21.4775	429.55	21.4775	8.6	451.0275
## 576	81.31	7	28.4585	569.17	28.4585	6.3	597.6285
## 577	60.30	4	12.0600	241.20	12.0600	5.8	253.2600
## 578	31.77	4	6.3540	127.08	6.3540	6.2	133.4340
## 579	64.27	4	12.8540	257.08	12.8540	7.7	269.9340
## 580	69.51	2	6.9510	139.02	6.9510	8.1	145.9710
## 581	27.22	3	4.0830	81.66	4.0830	7.3	85.7430
## 582	77.68	4	15.5360	310.72	15.5360	8.4	326.2560
## 583	92.98	2	9.2980	185.96	9.2980	8.0	195.2580
## 584	18.08	4	3.6160	72.32	3.6160	9.5	75.9360
## 585	63.06	3	9.4590	189.18	9.4590	7.0	198.6390
## 586	51.71	4	10.3420	206.84	10.3420	9.8	217.1820
## 587	52.34	3	7.8510	157.02	7.8510	9.2	164.8710
## 588	43.06	5	10.7650	215.30	10.7650	7.7	226.0650
## 589	59.61	10	29.8050	596.10	29.8050	5.3	625.9050
## 590	14.62	5	3.6550	73.10	3.6550	4.4	76.7550
## 591	46.53	6	13.9590	279.18	13.9590	4.3	293.1390
## 592	24.24	7	8.4840	169.68	8.4840	9.4	178.1640
## 593	45.58	1	2.2790	45.58	2.2790	9.8	47.8590
## 594	75.20	3	11.2800	225.60	11.2800	4.8	236.8800
## 595	96.80	3	14.5200	290.40	14.5200	5.3	304.9200
## 596	14.82	3	2.2230	44.46	2.2230	8.7	46.6830
## 597	52.20	3	7.8300	156.60	7.8300	9.5	164.4300
## 598	46.66	9	20.9970	419.94	20.9970	5.3	440.9370
## 599	36.85	5	9.2125	184.25	9.2125	9.2	193.4625
## 600	70.32	2	7.0320	140.64	7.0320	9.6	147.6720
## 601	83.08	1	4.1540	83.08	4.1540	6.4	87.2340

## 602	64.99	1	3.2495	64.99	3.2495	4.5	68.2395
## 603	77.56	10	38.7800	775.60	38.7800	6.9	814.3800
## 604	54.51	6	16.3530	327.06	16.3530	7.8	343.4130
## 605	51.89	7	18.1615	363.23	18.1615	4.5	381.3915
## 606	31.75	4	6.3500	127.00	6.3500	8.6	133.3500
## 607	53.65	7	18.7775	375.55	18.7775	5.2	394.3275
## 608	49.79	4	9.9580	199.16	9.9580	6.4	209.1180
## 609	30.61	1	1.5305	30.61	1.5305	5.2	32.1405
## 610	57.89	2	5.7890	115.78	5.7890	8.9	121.5690
## 611	28.96	1	1.4480	28.96	1.4480	6.2	30.4080
## 612	98.97	9	44.5365	890.73	44.5365	6.7	935.2665
## 613	93.22	3	13.9830	279.66	13.9830	7.2	293.6430
## 614	80.93	1	4.0465	80.93	4.0465	9.0	84.9765
## 615	67.45	10	33.7250	674.50	33.7250	4.2	708.2250
## 616	38.72	9	17.4240	348.48	17.4240	4.2	365.9040
## 617	72.60	6	21.7800	435.60	21.7800	6.9	457.3800
## 618	87.91	5	21.9775	439.55	21.9775	4.4	461.5275
## 619	98.53	6	29.5590	591.18	29.5590	4.0	620.7390
## 620	43.46	6	13.0380	260.76	13.0380	8.5	273.7980
## 621	71.68	3	10.7520	215.04	10.7520	9.2	225.7920
## 622	91.61	1	4.5805	91.61	4.5805	9.8	96.1905
## 623	94.59	7	33.1065	662.13	33.1065	4.9	695.2365
## 624	83.25	10	41.6250	832.50	41.6250	4.4	874.1250
## 625	91.35	1	4.5675	91.35	4.5675	6.8	95.9175
## 626	78.88	2	7.8880	157.76	7.8880	9.1	165.6480
## 627	60.87	2	6.0870	121.74	6.0870	8.7	127.8270
## 628	82.58	10	41.2900	825.80	41.2900	5.0	867.0900
## 629	53.30	3	7.9950	159.90	7.9950	7.5	167.8950
## 630	12.09	1	0.6045	12.09	0.6045	8.2	12.6945
## 631	64.19	10	32.0950	641.90	32.0950	6.7	673.9950
## 632	78.31	3	11.7465	234.93	11.7465	5.4	246.6765
## 633	83.77	2	8.3770	167.54	8.3770	7.0	175.9170
## 634	99.70	3	14.9550	299.10	14.9550	4.7	314.0550
## 635	79.91	3	11.9865	239.73	11.9865	5.0	251.7165
## 636	66.47	10	33.2350	664.70	33.2350	5.0	697.9350
## 637	28.95	7	10.1325	202.65	10.1325	6.0	212.7825
## 638	46.20	1	2.3100	46.20	2.3100	6.3	48.5100
## 639	17.63	5	4.4075	88.15	4.4075	8.5	92.5575
## 640	52.42	3	7.8630	157.26	7.8630	7.5	165.1230
## 641	98.79	3	14.8185	296.37	14.8185	6.4	311.1885
## 642	88.55	8	35.4200	708.40	35.4200	4.7	743.8200
## 643	55.67	2	5.5670	111.34	5.5670	6.0	116.9070
## 644	72.52	8	29.0080	580.16	29.0080	4.0	609.1680
## 645	12.05	5	3.0125	60.25	3.0125	5.5	63.2625
## 646	19.36	9	8.7120	174.24	8.7120	8.7	182.9520
## 647	70.21	6	21.0630	421.26	21.0630	7.4	442.3230
## 648	33.63	1	1.6815	33.63	1.6815	5.6	35.3115
## 649	15.49	2	1.5490	30.98	1.5490	6.3	32.5290
## 650	24.74	10	12.3700	247.40	12.3700	7.1	259.7700
## 651	75.66	5	18.9150	378.30	18.9150	7.8	397.2150
## 652	55.81	6	16.7430	334.86	16.7430	9.9	351.6030
## 653	72.78	10	36.3900	727.80	36.3900	7.3	764.1900
## 654	37.32	9	16.7940	335.88	16.7940	5.1	352.6740
## 655	60.18	4	12.0360	240.72	12.0360	9.4	252.7560

## 656	15.69	3	2.3535	47.07	2.3535	5.8	49.4235
## 657	99.69	1	4.9845	99.69	4.9845	8.0	104.6745
## 658	88.15	3	13.2225	264.45	13.2225	7.9	277.6725
## 659	27.93	5	6.9825	139.65	6.9825	5.9	146.6325
## 660	55.45	1	2.7725	55.45	2.7725	4.9	58.2225
## 661	42.97	3	6.4455	128.91	6.4455	9.3	135.3555
## 662	17.14	7	5.9990	119.98	5.9990	7.9	125.9790
## 663	58.75	6	17.6250	352.50	17.6250	5.9	370.1250
## 664	87.10	10	43.5500	871.00	43.5500	9.9	914.5500
## 665	98.80	2	9.8800	197.60	9.8800	7.7	207.4800
## 666	48.63	4	9.7260	194.52	9.7260	7.6	204.2460
## 667	57.74	3	8.6610	173.22	8.6610	7.7	181.8810
## 668	17.97	4	3.5940	71.88	3.5940	6.4	75.4740
## 669	47.71	6	14.3130	286.26	14.3130	4.4	300.5730
## 670	40.62	2	4.0620	81.24	4.0620	4.1	85.3020
## 671	56.04	10	28.0200	560.40	28.0200	4.4	588.4200
## 672	93.40	2	9.3400	186.80	9.3400	5.5	196.1400
## 673	73.41	3	11.0115	220.23	11.0115	4.0	231.2415
## 674	33.64	8	13.4560	269.12	13.4560	9.3	282.5760
## 675	45.48	10	22.7400	454.80	22.7400	4.8	477.5400
## 676	83.77	2	8.3770	167.54	8.3770	4.6	175.9170
## 677	64.08	7	22.4280	448.56	22.4280	7.3	470.9880
## 678	73.47	4	14.6940	293.88	14.6940	6.0	308.5740
## 679	58.95	10	29.4750	589.50	29.4750	8.1	618.9750
## 680	48.50	6	14.5500	291.00	14.5500	9.4	305.5500
## 681	39.48	1	1.9740	39.48	1.9740	6.5	41.4540
## 682	34.81	1	1.7405	34.81	1.7405	7.0	36.5505
## 683	49.32	6	14.7960	295.92	14.7960	7.1	310.7160
## 684	21.48	2	2.1480	42.96	2.1480	6.6	45.1080
## 685	23.08	6	6.9240	138.48	6.9240	4.9	145.4040
## 686	49.10	2	4.9100	98.20	4.9100	6.4	103.1100
## 687	64.83	2	6.4830	129.66	6.4830	8.0	136.1430
## 688	63.56	10	31.7800	635.60	31.7800	4.3	667.3800
## 689	72.88	2	7.2880	145.76	7.2880	6.1	153.0480
## 690	67.10	3	10.0650	201.30	10.0650	7.5	211.3650
## 691	70.19	9	31.5855	631.71	31.5855	6.7	663.2955
## 692	55.04	7	19.2640	385.28	19.2640	5.2	404.5440
## 693	48.63	10	24.3150	486.30	24.3150	8.8	510.6150
## 694	73.38	7	25.6830	513.66	25.6830	9.5	539.3430
## 695	52.60	9	23.6700	473.40	23.6700	7.6	497.0700
## 696	87.37	5	21.8425	436.85	21.8425	6.6	458.6925
## 697	27.04	4	5.4080	108.16	5.4080	6.9	113.5680
## 698	62.19	4	12.4380	248.76	12.4380	4.3	261.1980
## 699	69.58	9	31.3110	626.22	31.3110	7.8	657.5310
## 700	97.50	10	48.7500	975.00	48.7500	8.0	1023.7500
## 701	60.41	8	24.1640	483.28	24.1640	9.6	507.4440
## 702	32.32	3	4.8480	96.96	4.8480	4.3	101.8080
## 703	19.77	10	9.8850	197.70	9.8850	5.0	207.5850
## 704	80.47	9	36.2115	724.23	36.2115	9.2	760.4415
## 705	88.39	9	39.7755	795.51	39.7755	6.3	835.2855
## 706	71.77	7	25.1195	502.39	25.1195	8.9	527.5095
## 707	43.00	4	8.6000	172.00	8.6000	7.6	180.6000
## 708	68.98	1	3.4490	68.98	3.4490	4.8	72.4290
## 709	15.62	8	6.2480	124.96	6.2480	9.1	131.2080

