

Week 13 IP - Unsupervised Learning

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1. Defining the Question

In this week's project I'll be working as a Data Science Consultant to Kira Plastinina. The brand's Sales and Marketing team would like to understand their customer's behavior from data that they have collected over the past year. More specifically, they would like to learn the characteristics of customer groups.

2. Defining the Metric for Success

Our metrics for success would be building clustering models using K-Means and Hierarchical clustering

3. Understanding the context

Kira Plastinina is a Russian brand that is sold through a defunct chain of retail stores in Russia, Ukraine, Kazakhstan, Belarus, China, Philippines, and Armenia. The owner goes by the same name, Kira Plastinina, a Russian fashion designer and entrepreneur. In 2007, the first Kira Plastinina store opened in Moscow, Plastinina introduced her first collection and became one of the youngest fashion designers in the world. Since then, the company has opened over 300 stores in Russia and CIS. Throughout her career, Plastinina has presented her fashion collections during Rome, Milan, New York and Moscow fashion weeks. Her brand has been worn by many celebrities including Paris Hilton, Lindsay Lohan, Georgia May Jagger, Karlie Kloss, Rowan Blanchard, Lyndsy Fonseca, Victoria Justice, and many others.

4. Recording the Experimental Design

The following are the steps taken to implement the solution :

Define the question, the metric for success, the context, experimental design taken.

Read and explore the given dataset.

Define the appropriateness of the available data to answer the given question.

Find and deal with outliers, anomalies, and missing data within the dataset.

Perform Univariate and Bivariate Analysis recording our observations.

Perform clustering stating insights drawn from your analysis and visualizations.

Upon implementation, provide comparisons between K-Means clustering vs Hierarchical clustering highlighting the strengths and limitations of each approach in the context of your analysis.

Provide a conclusion and recommendation from the analysis.

5. Data Relevance

Our data is very relevant to our research question. It contains very detailed information about the website and the traffic in it. #6. Previewing and Reading the Data

```
#Importing libraries
# Importing the required packages

library("data.table")
library("plyr")
library("dplyr")

##
## Attaching package: 'dplyr'

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

## The following objects are masked from 'package:data.table':
##   between, first, last

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

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

library("tidyverse")

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

## v ggplot2 3.3.2      v purrr    0.3.4
## v tibble   3.0.3      v stringr  1.4.0
## v tidyr    1.1.2      vforcats  0.5.0
## v readr    1.3.1
```

```

## -- Conflicts ----- tidyverse
## x dplyr::arrange()    masks plyr::arrange()
## x dplyr::between()   masks data.table::between()
## x purrr::compact()   masks plyr::compact()
## x dplyr::count()     masks plyr::count()
## x dplyr::failwith()  masks plyr::failwith()
## x dplyr::filter()    masks stats::filter()
## x dplyr::first()     masks data.table::first()
## x dplyr::id()        masks plyr::id()
## x dplyr::lag()       masks stats::lag()
## x dplyr::last()      masks data.table::last()
## x dplyr::mutate()    masks plyr::mutate()
## x dplyr::rename()    masks plyr::rename()
## x dplyr::summarise() masks plyr::summarise()
## x dplyr::summarize() masks plyr::summarize()
## x purrr::transpose() masks data.table::transpose()

library("tidyverse")
library("lubridate")

##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:data.table':
## 
##     hour, isoweek, mday, minute, month, quarter, second, wday, week,
##     yday, year

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

library("ggcorrplot")
library("ggplot2")
library("corrplot")

## corrplot 0.84 loaded

library("moments")
library('psych')

##
## Attaching package: 'psych'

## The following objects are masked from 'package:ggplot2':
## 
##     %+%, alpha