## 710	25.70	3	3.8550	77.10	3.8550	6.1	80.9550
## 711	80.62	6	24.1860	483.72	24.1860	9.1	507.9060
## 712	75.53	4	15.1060	302.12	15.1060	8.3	317.2260
## 713	77.63	9	34.9335	698.67	34.9335	7.2	733.6035
## 714	13.85	9	6.2325	124.65	6.2325	6.0	130.8825
## 715	98.70	8	39.4800	789.60	39.4800	8.5	829.0800
## 716	35.68	5	8.9200	178.40	8.9200	6.6	187.3200
## 717	71.46	7	25.0110	500.22	25.0110	4.5	525.2310
## 718	11.94	3	1.7910	35.82	1.7910	8.1	37.6110
## 719	45.38	3	6.8070	136.14	6.8070	7.2	142.9470
## 720	17.48	6	5.2440	104.88	5.2440	6.1	110.1240
## 721	25.56	7	8.9460	178.92	8.9460	7.1	187.8660
## 722	90.63	9	40.7835	815.67	40.7835	5.1	856.4535
## 723	44.12	3	6.6180	132.36	6.6180	7.9	138.9780
## 724	36.77	7	12.8695	257.39	12.8695	7.4	270.2595
## 725	23.34	4	4.6680	93.36	4.6680	7.4	98.0280
## 726	28.50	8	11.4000	228.00	11.4000	6.6	239.4000
## 727	55.57	3	8.3355	166.71	8.3355	5.9	175.0455
## 728	69.74	10	34.8700	697.40	34.8700	8.9	732.2700
## 729	97.26	4	19.4520	389.04	19.4520	6.8	408.4920
## 730	52.18	7	18.2630	365.26	18.2630	9.3	383.5230
## 731	22.32	4	4.4640	89.28	4.4640	4.4	93.7440
## 732	56.00	3	8.4000	168.00	8.4000	4.8	176.4000
## 733	19.70	1	0.9850	19.70	0.9850	9.5	20.6850
## 734	75.88	7	26.5580	531.16	26.5580	8.9	557.7180
## 735	53.72	1	2.6860	53.72	2.6860	6.4	56.4060
## 736	81.95	10	40.9750	819.50	40.9750	6.0	860.4750
## 737	81.20	7	28.4200	568.40	28.4200	8.1	596.8200
## 738	58.76	10	29.3800	587.60	29.3800	9.0	616.9800
## 739	91.56	8	36.6240	732.48	36.6240	6.0	769.1040
## 740	93.96	9	42.2820	845.64	42.2820	9.8	887.9220
## 741	55.61	7	19.4635	389.27	19.4635	8.5	408.7335
## 742	84.83	1	4.2415	84.83	4.2415	8.8	89.0715
## 743	71.63	2	7.1630	143.26	7.1630	8.8	150.4230
## 744	37.69	2	3.7690	75.38	3.7690	9.5	79.1490
## 745	31.67	8	12.6680	253.36	12.6680	5.6	266.0280
## 746	38.42	1	1.9210	38.42	1.9210	8.6	40.3410
## 747	65.23	10	32.6150	652.30	32.6150	5.2	684.9150
## 748	10.53	5	2.6325	52.65	2.6325	5.8	55.2825
## 749	12.29	9	5.5305	110.61	5.5305	8.0	116.1405
## 750	81.23	7	28.4305	568.61	28.4305	9.0	597.0405
## 751	22.32	4	4.4640	89.28	4.4640	4.1	93.7440
## 752	27.28	5	6.8200	136.40	6.8200	8.6	143.2200
## 753	17.42	10	8.7100	174.20	8.7100	7.0	182.9100
## 754	73.28	5	18.3200	366.40	18.3200	8.4	384.7200
## 755	84.87	3	12.7305	254.61	12.7305	7.4	267.3405
## 756	97.29	8	38.9160	778.32	38.9160	6.2	817.2360
## 757	35.74	8	14.2960	285.92	14.2960	4.9	300.2160
## 758	96.52	6	28.9560	579.12	28.9560	4.5	608.0760
## 759	18.85	10	9.4250	188.50	9.4250	5.6	197.9250
## 760	55.39	4	11.0780	221.56	11.0780	8.0	232.6380
## 761	77.20	10	38.6000	772.00	38.6000	5.6	810.6000
## 762	72.13	10	36.0650	721.30	36.0650	4.2	757.3650
## 763	63.88	8	25.5520	511.04	25.5520	9.9	536.5920

## 764	10.69	5	2.6725	53.45	2.6725	7.6	56.1225
## 765	55.50	4	11.1000	222.00	11.1000	6.6	233.1000
## 766	95.46	8	38.1840	763.68	38.1840	4.7	801.8640
## 767	76.06	3	11.4090	228.18	11.4090	9.8	239.5890
## 768	13.69	6	4.1070	82.14	4.1070	6.3	86.2470
## 769	95.64	4	19.1280	382.56	19.1280	7.9	401.6880
## 770	11.43	6	3.4290	68.58	3.4290	7.7	72.0090
## 771	95.54	4	19.1080	382.16	19.1080	4.5	401.2680
## 772	85.87	7	30.0545	601.09	30.0545	8.0	631.1445
## 773	67.99	7	23.7965	475.93	23.7965	5.7	499.7265
## 774	52.42	1	2.6210	52.42	2.6210	6.3	55.0410
## 775	65.65	2	6.5650	131.30	6.5650	6.0	137.8650
## 776	28.86	5	7.2150	144.30	7.2150	8.0	151.5150
## 777	65.31	7	22.8585	457.17	22.8585	4.2	480.0285
## 778	93.38	1	4.6690	93.38	4.6690	9.6	98.0490
## 779	25.25	5	6.3125	126.25	6.3125	6.1	132.5625
## 780	87.87	9	39.5415	790.83	39.5415	5.6	830.3715
## 781	21.80	8	8.7200	174.40	8.7200	8.3	183.1200
## 782	94.76	4	18.9520	379.04	18.9520	7.8	397.9920
## 783	30.62	1	1.5310	30.62	1.5310	4.1	32.1510
## 784	44.01	8	17.6040	352.08	17.6040	8.8	369.6840
## 785	10.16	5	2.5400	50.80	2.5400	4.1	53.3400
## 786	74.58	7	26.1030	522.06	26.1030	9.0	548.1630
## 787	71.89	8	28.7560	575.12	28.7560	5.5	603.8760
## 788	10.99	5	2.7475	54.95	2.7475	9.3	57.6975
## 789	60.47	3	9.0705	181.41	9.0705	5.6	190.4805
## 790	58.91	7	20.6185	412.37	20.6185	9.7	432.9885
## 791	46.41	1	2.3205	46.41	2.3205	4.0	48.7305
## 792	68.55	4	13.7100	274.20	13.7100	9.2	287.9100
## 793	97.37	10	48.6850	973.70	48.6850	4.9	1022.3850
## 794	92.60	7	32.4100	648.20	32.4100	9.3	680.6100
## 795	46.61	2	4.6610	93.22	4.6610	6.6	97.8810
## 796	27.18	2	2.7180	54.36	2.7180	4.3	57.0780
## 797	60.87	1	3.0435	60.87	3.0435	5.5	63.9135
## 798	24.49	10	12.2450	244.90	12.2450	8.1	257.1450
## 799	92.78	1	4.6390	92.78	4.6390	9.8	97.4190
## 800	86.69	5	21.6725	433.45	21.6725	9.4	455.1225
## 801	23.01	6	6.9030	138.06	6.9030	7.9	144.9630
## 802	30.20	8	12.0800	241.60	12.0800	5.1	253.6800
## 803	67.39	7	23.5865	471.73	23.5865	6.9	495.3165
## 804	48.96	9	22.0320	440.64	22.0320	8.0	462.6720
## 805	75.59	9	34.0155	680.31	34.0155	8.0	714.3255
## 806	77.47	4	15.4940	309.88	15.4940	4.2	325.3740
## 807	93.18	2	9.3180	186.36	9.3180	8.5	195.6780
## 808	50.23	4	10.0460	200.92	10.0460	9.0	210.9660
## 809	17.75	1	0.8875	17.75	0.8875	8.6	18.6375
## 810	62.18	10	31.0900	621.80	31.0900	6.0	652.8900
## 811	10.75	8	4.3000	86.00	4.3000	6.2	90.3000
## 812	40.26	10	20.1300	402.60	20.1300	5.0	422.7300
## 813	64.97	5	16.2425	324.85	16.2425	6.5	341.0925
## 814	95.15	1	4.7575	95.15	4.7575	6.0	99.9075
## 815	48.62	8	19.4480	388.96	19.4480	5.0	408.4080
## 816	53.21	8	21.2840	425.68	21.2840	5.0	446.9640
## 817	45.44	7	15.9040	318.08	15.9040	9.2	333.9840

## 818	33.88	8	13.5520	271.04	13.5520	9.6	284.5920
## 819	96.16	4	19.2320	384.64	19.2320	8.4	403.8720
## 820	47.16	5	11.7900	235.80	11.7900	6.0	247.5900
## 821	52.89	4	10.5780	211.56	10.5780	6.7	222.1380
## 822	47.68	2	4.7680	95.36	4.7680	4.1	100.1280
## 823	10.17	1	0.5085	10.17	0.5085	5.9	10.6785
## 824	68.71	3	10.3065	206.13	10.3065	8.7	216.4365
## 825	60.08	7	21.0280	420.56	21.0280	4.5	441.5880
## 826	22.01	4	4.4020	88.04	4.4020	6.6	92.4420
## 827	72.11	9	32.4495	648.99	32.4495	7.7	681.4395
## 828	41.28	3	6.1920	123.84	6.1920	8.5	130.0320
## 829	64.95	10	32.4750	649.50	32.4750	5.2	681.9750
## 830	74.22	10	37.1100	742.20	37.1100	4.3	779.3100
## 831	10.56	8	4.2240	84.48	4.2240	7.6	88.7040
## 832	62.57	4	12.5140	250.28	12.5140	9.5	262.7940
## 833	11.85	8	4.7400	94.80	4.7400	4.1	99.5400
## 834	91.30	1	4.5650	91.30	4.5650	9.2	95.8650
## 835	40.73	7	14.2555	285.11	14.2555	5.4	299.3655
## 836	52.38	1	2.6190	52.38	2.6190	5.8	54.9990
## 837	38.54	5	9.6350	192.70	9.6350	5.6	202.3350
## 838	44.63	6	13.3890	267.78	13.3890	5.1	281.1690
## 839	55.87	10	27.9350	558.70	27.9350	5.8	586.6350
## 840	29.22	6	8.7660	175.32	8.7660	5.0	184.0860
## 841	51.94	3	7.7910	155.82	7.7910	7.9	163.6110
## 842	60.30	1	3.0150	60.30	3.0150	6.0	63.3150
## 843	39.47	2	3.9470	78.94	3.9470	5.0	82.8870
## 844	14.87	2	1.4870	29.74	1.4870	8.9	31.2270
## 845	21.32	1	1.0660	21.32	1.0660	5.9	22.3860
## 846	93.78	3	14.0670	281.34	14.0670	5.9	295.4070
## 847	73.26	1	3.6630	73.26	3.6630	9.7	76.9230
## 848	22.38	1	1.1190	22.38	1.1190	8.6	23.4990
## 849	72.88	9	32.7960	655.92	32.7960	4.0	688.7160
## 850	99.10	6	29.7300	594.60	29.7300	4.2	624.3300
## 851	74.10	1	3.7050	74.10	3.7050	9.2	77.8050
## 852	98.48	2	9.8480	196.96	9.8480	9.2	206.8080
## 853	53.19	7	18.6165	372.33	18.6165	5.0	390.9465
## 854	52.79	10	26.3950	527.90	26.3950	10.0	554.2950
## 855	95.95	5	23.9875	479.75	23.9875	8.8	503.7375
## 856	36.51	9	16.4295	328.59	16.4295	4.2	345.0195
## 857	21.12	8	8.4480	168.96	8.4480	6.3	177.4080
## 858	28.31	4	5.6620	113.24	5.6620	8.2	118.9020
## 859	57.59	6	17.2770	345.54	17.2770	5.1	362.8170
## 860	47.63	9	21.4335	428.67	21.4335	5.0	450.1035
## 861	86.27	1	4.3135	86.27	4.3135	7.0	90.5835
## 862	12.76	2	1.2760	25.52	1.2760	7.8	26.7960
## 863	11.28	9	5.0760	101.52	5.0760	4.3	106.5960
## 864	51.07	7	17.8745	357.49	17.8745	7.0	375.3645
## 865	79.59	3	11.9385	238.77	11.9385	6.6	250.7085
## 866	33.81	3	5.0715	101.43	5.0715	7.3	106.5015
## 867	90.53	8	36.2120	724.24	36.2120	6.5	760.4520
## 868	62.82	2	6.2820	125.64	6.2820	4.9	131.9220
## 869	24.31	3	3.6465	72.93	3.6465	4.3	76.5765
## 870	64.59	4	12.9180	258.36	12.9180	9.3	271.2780
## 871	24.82	7	8.6870	173.74	8.6870	7.1	182.4270