```

```

library('countrycode')
library('class')
library("rpart")
library("rpart.plot")
library("mlbench")
library('e1071')

## 
## Attaching package: 'e1071'

## The following objects are masked from 'package:moments':
## 
##     kurtosis, moment, skewness

library('rpart')
library('caret')

## Loading required package: lattice

## 
## Attaching package: 'caret'

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

library('ranger')
library('kernlab')

## 
## Attaching package: 'kernlab'

## The following object is masked from 'package:psych':
## 
##     alpha

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

## The following object is masked from 'package:ggplot2':
## 
##     alpha

library('pdp')

## 
## Attaching package: 'pdp'

```

```

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

library('vip')

##
## Attaching package: 'vip'

## The following object is masked from 'package:utils':
##
##     vi

library('cluster')
library('factoextra')

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

# Loading the Dataset

ec_df <- read.csv(url("http://bit.ly/EcommerceCustomersDataset"))

#Previewing the top of our dataset
head(ec_df)

##   Administrative Administrative_Duration Informational Informational_Duration
## 1             0                      0            0                  0
## 2             0                      0            0                  0
## 3             0                     -1            0                 -1
## 4             0                      0            0                  0
## 5             0                      0            0                  0
## 6             0                      0            0                  0
##   ProductRelated ProductRelated_Duration BounceRates ExitRates PageValues
## 1             1                   0.000000  0.2000000  0.2000000          0
## 2             2                   64.000000 0.0000000  0.1000000          0
## 3             1                  -1.000000  0.2000000  0.2000000          0
## 4             2                  2.666667  0.0500000  0.1400000          0
## 5            10                  627.500000 0.0200000  0.0500000          0
## 6            19                 154.216667 0.01578947 0.0245614          0
##   SpecialDay Month OperatingSystems Browser Region TrafficType
## 1           0   Feb        MicrosoftIE    Chrome       1          1
## 2           0   Feb        MicrosoftIE    Chrome       2          2
## 3           0   Feb        MicrosoftIE    Chrome       4          3
## 4           0   Feb        MicrosoftIE    Chrome       3          4
## 5           0   Feb        MicrosoftIE    Chrome       3          4
## 6           0   Feb        MicrosoftIE    Chrome       2          3
##   VisitorType Weekend Revenue
## 1 Returning_Visitor FALSE  FALSE
## 2 Returning_Visitor FALSE  FALSE
## 3 Returning_Visitor FALSE  FALSE
## 4 Returning_Visitor FALSE  FALSE
## 5 Returning_Visitor TRUE  FALSE
## 6 Returning_Visitor FALSE  FALSE

```

```
# Previewing the column names in the dataset
```

```
names(ec_df)
```

```
## [1] "Administrative"          "Administrative_Duration"  
## [3] "Informational"           "Informational_Duration"  
## [5] "ProductRelated"          "ProductRelated_Duration"  
## [7] "BounceRates"              "ExitRates"  
## [9] "PageValues"               "SpecialDay"  
## [11] "Month"                    "OperatingSystems"  
## [13] "Browser"                  "Region"  
## [15] "TrafficType"              "VisitorType"  
## [17] "Weekend"                  "Revenue"
```

```
#Displaying the structure of our dataset
```

```
str(ec_df)
```

```
## 'data.frame': 12330 obs. of 18 variables:  
## $ Administrative : int 0 0 0 0 0 0 0 1 0 0 ...  
## $ Administrative_Duration: num 0 0 -1 0 0 0 -1 -1 0 0 ...  
## $ Informational : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Informational_Duration : num 0 0 -1 0 0 0 -1 -1 0 0 ...  
## $ ProductRelated : int 1 2 1 2 10 19 1 1 2 3 ...  
## $ ProductRelated_Duration: num 0 64 -1 2.67 627.5 ...  
## $ BounceRates : num 0.2 0 0.2 0.05 0.02 ...  
## $ ExitRates : num 0.2 0.1 0.2 0.14 0.05 ...  
## $ PageValues : num 0 0 0 0 0 0 0 0 0 0 ...  
## $ SpecialDay : num 0 0 0 0 0 0 0.4 0 0.8 0.4 ...  
## $ Month : chr "Feb" "Feb" "Feb" "Feb" ...  
## $ OperatingSystems : int 1 2 4 3 3 2 2 1 2 2 ...  
## $ Browser : int 1 2 1 2 3 2 4 2 2 4 ...  
## $ Region : int 1 1 9 2 1 1 3 1 2 1 ...  
## $ TrafficType : int 1 2 3 4 4 3 3 5 3 2 ...  
## $ VisitorType : chr "Returning_Visitor" "Returning_Visitor" "Returning_Visitor" "Returning_Visitor" "Returning_Visitor" ...  
## $ Weekend : logi FALSE FALSE FALSE FALSE TRUE FALSE ...  
## $ Revenue : logi FALSE FALSE FALSE FALSE FALSE FALSE ...
```

```
#Checking the dimension of our dataset
```

```
dim(ec_df)
```

```
## [1] 12330 18
```

```
# Checking the datatypes for each column
```

```
columns = colnames(ec_df)  
for (column in seq(length(colnames(ec_df)))){  
  print(columns[column])  
  print(class(ec_df[, column]))  
  cat('\n')  
}
```

Our dataset has 12330 records and 18 columns

```
## [1] "Administrative"
## [1] "integer"
##
## [1] "Administrative_Duration"
## [1] "numeric"
##
## [1] "Informational"
## [1] "integer"
##
## [1] "Informational_Duration"
## [1] "numeric"
##
## [1] "ProductRelated"
## [1] "integer"
##
## [1] "ProductRelated_Duration"
## [1] "numeric"
##
## [1] "BounceRates"
## [1] "numeric"
##
## [1] "ExitRates"
## [1] "numeric"
##
## [1] "PageValues"
## [1] "numeric"
##
## [1] "SpecialDay"
## [1] "numeric"
##
## [1] "Month"
## [1] "character"
##
## [1] "OperatingSystems"
## [1] "integer"
##
## [1] "Browser"
## [1] "integer"
##
## [1] "Region"
## [1] "integer"
##
## [1] "TrafficType"
## [1] "integer"
##
## [1] "VisitorType"
## [1] "character"
##
## [1] "Weekend"
## [1] "logical"
##
## [1] "Revenue"
```

```

## [1] "logical"

# Checking for unique values in the variables

lapply(ec_df, function (x) {length(unique(x))})

## $Administrative
## [1] 28
##
## $Administrative_Duration
## [1] 3337
##
## $Informational
## [1] 18
##
## $Informational_Duration
## [1] 1260
##
## $ProductRelated
## [1] 312
##
## $ProductRelated_Duration
## [1] 9553
##
## $BounceRates
## [1] 1873
##
## $ExitRates
## [1] 4778
##
## $PageValues
## [1] 2704
##
## $SpecialDay
## [1] 6
##
## $Month
## [1] 10
##
## $OperatingSystems
## [1] 8
##
## $Browser
## [1] 13
##
## $Region
## [1] 9
##
## $TrafficType
## [1] 20
##
## $VisitorType
## [1] 3
##

```

```

## $Weekend
## [1] 2
##
## $Revenue
## [1] 2

```

```

# Checking the number of missing data in our dataset

sum(is.na(ec_df))

```

The data types of the columns in our dataset comprise of integer, numeric, character and logical. However the last 8 columns are not categorized as factor data types although they are categorical. We'll correct this when tidying up the dataset.

```

## [1] 112

# Checking the total missing values in each column

colSums(is.na(ec_df))