## 872	56.50	1	2.8250	56.50	2.8250	9.6	59.3250
## 873	21.43	10	10.7150	214.30	10.7150	6.2	225.0150
## 874	89.06	6	26.7180	534.36	26.7180	9.9	561.0780
## 875	23.29	4	4.6580	93.16	4.6580	5.9	97.8180
## 876	65.26	8	26.1040	522.08	26.1040	6.3	548.1840
## 877	52.35	1	2.6175	52.35	2.6175	4.0	54.9675
## 878	39.75	1	1.9875	39.75	1.9875	6.1	41.7375
## 879	90.02	8	36.0080	720.16	36.0080	4.5	756.1680
## 880	12.10	8	4.8400	96.80	4.8400	8.6	101.6400
## 881	33.21	10	16.6050	332.10	16.6050	6.0	348.7050
## 882	10.18	8	4.0720	81.44	4.0720	9.5	85.5120
## 883	31.99	10	15.9950	319.90	15.9950	9.9	335.8950
## 884	34.42	6	10.3260	206.52	10.3260	7.5	216.8460
## 885	83.34	2	8.3340	166.68	8.3340	7.6	175.0140
## 886	45.58	7	15.9530	319.06	15.9530	5.0	335.0130
## 887	87.90	1	4.3950	87.90	4.3950	6.7	92.2950
## 888	73.47	10	36.7350	734.70	36.7350	9.5	771.4350
## 889	12.19	8	4.8760	97.52	4.8760	6.8	102.3960
## 890	76.92	10	38.4600	769.20	38.4600	5.6	807.6600
## 891	83.66	5	20.9150	418.30	20.9150	7.2	439.2150
## 892	57.91	8	23.1640	463.28	23.1640	8.1	486.4440
## 893	92.49	5	23.1225	462.45	23.1225	8.6	485.5725
## 894	28.38	5	7.0950	141.90	7.0950	9.4	148.9950
## 895	50.45	6	15.1350	302.70	15.1350	8.9	317.8350
## 896	99.16	8	39.6640	793.28	39.6640	4.2	832.9440
## 897	60.74	7	21.2590	425.18	21.2590	5.0	446.4390
## 898	47.27	6	14.1810	283.62	14.1810	8.8	297.8010
## 899	85.60	7	29.9600	599.20	29.9600	5.3	629.1600
## 900	35.04	9	15.7680	315.36	15.7680	4.6	331.1280
## 901	44.84	9	20.1780	403.56	20.1780	7.5	423.7380
## 902	45.97	4	9.1940	183.88	9.1940	5.1	193.0740
## 903	27.73	5	6.9325	138.65	6.9325	4.2	145.5825
## 904	11.53	7	4.0355	80.71	4.0355	8.1	84.7455
## 905	58.32	2	5.8320	116.64	5.8320	6.0	122.4720
## 906	78.38	4	15.6760	313.52	15.6760	7.9	329.1960
## 907	84.61	10	42.3050	846.10	42.3050	8.8	888.4050
## 908	82.88	5	20.7200	414.40	20.7200	6.6	435.1200
## 909	79.54	2	7.9540	159.08	7.9540	6.2	167.0340
## 910	49.01	10	24.5050	490.10	24.5050	4.2	514.6050
## 911	29.15	3	4.3725	87.45	4.3725	7.3	91.8225
## 912	56.13	4	11.2260	224.52	11.2260	8.6	235.7460
## 913	93.12	8	37.2480	744.96	37.2480	6.8	782.2080
## 914	51.34	8	20.5360	410.72	20.5360	7.6	431.2560
## 915	99.60	3	14.9400	298.80	14.9400	5.8	313.7400
## 916	35.49	6	10.6470	212.94	10.6470	4.1	223.5870
## 917	42.85	1	2.1425	42.85	2.1425	9.3	44.9925
## 918	94.67	4	18.9340	378.68	18.9340	6.8	397.6140
## 919	68.97	3	10.3455	206.91	10.3455	8.7	217.2555
## 920	26.26	3	3.9390	78.78	3.9390	6.3	82.7190
## 921	35.79	9	16.1055	322.11	16.1055	5.1	338.2155
## 922	16.37	6	4.9110	98.22	4.9110	7.0	103.1310
## 923	12.73	2	1.2730	25.46	1.2730	5.2	26.7330
## 924	83.14	7	29.0990	581.98	29.0990	6.6	611.0790
## 925	35.22	6	10.5660	211.32	10.5660	6.5	221.8860

## 926	13.78	4	2.7560	55.12	2.7560	9.0	57.8760
## 927	88.31	1	4.4155	88.31	4.4155	5.2	92.7255
## 928	39.62	9	17.8290	356.58	17.8290	6.8	374.4090
## 929	88.25	9	39.7125	794.25	39.7125	7.6	833.9625
## 930	25.31	2	2.5310	50.62	2.5310	7.2	53.1510
## 931	99.92	6	29.9760	599.52	29.9760	7.1	629.4960
## 932	83.35	2	8.3350	166.70	8.3350	9.5	175.0350
## 933	74.44	10	37.2200	744.40	37.2200	5.1	781.6200
## 934	64.08	7	22.4280	448.56	22.4280	7.6	470.9880
## 935	63.15	6	18.9450	378.90	18.9450	9.8	397.8450
## 936	85.72	3	12.8580	257.16	12.8580	5.1	270.0180
## 937	78.89	7	27.6115	552.23	27.6115	7.5	579.8415
## 938	89.48	5	22.3700	447.40	22.3700	7.4	469.7700
## 939	92.09	3	13.8135	276.27	13.8135	4.2	290.0835
## 940	57.29	6	17.1870	343.74	17.1870	5.9	360.9270
## 941	66.52	4	13.3040	266.08	13.3040	6.9	279.3840
## 942	99.82	9	44.9190	898.38	44.9190	6.6	943.2990
## 943	45.68	10	22.8400	456.80	22.8400	5.7	479.6400
## 944	50.79	5	12.6975	253.95	12.6975	5.3	266.6475
## 945	10.08	7	3.5280	70.56	3.5280	4.2	74.0880
## 946	93.88	7	32.8580	657.16	32.8580	7.3	690.0180
## 947	84.25	2	8.4250	168.50	8.4250	5.3	176.9250
## 948	53.78	1	2.6890	53.78	2.6890	4.7	56.4690
## 949	35.81	5	8.9525	179.05	8.9525	7.9	188.0025
## 950	26.43	8	10.5720	211.44	10.5720	8.9	222.0120
## 951	39.91	3	5.9865	119.73	5.9865	9.3	125.7165
## 952	21.90	3	3.2850	65.70	3.2850	4.7	68.9850
## 953	62.85	4	12.5700	251.40	12.5700	8.7	263.9700
## 954	21.04	4	4.2080	84.16	4.2080	7.6	88.3680
## 955	65.91	6	19.7730	395.46	19.7730	5.7	415.2330
## 956	42.57	7	14.8995	297.99	14.8995	6.8	312.8895
## 957	50.49	9	22.7205	454.41	22.7205	5.4	477.1305
## 958	46.02	6	13.8060	276.12	13.8060	7.1	289.9260
## 959	15.80	10	7.9000	158.00	7.9000	7.8	165.9000
## 960	98.66	9	44.3970	887.94	44.3970	8.4	932.3370
## 961	91.98	1	4.5990	91.98	4.5990	9.8	96.5790
## 962	20.89	2	2.0890	41.78	2.0890	9.8	43.8690
## 963	15.50	1	0.7750	15.50	0.7750	7.4	16.2750
## 964	96.82	3	14.5230	290.46	14.5230	6.7	304.9830
## 965	33.33	2	3.3330	66.66	3.3330	6.4	69.9930
## 966	38.27	2	3.8270	76.54	3.8270	5.8	80.3670
## 967	33.30	9	14.9850	299.70	14.9850	7.2	314.6850
## 968	81.01	3	12.1515	243.03	12.1515	9.3	255.1815
## 969	15.80	3	2.3700	47.40	2.3700	9.5	49.7700
## 970	34.49	5	8.6225	172.45	8.6225	9.0	181.0725
## 971	84.63	10	42.3150	846.30	42.3150	9.0	888.6150
## 972	36.91	7	12.9185	258.37	12.9185	6.7	271.2885
## 973	87.08	7	30.4780	609.56	30.4780	5.5	640.0380
## 974	80.08	3	12.0120	240.24	12.0120	5.4	252.2520
## 975	86.13	2	8.6130	172.26	8.6130	8.2	180.8730
## 976	49.92	2	4.9920	99.84	4.9920	7.0	104.8320
## 977	74.66	4	14.9320	298.64	14.9320	8.5	313.5720
## 978	26.60	6	7.9800	159.60	7.9800	4.9	167.5800
## 979	25.45	1	1.2725	25.45	1.2725	5.1	26.7225

```
## 980      67.77      1  3.3885  67.77      3.3885      6.5    71.1585
## 981      59.59      4 11.9180 238.36     11.9180      9.8    250.2780
## 982      58.15      4 11.6300 232.60     11.6300      8.4    244.2300
## 983      97.48      9 43.8660 877.32     43.8660      7.4    921.1860
## 984      99.96      7 34.9860 699.72     34.9860      6.1    734.7060
## 985      96.37      7 33.7295 674.59     33.7295      6.0    708.3195
## 986      63.71      5 15.9275 318.55     15.9275      8.5    334.4775
## 987      14.76      2  1.4760  29.52      1.4760      4.3     30.9960
## 988      62.00      8 24.8000 496.00     24.8000      6.2    520.8000
## 989      82.34     10 41.1700 823.40     41.1700      4.3    864.5700
## 990      75.37      8 30.1480 602.96     30.1480      8.4    633.1080
## 991      56.56      5 14.1400 282.80     14.1400      4.5    296.9400
## 992      76.60     10 38.3000 766.00     38.3000      6.0    804.3000
## 993      58.03      2  5.8030 116.06      5.8030      8.8    121.8630
## 994      17.49     10  8.7450 174.90      8.7450      6.6    183.6450
## 995      60.95      1  3.0475  60.95      3.0475      5.9     63.9975
## 996      40.35      1  2.0175  40.35      2.0175      6.2     42.3675
## 997      97.38     10 48.6900 973.80     48.6900      4.4   1022.4900
## 998      31.84      1  1.5920  31.84      1.5920      7.7     33.4320
## 999      65.82      1  3.2910  65.82      3.2910      4.1     69.1110
## 1000     88.34      7 30.9190 618.38     30.9190      6.6    649.2990
```

```
data.pca <- prcomp(num_v, center = TRUE, scale. = TRUE)

summary(data.pca)
```

```
## Importance of components:
##              PC1      PC2      PC3      PC4              PC5
## Standard deviation    2.2185 1.0002 0.9939 0.30001 0.0000000000000002981
## Proportion of Variance 0.7031 0.1429 0.1411 0.01286 0.0000000000000000000
## Cumulative Proportion 0.7031 0.8460 0.9871 1.00000 1.0000000000000000000
##              PC6              PC7
## Standard deviation    0.0000000000000001493 0.00000000000000009831
## Proportion of Variance 0.0000000000000000000 0.0000000000000000000
## Cumulative Proportion 1.0000000000000000000 1.0000000000000000000
```

We obtained 7 principal components. PC1 has a cumulative proportion of 70% and PC2 80% meaning almost all components of the dataset can be encapsulated in this components.

Plotting PCA

```
#install.packages("devtools")
library(devtools)
```

```
## Loading required package: usethis
```

```
#install_github("vqv/ggbiplot")#Plotting the necessary library
```

```
library(ggbiplot)
```

```
## Loading required package: plyr
```

```

## -----

## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first, then dplyr:
## library(plyr); library(dplyr)

## -----

##
## Attaching package: 'plyr'

## The following object is masked from 'package:lessR':
##
## .

## The following object is masked from 'package:purrr':
##
## compact

## The following objects are masked from 'package:dplyr':
##
## arrange, count, desc, failwith, id, mutate, rename, summarise,
## summarize

## The following objects are masked from 'package:Hmisc':
##
## is.discrete, summarize

## Loading required package: scales

##
## Attaching package: 'scales'

## The following object is masked from 'package:lessR':
##
## rescale

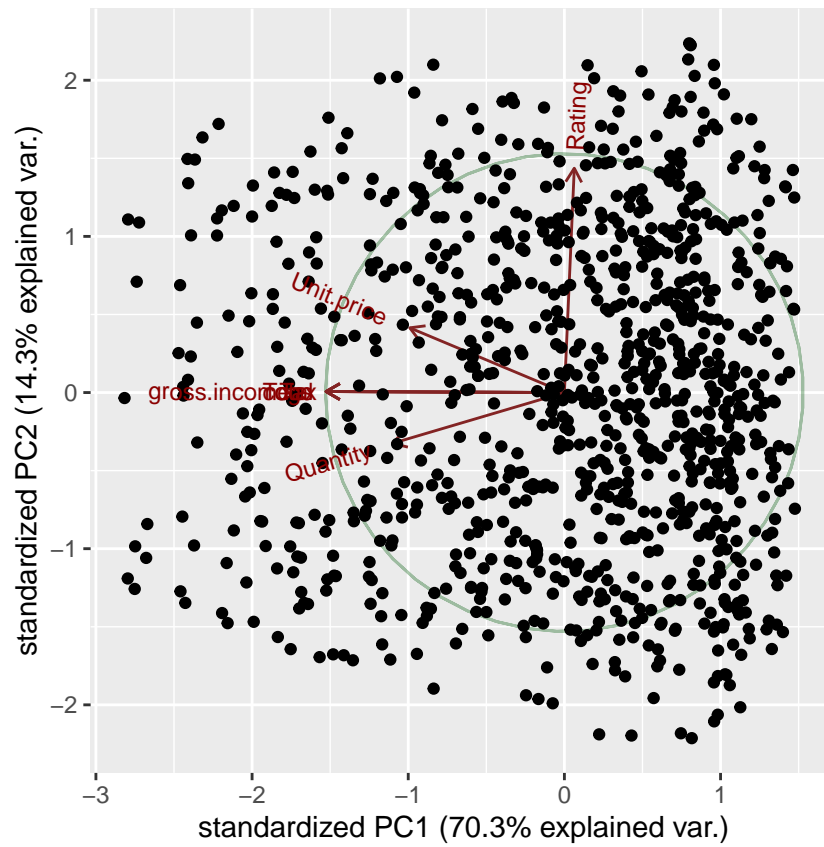
## The following object is masked from 'package:purrr':
##
## discard

## The following object is masked from 'package:readr':
##
## col_factor

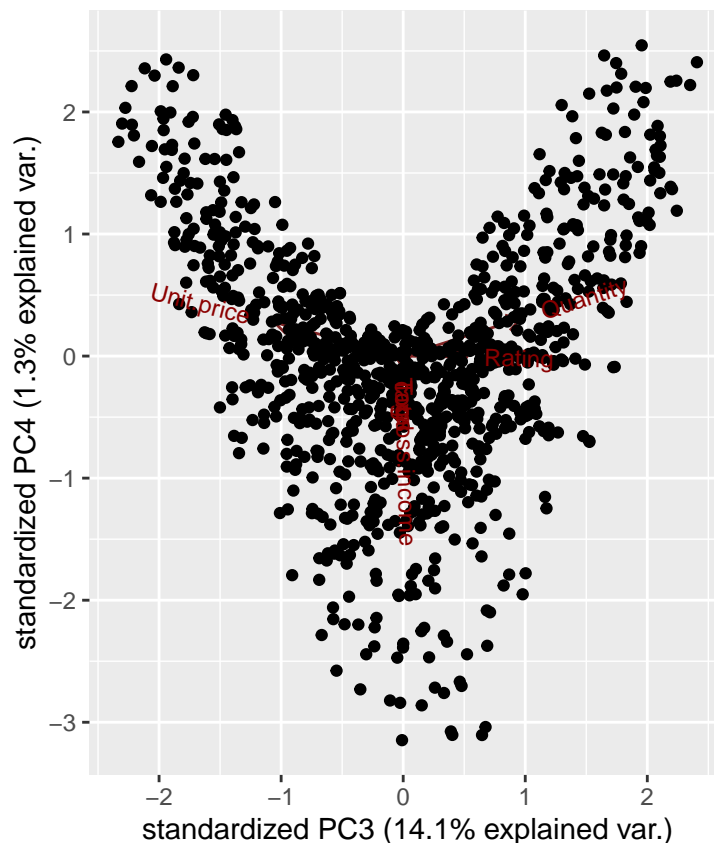
## Loading required package: grid

ggbiplot(data.pca,ellipse=TRUE, circle=TRUE)

```



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



PC3 account for 14% variation.

The quantity, unit price, rating, gross income form the PC1 and PC2 component which accounts for 70.3% variance. Quantity, unit price, gross income, and rating are the factors that provide the most information about our dataset.

Feature Selection

We will use the Caret R package provides the findCorrelation which will analyze a correlation matrix of our data's attributes report on attributes that can be removed.

```
#set.seed(7)
# load the library
#install.packages("mlbench")
library(mlbench)
library(caret)
```

```
##
## Attaching package: 'caret'
```

```
## The following object is masked from 'package:purrr':
##
## lift
```

```
## The following object is masked from 'package:survival':
```



```
##
##      cluster
```

```
# calculate correlation matrix
correlationMatrix <- cor(num_v)
# summarize the correlation matrix
print(correlationMatrix)
```

```
##           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
```

```
# find attributes that are highly correlated (ideally >0.75)
highlyCorrelated <- findCorrelation(correlationMatrix, cutoff=0.5)
# print indexes of highly correlated attributes
print(highlyCorrelated)
```

```
## [1] 4 7 3 5
```

```
#Printing the names of the highly correlated features
names(num_v[,highlyCorrelated])
```

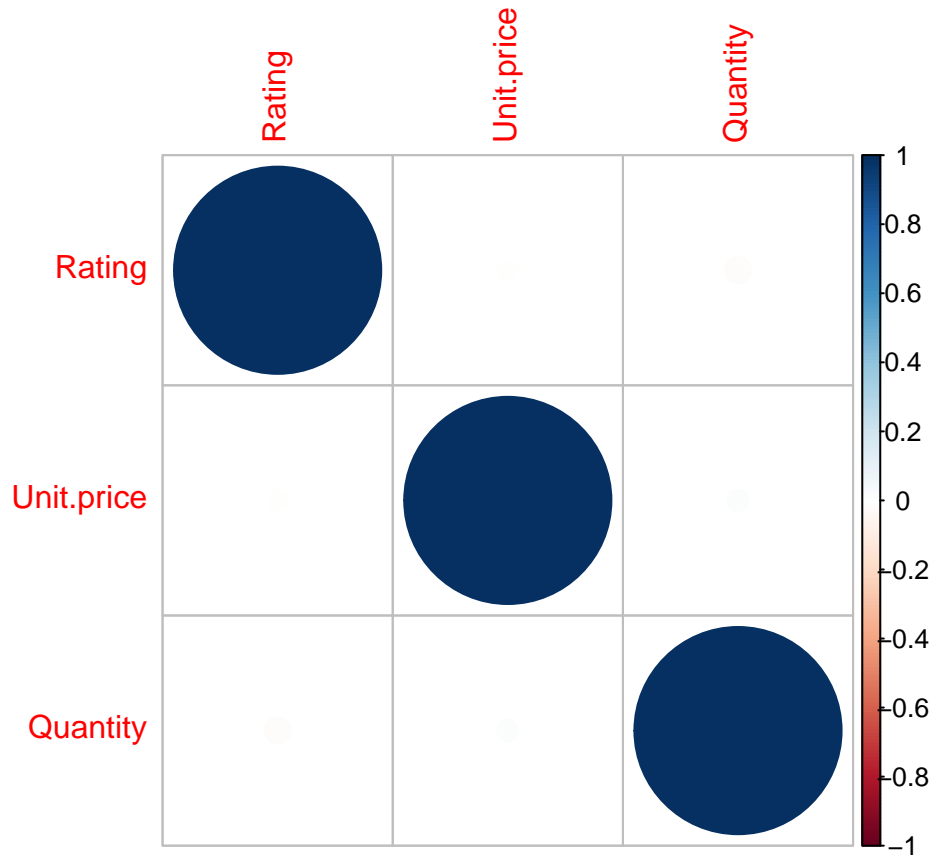
```
## [1] "cogs"      "Total"     "Tax"       "gross.income"
```

cogs, Total and Tax account are highly correlated hence are redundant features in our data.

```
#Removing the redundant features and plotting the graphical representation
```

```
df<- num_v[~highlyCorrelated]
```

```
corrplot(cor(df),order="hclust")
```



We reduced our features to the ones that provide the most information about our dataset which are Quantity, Unit price and Rating.

Association Analysis

Association analysis is used when you want to find an association between different objects in a set, find frequent patterns in a transaction database, relational databases or any other information repository. Dataset 2 contains transaction data and items bought in transactions.

```
#install and load package arules
#install.packages("arules")
library(arules)
```

```
## Loading required package: Matrix
```

```
##
```

```
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
```

```
##
```

```
## expand, pack, unpack
```

```
##
```

```
## Attaching package: 'arules'
```

```
## The following object is masked from 'package:lessR':
##
##   recode
```

```
## The following object is masked from 'package:dplyr':
##
##   recode
```

```
## The following objects are masked from 'package:base':
##
##   abbreviate, write
```

```
#install and load arulesViz
#install.packages("arulesViz")
library(arulesViz)
```

Loading our dataset

```
tr <- read.transactions('Supermarket_Sales_Dataset II.csv', format = 'basket', sep=',')
```

viewing the tr dataset and summaries

```
summary(tr)
```

```
## transactions as itemMatrix in sparse format with
## 7501 rows (elements/itemsets/transactions) and
## 119 columns (items) and a density of 0.03288973
##
## most frequent items:
## mineral water      eggs      spaghetti  french fries      chocolate
##           1788      1348           1306           1282           1229
##           (Other)
##           22405
##
## element (itemset/transaction) length distribution:
## sizes
##    1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16
## 1754 1358 1044  816  667  493  391  324  259  139  102   67   40   22   17    4
##   18   19   20
##    1    2    1
##
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000  2.000   3.000   3.914  5.000  20.000
##
## includes extended item information - examples:
##           labels
## 1           almonds
## 2 antioxydant juice
## 3           asparagus
```