```

| | | | |
|----|------------------------|-------------------------|-------------------------|
| ## | Administrative | Administrative_Duration | Informational |
| ## | 14 | 14 | 14 |
| ## | Informational_Duration | ProductRelated | ProductRelated_Duration |
| ## | 14 | 14 | 14 |
| ## | BounceRates | ExitRates | PageValues |
| ## | 14 | 14 | 0 |
| ## | SpecialDay | Month | OperatingSystems |
| ## | 0 | 0 | 0 |
| ## | Browser | Region | TrafficType |
| ## | 0 | 0 | 0 |
| ## | VisitorType | Weekend | Revenue |
| ## | 0 | 0 | 0 |

```

# Checking for duplicated data
duplicated <- ec_df[duplicated(ec_df),]
duplicated

```

Our dataset has 112 missing entries. The first 8 columns are the ones with missing values. We'll deal with these missing values later on while cleaning the dataset.

| | | | |
|--------|----------------|-------------------------|---------------|
| ## | Administrative | Administrative_Duration | Informational |
| ## 159 | 0 | 0 | 0 |
| ## 179 | 0 | 0 | 0 |
| ## 419 | 0 | 0 | 0 |
| ## 457 | 0 | 0 | 0 |
| ## 484 | 0 | 0 | 0 |
| ## 513 | 0 | 0 | 0 |

| | | | |
|---------|----|----|----|
| ## 555 | 0 | 0 | 0 |
| ## 590 | 0 | 0 | 0 |
| ## 660 | 0 | 0 | 0 |
| ## 775 | 0 | 0 | 0 |
| ## 873 | 0 | 0 | 0 |
| ## 890 | 0 | 0 | 0 |
| ## 923 | 0 | 0 | 0 |
| ## 948 | 0 | 0 | 0 |
| ## 975 | 0 | 0 | 0 |
| ## 1035 | 0 | 0 | 0 |
| ## 1120 | 0 | 0 | 0 |
| ## 1137 | NA | NA | NA |
| ## 1171 | 0 | 0 | 0 |
| ## 1177 | 0 | 0 | 0 |
| ## 1214 | 0 | 0 | 0 |
| ## 1215 | 0 | 0 | 0 |
| ## 1292 | 0 | 0 | 0 |
| ## 1326 | 0 | 0 | 0 |
| ## 1357 | 0 | 0 | 0 |
| ## 1367 | 0 | 0 | 0 |
| ## 1382 | 0 | 0 | 0 |
| ## 1391 | 0 | 0 | 0 |
| ## 1395 | 0 | 0 | 0 |
| ## 1437 | 0 | 0 | 0 |
| ## 1454 | 0 | 0 | 0 |
| ## 1516 | 0 | 0 | 0 |
| ## 1574 | 0 | 0 | 0 |
| ## 1609 | 0 | 0 | 0 |
| ## 1698 | 0 | 0 | 0 |
| ## 1776 | 0 | 0 | 0 |
| ## 1805 | 0 | 0 | 0 |
| ## 1840 | 0 | 0 | 0 |
| ## 1867 | 0 | 0 | 0 |
| ## 1926 | 0 | 0 | 0 |
| ## 1934 | 0 | 0 | 0 |
| ## 1950 | 0 | 0 | 0 |
| ## 2039 | NA | NA | NA |
| ## 2057 | 0 | 0 | 0 |
| ## 2058 | 0 | 0 | 0 |
| ## 2236 | 0 | 0 | 0 |
| ## 2622 | 0 | 0 | 0 |
| ## 2740 | 0 | 0 | 0 |
| ## 3232 | 0 | 0 | 0 |
| ## 3273 | 0 | 0 | 0 |
| ## 3282 | 0 | 0 | 0 |
| ## 3578 | 0 | 0 | 0 |
| ## 3651 | 0 | 0 | 0 |
| ## 3664 | 0 | 0 | 0 |
| ## 3722 | 0 | 0 | 0 |
| ## 3892 | 0 | 0 | 0 |
| ## 4164 | 0 | 0 | 0 |
| ## 4183 | 0 | 0 | 0 |
| ## 4232 | 0 | 0 | 0 |
| ## 4344 | 0 | 0 | 0 |

| | | | |
|----------|---|---|---|
| ## 4375 | 0 | 0 | 0 |
| ## 4404 | 0 | 0 | 0 |
| ## 4427 | 0 | 0 | 0 |
| ## 4464 | 0 | 0 | 0 |
| ## 4490 | 0 | 0 | 0 |
| ## 4553 | 0 | 0 | 0 |
| ## 4818 | 0 | 0 | 0 |
| ## 4884 | 0 | 0 | 0 |
| ## 4914 | 0 | 0 | 0 |
| ## 5039 | 0 | 0 | 0 |
| ## 5044 | 0 | 0 | 0 |
| ## 5057 | 0 | 0 | 0 |
| ## 5119 | 0 | 0 | 0 |
| ## 5199 | 0 | 0 | 0 |
| ## 5200 | 0 | 0 | 0 |
| ## 5255 | 0 | 0 | 0 |
| ## 5277 | 0 | 0 | 0 |
| ## 5287 | 0 | 0 | 0 |
| ## 5356 | 0 | 0 | 0 |
| ## 5408 | 0 | 0 | 0 |
| ## 6930 | 0 | 0 | 0 |
| ## 7152 | 0 | 0 | 0 |
| ## 7636 | 0 | 0 | 0 |
| ## 8545 | 0 | 0 | 0 |
| ## 9307 | 0 | 0 | 0 |
| ## 9495 | 0 | 0 | 0 |
| ## 9552 | 0 | 0 | 0 |
| ## 9569 | 0 | 0 | 0 |
| ## 9582 | 0 | 0 | 0 |
| ## 9719 | 0 | 0 | 0 |
| ## 9770 | 0 | 0 | 0 |
| ## 9879 | 0 | 0 | 0 |
| ## 9908 | 0 | 0 | 0 |
| ## 10147 | 0 | 0 | 0 |
| ## 10223 | 0 | 0 | 0 |
| ## 10270 | 0 | 0 | 0 |
| ## 10573 | 0 | 0 | 0 |
| ## 10632 | 0 | 0 | 0 |
| ## 10752 | 0 | 0 | 0 |
| ## 10796 | 0 | 0 | 0 |
| ## 10842 | 0 | 0 | 0 |
| ## 10989 | 0 | 0 | 0 |
| ## 11044 | 0 | 0 | 0 |
| ## 11206 | 0 | 0 | 0 |
| ## 11405 | 0 | 0 | 0 |
| ## 11524 | 0 | 0 | 0 |
| ## 11582 | 0 | 0 | 0 |
| ## 11625 | 0 | 0 | 0 |
| ## 11659 | 0 | 0 | 0 |
| ## 11734 | 0 | 0 | 0 |
| ## 11748 | 0 | 0 | 0 |
| ## 11802 | 0 | 0 | 0 |
| ## 11814 | 0 | 0 | 0 |
| ## 11828 | 0 | 0 | 0 |