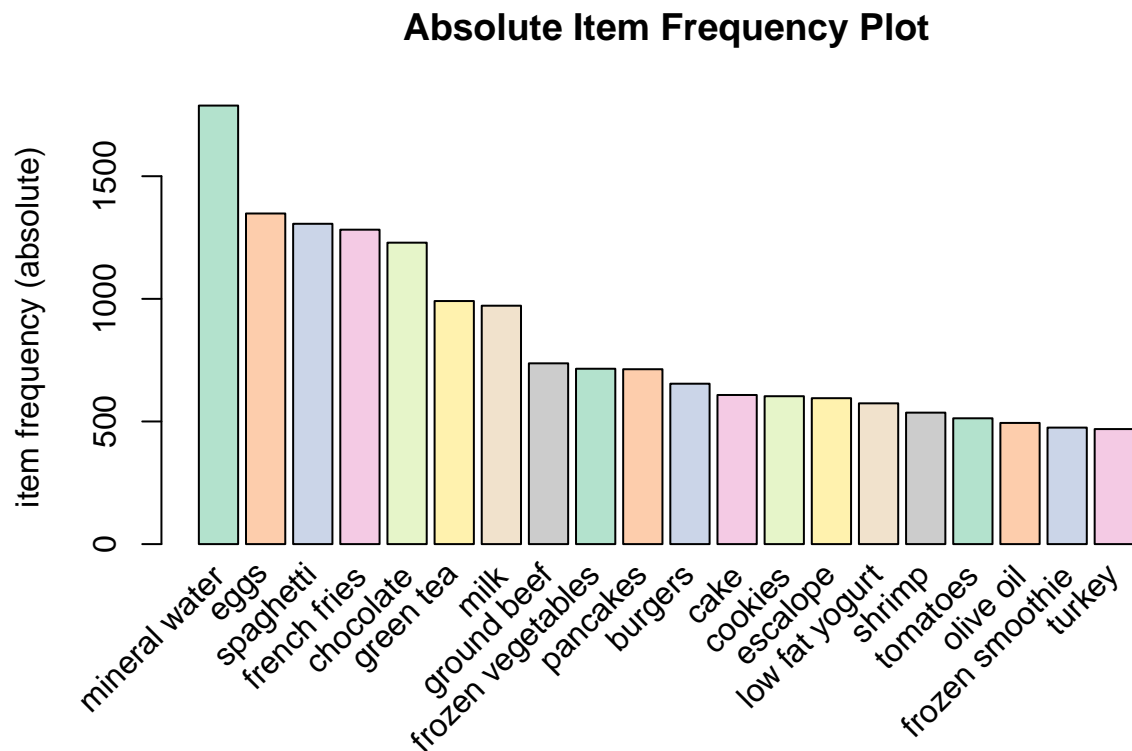
The dataset has 7501 rows (elements/itemsets/transactions) and 119 columns (items). The most frequently bought items are: mineral water, eggs, spaghetti, french fries and chocolates

We can also generate a frequency visualization to show the frequency of the items boughts.

```
# Create an item frequency plot for the top 20 items
if (!require("RColorBrewer")) {
install.packages("RColorBrewer") # install color package of R
#include library RColorBrewer
library(RColorBrewer)
}
```

```
## Loading required package: RColorBrewer
```

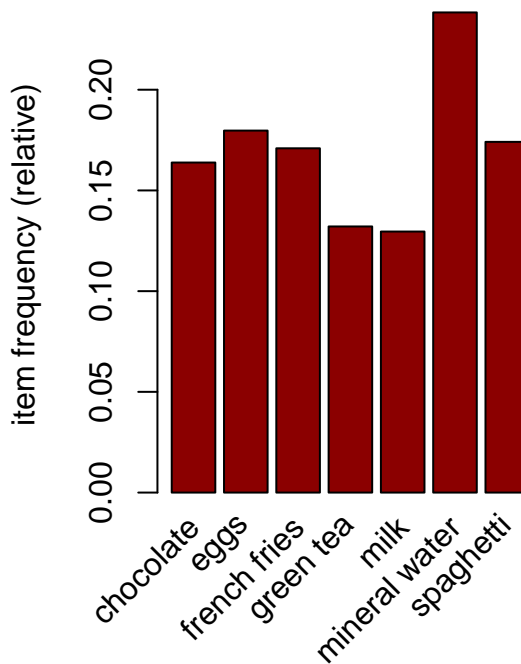
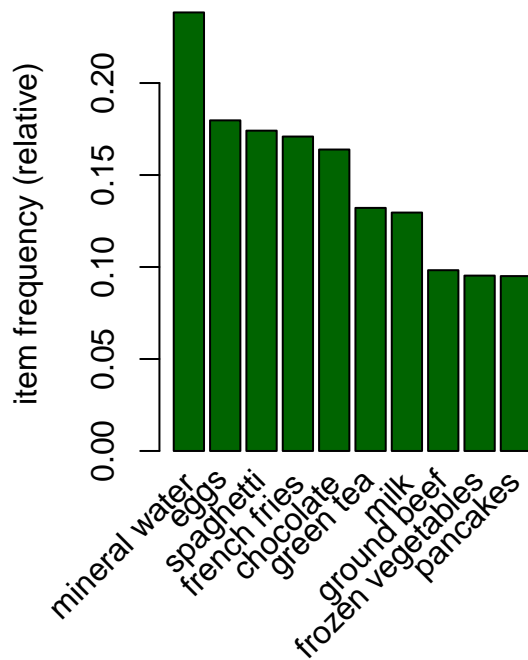
```
itemFrequencyPlot(tr,topN=20,type="absolute",col=brewer.pal(8,'Pastel1'), main="Absolute Item Frequency
```



This plot confirms that mineral water and eggs are the most frequently bought items.

```
# Displaying top 10 most common items in the transactions dataset
# and the items whose relative importance is at least 10%
#
par(mfrow = c(1, 2))

# plot the frequency of items
itemFrequencyPlot(tr, topN = 10,col="darkgreen")
itemFrequencyPlot(tr, support = 0.1,col="darkred")
```



Building a model using association rules. We will use the apriori function

```
# Min Support as 0.001, confidence as 0.8.
association.rules <- apriori(tr, parameter = list(supp=0.001, conf=0.8,maxlen=10))
```

```
## Apriori
##
## Parameter specification:
## confidence minval smax arem aval originalSupport maxtime support minlen
##          0.8    0.1    1 none FALSE          TRUE     5  0.001     1
## maxlen target  ext
##          10  rules TRUE
##
## Algorithmic control:
## filter tree heap memopt load sort verbose
##    0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## Absolute minimum support count: 7
##
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[119 item(s), 7501 transaction(s)] done [0.01s].
## sorting and recoding items ... [116 item(s)] done [0.00s].
## creating transaction tree ... done [0.00s].
## checking subsets of size 1 2 3 4 5 6 done [0.01s].
## writing ... [74 rule(s)] done [0.00s].
## creating S4 object ... done [0.00s].
```

Lets print the first 10 association rules

```
inspect(association.rules[1:10])
```

```
##      lhs                                rhs      support    confidence
## [1] {frozen smoothie,spinach} => {mineral water} 0.001066524 0.8888889
## [2] {bacon,pancakes}          => {spaghetti}    0.001733102 0.8125000
## [3] {nonfat milk,turkey}       => {mineral water} 0.001199840 0.8181818
## [4] {ground beef,nonfat milk} => {mineral water} 0.001599787 0.8571429
## [5] {mushroom cream sauce,pasta} => {escalope}     0.002532996 0.9500000
## [6] {milk,pasta}               => {shrimp}       0.001599787 0.8571429
## [7] {cooking oil,fromage blanc} => {mineral water} 0.001199840 0.8181818
## [8] {black tea,salmon}         => {mineral water} 0.001066524 0.8000000
## [9] {black tea,frozen smoothie} => {milk}         0.001199840 0.8181818
## [10] {red wine,tomato sauce}    => {chocolate}   0.001066524 0.8000000
##      coverage    lift    count
## [1] 0.001199840 3.729058    8
## [2] 0.002133049 4.666587   13
## [3] 0.001466471 3.432428    9
## [4] 0.001866418 3.595877   12
## [5] 0.002666311 11.976387   19
## [6] 0.001866418 11.995203   12
## [7] 0.001466471 3.432428    9
## [8] 0.001333156 3.356152    8
## [9] 0.001466471 6.313973    9
## [10] 0.001333156 4.882669    8
```

Using the analysis above, we can see that 88% of customers who bough frozen smoothie and spinach bought mineral water, 95% of those who bought mushroom cream sauce and pasta also bought escalope, 81% of those who bought black tea and frozen smoothies also bought milk, 85% of customers who bought milk and pasta also bought shrimp

Removing redundant rules

```
subset.rules <- which(colSums(is.subset(association.rules, association.rules)) > 1) # get subset rules
print(length(subset.rules))
```

```
## [1] 12
```

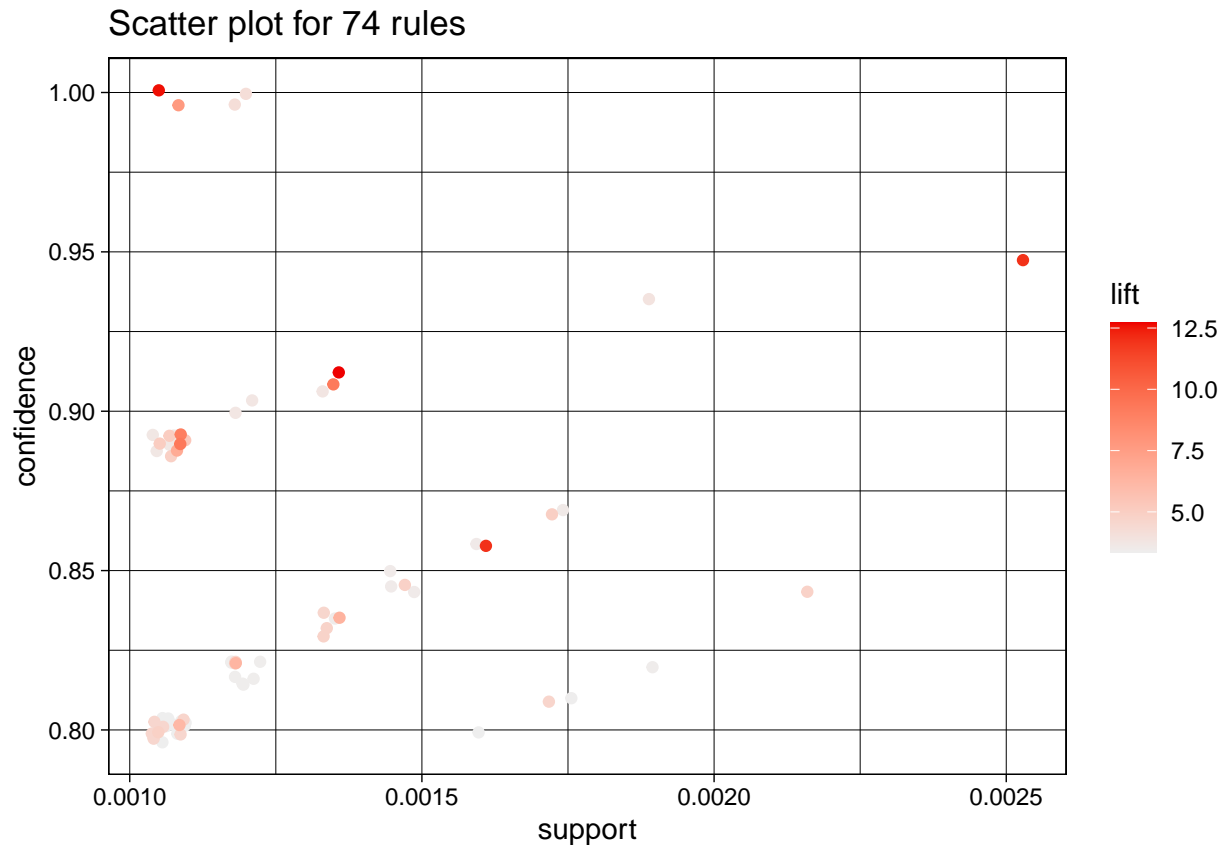
```
subset.association.rules <- association.rules[-subset.rules] # remove subset rules.
print(subset.association.rules)
```

```
## set of 62 rules
```

Plotting the subrules using a scatterplot

```
# Filter rules with confidence greater than 0.4 or 40%
subRules<-association.rules[quality(association.rules)$confidence>0.4]
#Plot SubRules
plot(subRules)
```

```
## To reduce overplotting, jitter is added! Use jitter = 0 to prevent jitter.
```



Anomaly Detection

Anomalies are considered the data points that are outliers or an exceptional event.

```
library(tidyverse)
library(tibble)
library(tibbletime)
```

```
##
## Attaching package: 'tibbletime'

## The following object is masked from 'package:stats':
##
##   filter
```

```
library(anomalize) #Installing the anomalize package
```

```
## == Use anomalize to improve your Forecasts by 50%! =====
## Business Science offers a 1-hour course - Lab #18: Time Series Anomaly Detection!
## </> Learn more at: https://university.business-science.io/p/learning-labs-pro </>
```

Loading our dataset

```
#As we had already loaded our dataset previously, we will just preview the summary
```

```
glimpse(data_3)
```

```
## Rows: 1,000
## Columns: 2
## $ Date <chr> "1/5/2019", "3/8/2019", "3/3/2019", "1/27/2019", "2/8/2019", "3/~
## $ Sales <dbl> 548.9715, 80.2200, 340.5255, 489.0480, 634.3785, 627.6165, 433.6~
```

The data set contains two variables. The Date variable is a time series, while the Sales variable contains the sales over the specified period of time

```
#We will convert the Date column to timeseries
#install.packages("magrittr")
library(magrittr)
```

```
##
## Attaching package: 'magrittr'

## The following object is masked from 'package:purrr':
##
##   set_names

## The following object is masked from 'package:tidyr':
##
##   extract
```

```
data_3$Date<- as.Date(data_3$Date,"%m/%d/%y")
```

```
#atr <- data_3 %>% rownames_to_column() %>% as.tibble() %>%
# mutate(date = as.Date(rowname)) %>% select(-one_of('rowname'))
```

```
#Confirming that the change has been implemented and arranging our data by sales
data_3= data_3%>%arrange(Date)
print(data_3)
```

```
##      Date      Sales
## 1 2020-01-01  457.4430
## 2 2020-01-01  399.7560
## 3 2020-01-01  470.6730
## 4 2020-01-01  388.2900
## 5 2020-01-01  132.7620
## 6 2020-01-01  132.0270
## 7 2020-01-01  621.2430
## 8 2020-01-01  113.5680
## 9 2020-01-01  779.3100
## 10 2020-01-01  184.0860
## 11 2020-01-01  177.4080
## 12 2020-01-01  888.6150
## 13 2020-01-02   44.5935
```


## 14	2020-01-02	209.6220
## 15	2020-01-02	359.2050
## 16	2020-01-02	383.7645
## 17	2020-01-02	138.6630
## 18	2020-01-02	262.4580
## 19	2020-01-02	266.0280
## 20	2020-01-02	281.1690
## 21	2020-01-03	367.5525
## 22	2020-01-03	217.6335
## 23	2020-01-03	44.3520
## 24	2020-01-03	352.2225
## 25	2020-01-03	79.6740
## 26	2020-01-03	98.0490
## 27	2020-01-03	397.8450
## 28	2020-01-03	520.8000
## 29	2020-01-04	75.7785
## 30	2020-01-04	629.8425
## 31	2020-01-04	146.2230
## 32	2020-01-04	373.1700
## 33	2020-01-04	288.5820
## 34	2020-01-04	110.0925
## 35	2020-01-05	548.9715
## 36	2020-01-05	172.4940
## 37	2020-01-05	263.1300
## 38	2020-01-05	297.1080
## 39	2020-01-05	334.3410
## 40	2020-01-05	33.4950
## 41	2020-01-05	225.2775
## 42	2020-01-05	77.6580
## 43	2020-01-05	74.7600
## 44	2020-01-05	239.5890
## 45	2020-01-05	579.8415
## 46	2020-01-05	690.0180
## 47	2020-01-06	939.5400
## 48	2020-01-06	494.7600
## 49	2020-01-06	16.1070
## 50	2020-01-06	343.0560
## 51	2020-01-06	214.9350
## 52	2020-01-06	261.1980
## 53	2020-01-06	760.4415
## 54	2020-01-06	271.2780
## 55	2020-01-06	312.8895
## 56	2020-01-07	71.5260
## 57	2020-01-07	614.9430
## 58	2020-01-07	326.4240
## 59	2020-01-07	203.5530
## 60	2020-01-07	352.5795
## 61	2020-01-07	229.1100
## 62	2020-01-07	374.3880
## 63	2020-01-07	575.9775
## 64	2020-01-07	85.7430
## 65	2020-01-08	299.8485
## 66	2020-01-08	575.7360
## 67	2020-01-08	783.3000

## 68	2020-01-08	190.5960
## 69	2020-01-08	13.4190
## 70	2020-01-08	194.9850
## 71	2020-01-08	152.7750
## 72	2020-01-08	381.3915
## 73	2020-01-08	103.1100
## 74	2020-01-08	136.1430
## 75	2020-01-08	175.0455
## 76	2020-01-08	684.9150
## 77	2020-01-08	210.9660
## 78	2020-01-08	688.7160
## 79	2020-01-08	26.7960
## 80	2020-01-08	250.7085
## 81	2020-01-08	76.5765
## 82	2020-01-08	348.7050
## 83	2020-01-09	463.4280
## 84	2020-01-09	1002.1200
## 85	2020-01-09	310.7160
## 86	2020-01-09	99.5400
## 87	2020-01-09	202.3350
## 88	2020-01-09	68.9850
## 89	2020-01-09	165.9000
## 90	2020-01-09	708.3195
## 91	2020-01-10	76.1460
## 92	2020-01-10	703.7520
## 93	2020-01-10	161.5530
## 94	2020-01-10	493.7940
## 95	2020-01-10	392.6475
## 96	2020-01-10	586.9710
## 97	2020-01-10	611.0790
## 98	2020-01-10	57.8760
## 99	2020-01-10	477.1305
## 100	2020-01-11	183.0360
## 101	2020-01-11	94.1745
## 102	2020-01-11	235.6830
## 103	2020-01-11	345.7860
## 104	2020-01-11	72.3975
## 105	2020-01-11	305.5500
## 106	2020-01-11	270.2595
## 107	2020-01-11	608.0760
## 108	2020-01-12	189.0945
## 109	2020-01-12	931.0350
## 110	2020-01-12	419.8320
## 111	2020-01-12	120.1620
## 112	2020-01-12	28.4235
## 113	2020-01-12	308.9100
## 114	2020-01-12	874.1250
## 115	2020-01-12	1023.7500
## 116	2020-01-12	769.1040
## 117	2020-01-12	144.9630
## 118	2020-01-12	375.3645
## 119	2020-01-13	437.3250
## 120	2020-01-13	78.0045
## 121	2020-01-13	147.7980

##	122	2020-01-13	125.7060
##	123	2020-01-13	152.0190
##	124	2020-01-13	457.3800
##	125	2020-01-13	335.0130
##	126	2020-01-13	374.4090
##	127	2020-01-13	88.3680
##	128	2020-01-13	255.1815
##	129	2020-01-14	451.3635
##	130	2020-01-14	536.9910
##	131	2020-01-14	507.6750
##	132	2020-01-14	523.3725
##	133	2020-01-14	133.4340
##	134	2020-01-14	75.9360
##	135	2020-01-14	588.4200
##	136	2020-01-14	36.5505
##	137	2020-01-14	89.0715
##	138	2020-01-14	190.4805
##	139	2020-01-14	18.6375
##	140	2020-01-14	390.9465
##	141	2020-01-14	423.7380
##	142	2020-01-15	590.4360
##	143	2020-01-15	575.3160
##	144	2020-01-15	154.3920
##	145	2020-01-15	91.5600
##	146	2020-01-15	843.0345
##	147	2020-01-15	140.3850
##	148	2020-01-15	175.9170
##	149	2020-01-15	697.9350
##	150	2020-01-15	397.2150
##	151	2020-01-15	597.0405
##	152	2020-01-15	72.0090
##	153	2020-01-15	1022.3850
##	154	2020-01-15	586.6350
##	155	2020-01-16	53.9280
##	156	2020-01-16	1003.5900
##	157	2020-01-16	881.3070
##	158	2020-01-16	666.9390
##	159	2020-01-16	164.6820
##	160	2020-01-16	32.5290
##	161	2020-01-16	125.9790
##	162	2020-01-16	667.3800
##	163	2020-01-16	497.0700
##	164	2020-01-16	195.6780
##	165	2020-01-17	91.0560
##	166	2020-01-17	135.5760
##	167	2020-01-17	377.5800
##	168	2020-01-17	852.7050
##	169	2020-01-17	121.5690
##	170	2020-01-17	695.2365
##	171	2020-01-17	85.3020
##	172	2020-01-17	80.9550
##	173	2020-01-17	137.8650
##	174	2020-01-17	432.9885
##	175	2020-01-17	131.9220

##	176	2020-01-18	138.1275
##	177	2020-01-18	166.2360
##	178	2020-01-18	41.3910
##	179	2020-01-18	182.9520
##	180	2020-01-18	277.6725
##	181	2020-01-18	110.1240
##	182	2020-01-18	856.4535
##	183	2020-01-18	561.0780
##	184	2020-01-18	446.4390
##	185	2020-01-19	548.7615
##	186	2020-01-19	362.7120
##	187	2020-01-19	323.0640
##	188	2020-01-19	333.2070
##	189	2020-01-19	93.0405
##	190	2020-01-19	282.4920
##	191	2020-01-19	198.6390
##	192	2020-01-19	84.9765
##	193	2020-01-19	673.9950
##	194	2020-01-19	37.6110
##	195	2020-01-19	284.5920
##	196	2020-01-19	624.3300
##	197	2020-01-19	101.6400
##	198	2020-01-19	235.7460
##	199	2020-01-19	479.6400
##	200	2020-01-19	250.2780
##	201	2020-01-20	759.6750
##	202	2020-01-20	112.2240
##	203	2020-01-20	195.5940
##	204	2020-01-20	749.7000
##	205	2020-01-20	348.3060
##	206	2020-01-20	118.0620
##	207	2020-01-20	131.2080
##	208	2020-01-20	536.5920
##	209	2020-01-20	233.1000
##	210	2020-01-20	470.9880
##	211	2020-01-21	172.2105
##	212	2020-01-21	624.8970
##	213	2020-01-21	491.0850
##	214	2020-01-21	76.3560
##	215	2020-01-21	461.2860
##	216	2020-01-21	390.7995
##	217	2020-01-21	103.0365
##	218	2020-01-21	72.4290
##	219	2020-01-22	705.6315
##	220	2020-01-22	106.9950
##	221	2020-01-22	85.5855
##	222	2020-01-22	206.7975
##	223	2020-01-22	96.6420
##	224	2020-01-22	351.6030
##	225	2020-01-22	151.5150
##	226	2020-01-23	161.7000
##	227	2020-01-23	198.9960
##	228	2020-01-23	942.9000
##	229	2020-01-23	323.1480