| | 0 | 0 | 0 | 0 | 0 |
|----------|------------------------|----------------|-------------------------|-------------|----|
| ## 11935 | 0 | 0 | 0 | 0 | 0 |
| ## 11939 | 0 | 0 | 0 | 0 | 0 |
| ## 12160 | 0 | 0 | 0 | 0 | 0 |
| ## 12181 | 0 | 0 | 0 | 0 | 0 |
| ## 12186 | 0 | 0 | 0 | 0 | 0 |
| ## | Informational_Duration | ProductRelated | ProductRelated_Duration | BounceRates | |
| ## 159 | 0 | 1 | 0 | 0.2 | |
| ## 179 | 0 | 1 | 0 | 0.2 | |
| ## 419 | 0 | 1 | 0 | 0.2 | |
| ## 457 | 0 | 1 | 0 | 0.2 | |
| ## 484 | 0 | 1 | 0 | 0.2 | |
| ## 513 | 0 | 1 | 0 | 0.2 | |
| ## 555 | 0 | 1 | 0 | 0.2 | |
| ## 590 | 0 | 1 | 0 | 0.2 | |
| ## 660 | 0 | 2 | 0 | 0.2 | |
| ## 775 | 0 | 1 | 0 | 0.2 | |
| ## 873 | 0 | 1 | 0 | 0.2 | |
| ## 890 | 0 | 1 | 0 | 0.2 | |
| ## 923 | 0 | 1 | 0 | 0.2 | |
| ## 948 | 0 | 1 | 0 | 0.2 | |
| ## 975 | 0 | 1 | 0 | 0.2 | |
| ## 1035 | 0 | 1 | 0 | 0.2 | |
| ## 1120 | 0 | 1 | 0 | 0.2 | |
| ## 1137 | NA | NA | NA | NA | NA |
| ## 1171 | 0 | 1 | 0 | 0.2 | |
| ## 1177 | 0 | 1 | 0 | 0.2 | |
| ## 1214 | 0 | 1 | 0 | 0.2 | |
| ## 1215 | 0 | 1 | 0 | 0.2 | |
| ## 1292 | 0 | 2 | 0 | 0.2 | |
| ## 1326 | 0 | 1 | 0 | 0.2 | |
| ## 1357 | 0 | 2 | 0 | 0.2 | |
| ## 1367 | 0 | 1 | 0 | 0.2 | |
| ## 1382 | 0 | 1 | 0 | 0.2 | |
| ## 1391 | 0 | 1 | 0 | 0.2 | |
| ## 1395 | 0 | 1 | 0 | 0.2 | |
| ## 1437 | 0 | 1 | 0 | 0.2 | |
| ## 1454 | 0 | 1 | 0 | 0.2 | |
| ## 1516 | 0 | 1 | 0 | 0.2 | |
| ## 1574 | 0 | 1 | 0 | 0.2 | |
| ## 1609 | 0 | 1 | 0 | 0.2 | |
| ## 1698 | 0 | 1 | 0 | 0.2 | |
| ## 1776 | 0 | 1 | 0 | 0.2 | |
| ## 1805 | 0 | 1 | 0 | 0.2 | |
| ## 1840 | 0 | 1 | 0 | 0.2 | |
| ## 1867 | 0 | 1 | 0 | 0.2 | |
| ## 1926 | 0 | 1 | 0 | 0.2 | |
| ## 1934 | 0 | 1 | 0 | 0.2 | |
| ## 1950 | 0 | 1 | 0 | 0.2 | |
| ## 2039 | NA | NA | NA | NA | NA |
| ## 2057 | 0 | 1 | 0 | 0.2 | |
| ## 2058 | 0 | 1 | 0 | 0.2 | |
| ## 2236 | 0 | 1 | 0 | 0.2 | |
| ## 2622 | 0 | 1 | 0 | 0.2 | |
| ## 2740 | 0 | 1 | 0 | 0.2 | |