##	230	2020-01-23	94.1850
##	231	2020-01-23	264.7575
##	232	2020-01-23	527.7510
##	233	2020-01-23	416.1780
##	234	2020-01-23	87.2340
##	235	2020-01-23	32.1405
##	236	2020-01-23	620.7390
##	237	2020-01-23	57.6975
##	238	2020-01-23	333.9840
##	239	2020-01-23	503.7375
##	240	2020-01-23	450.1035
##	241	2020-01-23	244.2300
##	242	2020-01-23	734.7060
##	243	2020-01-24	827.0850
##	244	2020-01-24	423.1500
##	245	2020-01-24	406.8750
##	246	2020-01-24	728.1120
##	247	2020-01-24	293.6430
##	248	2020-01-24	145.4040
##	249	2020-01-24	557.7180
##	250	2020-01-24	384.7200
##	251	2020-01-24	63.9135
##	252	2020-01-24	408.4080
##	253	2020-01-24	88.7040
##	254	2020-01-24	270.0180
##	255	2020-01-24	804.3000
##	256	2020-01-25	463.8900
##	257	2020-01-25	16.2015
##	258	2020-01-25	291.2070
##	259	2020-01-25	950.2500
##	260	2020-01-25	288.2040
##	261	2020-01-25	247.8735
##	262	2020-01-25	356.5485
##	263	2020-01-25	252.0420
##	264	2020-01-25	214.7460
##	265	2020-01-25	128.0160
##	266	2020-01-25	45.9270
##	267	2020-01-25	100.9155
##	268	2020-01-25	168.2100
##	269	2020-01-25	167.8950
##	270	2020-01-25	663.2955
##	271	2020-01-25	267.3405
##	272	2020-01-25	77.8050
##	273	2020-01-26	304.5420
##	274	2020-01-26	471.0300
##	275	2020-01-26	420.2625
##	276	2020-01-26	107.3100
##	277	2020-01-26	655.5465
##	278	2020-01-26	170.8770
##	279	2020-01-26	379.9215
##	280	2020-01-26	398.4750
##	281	2020-01-26	270.5850
##	282	2020-01-26	193.4625
##	283	2020-01-26	68.2395

##	284	2020-01-26	165.6480
##	285	2020-01-26	12.6945
##	286	2020-01-26	22.3860
##	287	2020-01-26	106.5015
##	288	2020-01-26	69.9930
##	289	2020-01-26	640.0380
##	290	2020-01-27	489.0480
##	291	2020-01-27	169.3125
##	292	2020-01-27	25.2630
##	293	2020-01-27	150.7800
##	294	2020-01-27	510.9615
##	295	2020-01-27	488.9850
##	296	2020-01-27	568.5120
##	297	2020-01-27	145.7400
##	298	2020-01-27	398.9580
##	299	2020-01-27	514.7730
##	300	2020-01-27	178.1640
##	301	2020-01-27	403.8720
##	302	2020-01-27	76.9230
##	303	2020-01-27	514.6050
##	304	2020-01-28	737.7615
##	305	2020-01-28	680.1480
##	306	2020-01-28	273.4200
##	307	2020-01-28	293.2020
##	308	2020-01-28	91.4025
##	309	2020-01-28	125.0550
##	310	2020-01-28	20.1075
##	311	2020-01-28	203.1120
##	312	2020-01-28	118.2510
##	313	2020-01-28	681.4395
##	314	2020-01-28	225.0150
##	315	2020-01-28	832.9440
##	316	2020-01-28	84.7455
##	317	2020-01-28	633.1080
##	318	2020-01-29	786.6180
##	319	2020-01-29	120.6450
##	320	2020-01-29	137.0040
##	321	2020-01-29	265.1040
##	322	2020-01-29	40.5300
##	323	2020-01-29	529.5150
##	324	2020-01-29	280.0350
##	325	2020-01-29	146.6325
##	326	2020-01-29	458.6925
##	327	2020-01-29	616.9800
##	328	2020-01-29	92.4420
##	329	2020-01-29	42.3675
##	330	2020-01-30	160.4400
##	331	2020-01-30	509.4075
##	332	2020-01-30	99.3300
##	333	2020-01-30	24.1080
##	334	2020-01-30	1034.4600
##	335	2020-01-30	356.3280
##	336	2020-01-30	55.2825
##	337	2020-01-30	295.4070

##	338	2020-01-30	23.4990
##	339	2020-01-31	285.7050
##	340	2020-01-31	155.6520
##	341	2020-01-31	69.6675
##	342	2020-01-31	224.4375
##	343	2020-01-31	503.5590
##	344	2020-01-31	79.6110
##	345	2020-01-31	145.0680
##	346	2020-01-31	87.2340
##	347	2020-01-31	180.6000
##	348	2020-01-31	829.0800
##	349	2020-01-31	757.3650
##	350	2020-01-31	830.3715
##	351	2020-01-31	652.8900
##	352	2020-01-31	431.2560
##	353	2020-02-01	218.0115
##	354	2020-02-01	763.4655
##	355	2020-02-01	510.9720
##	356	2020-02-01	74.7075
##	357	2020-02-01	551.1240
##	358	2020-02-01	326.2560
##	359	2020-02-02	117.8310
##	360	2020-02-02	19.2465
##	361	2020-02-02	115.0800
##	362	2020-02-02	788.5080
##	363	2020-02-02	439.8975
##	364	2020-02-02	400.7640
##	365	2020-02-02	193.0110
##	366	2020-02-02	452.8650
##	367	2020-02-02	554.1480
##	368	2020-02-02	432.7680
##	369	2020-02-02	187.8660
##	370	2020-02-02	40.3410
##	371	2020-02-02	223.5870
##	372	2020-02-02	175.0350
##	373	2020-02-03	671.7900
##	374	2020-02-03	520.4115
##	375	2020-02-03	697.3680
##	376	2020-02-03	404.3550
##	377	2020-02-03	212.7300
##	378	2020-02-03	310.5900
##	379	2020-02-03	77.6685
##	380	2020-02-03	517.9650
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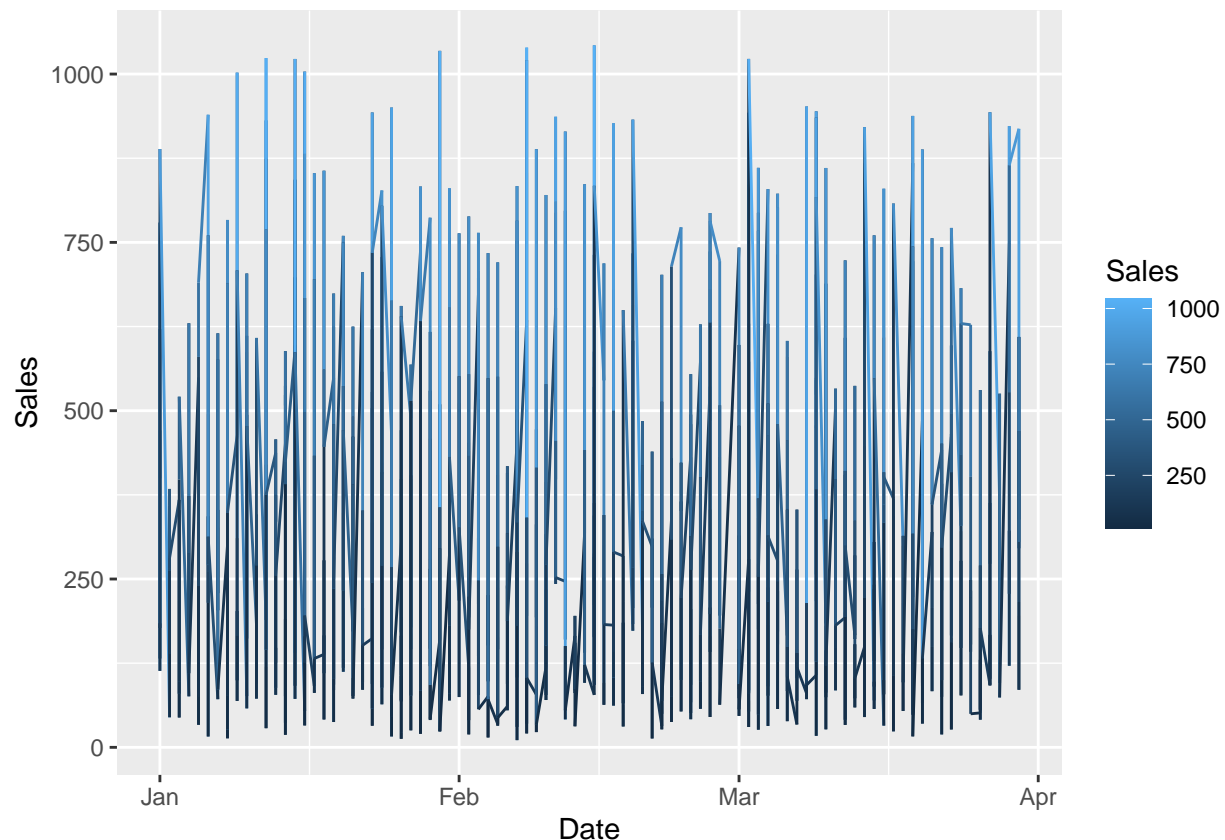
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##	880	2020-03-19	163.0020
##	881	2020-03-19	48.5100
##	882	2020-03-19	743.8200
##	883	2020-03-19	317.2260
##	884	2020-03-19	97.8180
##	885	2020-03-19	175.0140
##	886	2020-03-19	16.2750
##	887	2020-03-20	484.8900
##	888	2020-03-20	90.8250
##	889	2020-03-20	745.3950
##	890	2020-03-20	462.2100
##	891	2020-03-20	65.7405
##	892	2020-03-20	637.7280
##	893	2020-03-20	523.9710
##	894	2020-03-20	469.4130
##	895	2020-03-20	208.4250
##	896	2020-03-20	365.9040
##	897	2020-03-20	96.1905
##	898	2020-03-20	251.7165
##	899	2020-03-20	35.3115
##	900	2020-03-20	887.9220
##	901	2020-03-20	132.5625
##	902	2020-03-21	319.7880
##	903	2020-03-21	83.4120
##	904	2020-03-21	149.3625
##	905	2020-03-21	207.8580
##	906	2020-03-21	756.1680
##	907	2020-03-21	360.9270
##	908	2020-03-22	441.7560
##	909	2020-03-22	75.0540
##	910	2020-03-22	391.4190
##	911	2020-03-22	19.1940
##	912	2020-03-22	427.8120
##	913	2020-03-22	742.8120
##	914	2020-03-22	233.2260
##	915	2020-03-22	451.0275
##	916	2020-03-22	99.9075
##	917	2020-03-22	296.9400
##	918	2020-03-23	461.3280
##	919	2020-03-23	166.1625
##	920	2020-03-23	384.4680
##	921	2020-03-23	465.4440
##	922	2020-03-23	162.7500
##	923	2020-03-23	26.5545
##	924	2020-03-23	156.0300
##	925	2020-03-23	596.8200
##	926	2020-03-23	408.7335
##	927	2020-03-23	495.3165
##	928	2020-03-23	771.4350
##	929	2020-03-24	321.1110
##	930	2020-03-24	130.0425
##	931	2020-03-24	78.6030