| | | | | |
|----------|---|---|---|-----|
| ## 3232 | 0 | 1 | 0 | 0.2 |
| ## 3273 | 0 | 1 | 0 | 0.2 |
| ## 3282 | 0 | 1 | 0 | 0.2 |
| ## 3578 | 0 | 1 | 0 | 0.2 |
| ## 3651 | 0 | 1 | 0 | 0.2 |
| ## 3664 | 0 | 1 | 0 | 0.2 |
| ## 3722 | 0 | 1 | 0 | 0.2 |
| ## 3892 | 0 | 1 | 0 | 0.2 |
| ## 4164 | 0 | 1 | 0 | 0.2 |
| ## 4183 | 0 | 1 | 0 | 0.2 |
| ## 4232 | 0 | 1 | 0 | 0.2 |
| ## 4344 | 0 | 1 | 0 | 0.2 |
| ## 4375 | 0 | 1 | 0 | 0.2 |
| ## 4404 | 0 | 1 | 0 | 0.2 |
| ## 4427 | 0 | 1 | 0 | 0.2 |
| ## 4464 | 0 | 1 | 0 | 0.2 |
| ## 4490 | 0 | 1 | 0 | 0.2 |
| ## 4553 | 0 | 2 | 0 | 0.2 |
| ## 4818 | 0 | 1 | 0 | 0.2 |
| ## 4884 | 0 | 1 | 0 | 0.2 |
| ## 4914 | 0 | 1 | 0 | 0.2 |
| ## 5039 | 0 | 1 | 0 | 0.2 |
| ## 5044 | 0 | 1 | 0 | 0.2 |
| ## 5057 | 0 | 1 | 0 | 0.2 |
| ## 5119 | 0 | 1 | 0 | 0.2 |
| ## 5199 | 0 | 1 | 0 | 0.2 |
| ## 5200 | 0 | 2 | 0 | 0.2 |
| ## 5255 | 0 | 1 | 0 | 0.2 |
| ## 5277 | 0 | 1 | 0 | 0.2 |
| ## 5287 | 0 | 1 | 0 | 0.2 |
| ## 5356 | 0 | 1 | 0 | 0.2 |
| ## 5408 | 0 | 1 | 0 | 0.2 |
| ## 6930 | 0 | 1 | 0 | 0.2 |
| ## 7152 | 0 | 1 | 0 | 0.2 |
| ## 7636 | 0 | 1 | 0 | 0.2 |
| ## 8545 | 0 | 1 | 0 | 0.2 |
| ## 9307 | 0 | 1 | 0 | 0.2 |
| ## 9495 | 0 | 1 | 0 | 0.2 |
| ## 9552 | 0 | 1 | 0 | 0.2 |
| ## 9569 | 0 | 1 | 0 | 0.2 |
| ## 9582 | 0 | 1 | 0 | 0.2 |
| ## 9719 | 0 | 1 | 0 | 0.2 |
| ## 9770 | 0 | 1 | 0 | 0.2 |
| ## 9879 | 0 | 1 | 0 | 0.2 |
| ## 9908 | 0 | 1 | 0 | 0.2 |
| ## 10147 | 0 | 1 | 0 | 0.2 |
| ## 10223 | 0 | 2 | 0 | 0.2 |
| ## 10270 | 0 | 1 | 0 | 0.2 |
| ## 10573 | 0 | 1 | 0 | 0.2 |
| ## 10632 | 0 | 1 | 0 | 0.2 |
| ## 10752 | 0 | 1 | 0 | 0.2 |
| ## 10796 | 0 | 1 | 0 | 0.2 |
| ## 10842 | 0 | 1 | 0 | 0.2 |
| ## 10989 | 0 | 1 | 0 | 0.2 |

| | | | | | | | | |
|----------|-----------|------------|------------|-------|------------------|---------|--------|-----|
| ## 11044 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11206 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11405 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11524 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11582 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11625 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11659 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11734 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11748 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11802 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11814 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11828 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11935 | | 0 | | 1 | | 0 | | 0.2 |
| ## 11939 | | 0 | | 1 | | 0 | | 0.2 |
| ## 12160 | | 0 | | 1 | | 0 | | 0.2 |
| ## 12181 | | 0 | | 1 | | 0 | | 0.2 |
| ## 12186 | | 0 | | 1 | | 0 | | 0.2 |
| ## | ExitRates | PageValues | SpecialDay | Month | OperatingSystems | Browser | Region | |
| ## 159 | 0.2 | 0 | 0.0 | Feb | | 1 | 1 | 1 |
| ## 179 | 0.2 | 0 | 0.0 | Feb | | 3 | 2 | 3 |
| ## 419 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 1 |
| ## 457 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 4 |
| ## 484 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 3 |
| ## 513 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 555 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 590 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 660 | 0.2 | 0 | 0.0 | Mar | | 2 | 5 | 1 |
| ## 775 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 4 |
| ## 873 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 3 |
| ## 890 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 2 |
| ## 923 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 2 |
| ## 948 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 975 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1035 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1120 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1137 | NA | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1171 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 1 |
| ## 1177 | 0.2 | 0 | 0.0 | Mar | | 2 | 4 | 1 |
| ## 1214 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 3 |
| ## 1215 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 1 |
| ## 1292 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1326 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 3 |
| ## 1357 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 1 |
| ## 1367 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 8 |
| ## 1382 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 4 |
| ## 1391 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1395 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1437 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 3 |
| ## 1454 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1516 | 0.2 | 0 | 0.0 | Mar | | 1 | 1 | 1 |
| ## 1574 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 1 |
| ## 1609 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 7 |
| ## 1698 | 0.2 | 0 | 0.0 | Mar | | 2 | 2 | 2 |
| ## 1776 | 0.2 | 0 | 0.0 | Mar | | 3 | 2 | 1 |