##	932	2020-03-24	77.1750
##	933	2020-03-24	276.9480
##	934	2020-03-24	147.6720
##	935	2020-03-24	370.1250
##	936	2020-03-24	681.9750
##	937	2020-03-24	329.1960
##	938	2020-03-24	435.1200
##	939	2020-03-24	629.4960
##	940	2020-03-25	627.6165
##	941	2020-03-25	401.7300
##	942	2020-03-25	152.7120
##	943	2020-03-25	248.4090
##	944	2020-03-25	195.9510
##	945	2020-03-25	142.0020
##	946	2020-03-25	232.6380
##	947	2020-03-25	222.1380
##	948	2020-03-25	49.7700
##	949	2020-03-26	51.1455
##	950	2020-03-26	91.7700
##	951	2020-03-26	530.6700
##	952	2020-03-26	41.0760
##	953	2020-03-26	143.9865
##	954	2020-03-26	154.1295
##	955	2020-03-26	269.9340
##	956	2020-03-26	116.1405
##	957	2020-03-26	56.1225
##	958	2020-03-26	130.0320
##	959	2020-03-26	54.9990
##	960	2020-03-26	145.5825
##	961	2020-03-26	176.9250
##	962	2020-03-27	93.1140
##	963	2020-03-27	362.9430
##	964	2020-03-27	272.6640
##	965	2020-03-27	588.3570
##	966	2020-03-27	164.8710
##	967	2020-03-27	116.9070
##	968	2020-03-27	101.8080
##	969	2020-03-27	167.0340
##	970	2020-03-27	91.8225
##	971	2020-03-27	943.2990
##	972	2020-03-28	367.0380
##	973	2020-03-28	95.6655
##	974	2020-03-28	150.0975
##	975	2020-03-28	191.2470
##	976	2020-03-28	121.5900
##	977	2020-03-28	269.5350
##	978	2020-03-28	209.1180
##	979	2020-03-28	225.7920
##	980	2020-03-28	525.2310
##	981	2020-03-28	74.0880
##	982	2020-03-29	749.4900
##	983	2020-03-29	922.6350
##	984	2020-03-29	121.1280
##	985	2020-03-29	321.7725

```
## 986 2020-03-29 288.0150
## 987 2020-03-29 228.1230
## 988 2020-03-29 527.5095
## 989 2020-03-29 864.5700
## 990 2020-03-30 918.7290
## 991 2020-03-30 295.6905
## 992 2020-03-30 609.5880
## 993 2020-03-30 338.3100
## 994 2020-03-30 609.1680
## 995 2020-03-30 442.3230
## 996 2020-03-30 196.1400
## 997 2020-03-30 85.5120
## 998 2020-03-30 216.8460
## 999 2020-03-30 469.7700
## 1000 2020-03-30 304.9830
```

Sales distribution

```
#Plotting data
library(ggplot2)
ggplot(data_3, aes(x=Date, y=Sales, color=Sales)) + geom_line()
```



From the plot above, we cannot spot any anomalies. But we will have to confirm

Timeseries decomposition Next we will try to use the `time_decompose()` function which give four outputs which are: observed, season, trend, and remainder. Once the components are decomposed, `anomalize` can detect and flag anomalies in the decomposed data of the remainder component which then could be visualized with `plot_anomaly_decomposition()` but before that we will convert the data into `tbl_df` format

```
data_3=aggregate(Sales~Date,data_3,mean)
```

```
data_3=tbl_time(data_3, Date)
class(data_3)
```

```
## [1] "tbl_time" "tbl_df" "tbl" "data.frame"
```

As mentioned earlier the time series is decomposed into four columns that are observed, season, trend, and remainder. The default method used for decomposition is stl, which is a seasonal decomposition utilizing a Loess smoother.

```
#data_3 = data_3 %>%
# time_decompose(Sales)

#data_3%>% glimpse()
```

```
#data_3 = data_3%>%
# anomalize(remainder)

#data_3%>% glimpse()
```

Anomalies are high leverage points that distort the distribution. One of the methods that anomalize implements that is resistant to high leverage points is the GESD: Generalized Extreme Studentized Deviate Test

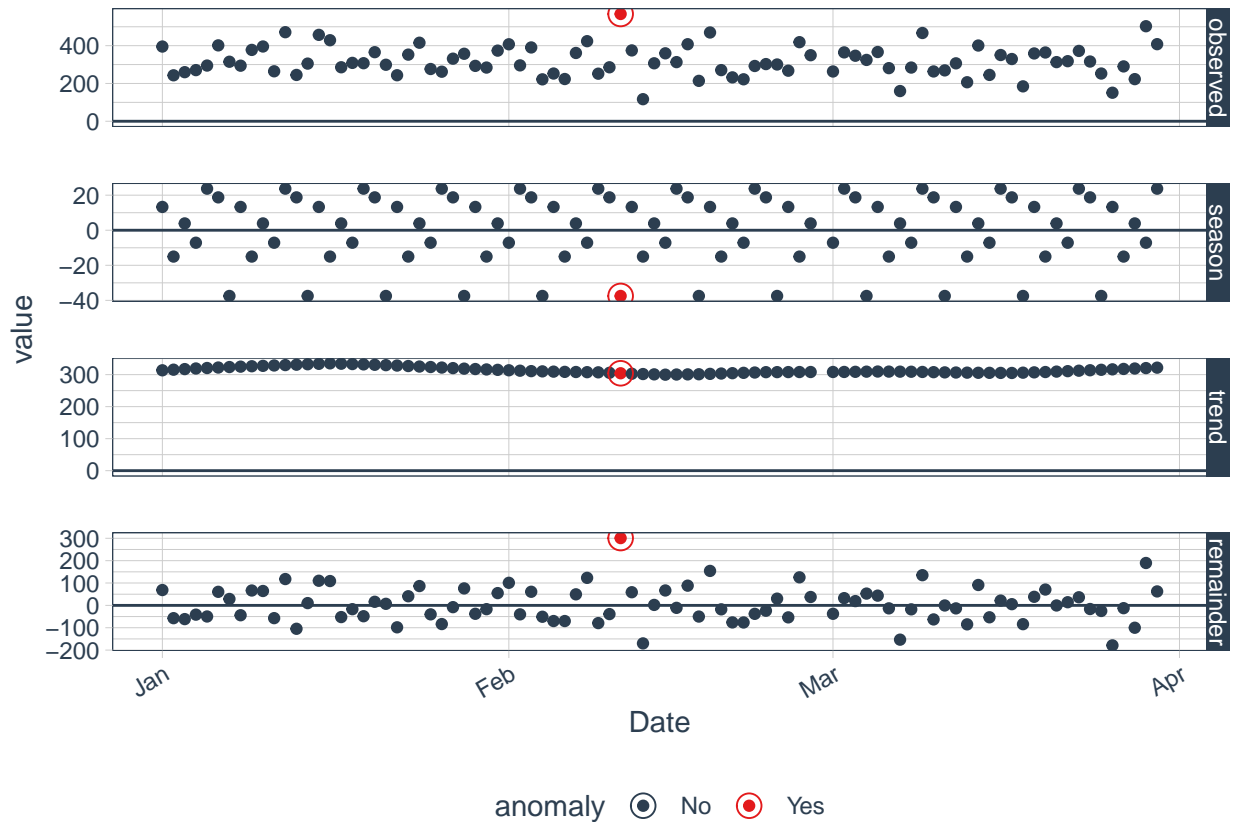
Visualizing the time decomposition and anomalies

```
data_3 %>%
  time_decompose(Sales, method = "stl", frequency = "auto", trend = "auto") %>%
  anomalize(remainder, method = "gesd", alpha = 0.05, max_anoms = 0.2) %>%
  plot_anomaly_decomposition()
```

```
## frequency = 7 days
```

```
## trend = 30 days
```

```
## Registered S3 method overwritten by 'quantmod':
##   method      from
##   as.zoo.data.frame zoo
```

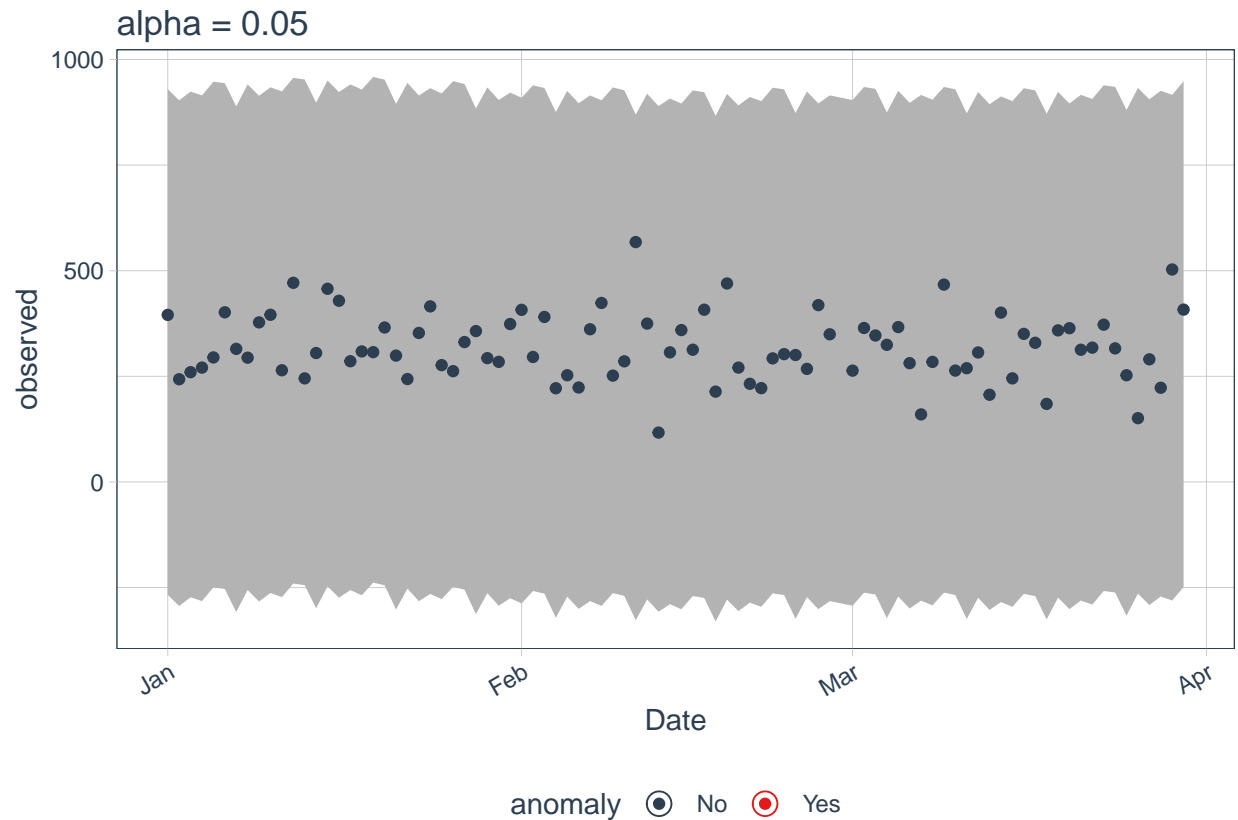


Adjusting Parameters for Anomaly detection anomaly is being decided according to the values of remainder calculating limits for categorizing the outliers. The alpha and max_anoms are two parameters that control anomalize() function. In simple words alpha control the band of the limit by default it is set to 0.05 decreasing its value will increase the size of the band thus making difficult for a point to be an anomaly. We will then create lower and upper bounds around the observed values with time_recompose.

```
data_3%>%
  time_decompose(Sales)%>%
  anomalize(remainder, alpha = 0.03,max_anoms = 0.2)%>%
  time_recompose()%>%
  plot_anomalies(time_recompose = T)+
  ggtitle("alpha = 0.05")
```

```
## frequency = 7 days
```

```
## trend = 30 days
```



The anomaly found in our data was in mid February indicated by higher sales. This is most likely due to the Valentines season which occur mid February.

```
##rlang::last_error()
```

Recommendations

As noted above the marketing team might use some of the data mining insights and try strategies to improve on product promotion and sales. There were noticeable trends during special days e.g in February, we realized that the sales were high especially around valentines day. The supermart should consider adding promotional items during these seasons. They should take advantage of the market basket items identified and add them next to the fast selling items e.g placing milk next to frozen milk and black tea may cause it to sell faster as it has been proven that (81%) of these customers who tend to buy frozen milk and black tea tend to buy milk. Internal Variables such as the quantity, rating, unit price of an item are vital in understanding the sales.