| | | | | | | | |
|---------|-----|---|-----|------|---|---|---|
| ## 1805 | 0.2 | 0 | 0.0 | Mar | 1 | 1 | 8 |
| ## 1840 | 0.2 | 0 | 0.0 | Mar | 2 | 2 | 1 |
| ## 1867 | 0.2 | 0 | 0.0 | Mar | 1 | 1 | 1 |
| ## 1926 | 0.2 | 0 | 0.0 | Mar | 3 | 2 | 1 |
| ## 1934 | 0.2 | 0 | 0.0 | Mar | 2 | 2 | 1 |
| ## 1950 | 0.2 | 0 | 0.0 | Mar | 2 | 2 | 1 |
| ## 2039 | NA | 0 | 0.0 | Mar | 2 | 2 | 1 |
| ## 2057 | 0.2 | 0 | 0.0 | Mar | 3 | 2 | 3 |
| ## 2058 | 0.2 | 0 | 0.0 | Mar | 2 | 4 | 1 |
| ## 2236 | 0.2 | 0 | 0.0 | May | 1 | 1 | 4 |
| ## 2622 | 0.2 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 2740 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 3232 | 0.2 | 0 | 0.0 | May | 2 | 4 | 1 |
| ## 3273 | 0.2 | 0 | 0.0 | May | 1 | 1 | 3 |
| ## 3282 | 0.2 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 3578 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 3651 | 0.2 | 0 | 0.0 | May | 2 | 2 | 4 |
| ## 3664 | 0.2 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 3722 | 0.2 | 0 | 0.0 | May | 1 | 1 | 4 |
| ## 3892 | 0.2 | 0 | 0.0 | May | 2 | 2 | 7 |
| ## 4164 | 0.2 | 0 | 0.0 | May | 1 | 1 | 4 |
| ## 4183 | 0.2 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 4232 | 0.2 | 0 | 0.0 | May | 2 | 2 | 2 |
| ## 4344 | 0.2 | 0 | 0.0 | May | 3 | 2 | 1 |
| ## 4375 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 4404 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 4427 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 4464 | 0.2 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 4490 | 0.2 | 0 | 0.0 | May | 3 | 2 | 9 |
| ## 4553 | 0.2 | 0 | 0.0 | May | 2 | 2 | 2 |
| ## 4818 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 4884 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 4914 | 0.2 | 0 | 0.8 | May | 2 | 2 | 1 |
| ## 5039 | 0.2 | 0 | 0.0 | May | 3 | 2 | 3 |
| ## 5044 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 5057 | 0.2 | 0 | 0.0 | May | 2 | 2 | 6 |
| ## 5119 | 0.2 | 0 | 0.0 | May | 1 | 1 | 6 |
| ## 5199 | 0.2 | 0 | 0.0 | May | 2 | 2 | 1 |
| ## 5200 | 0.2 | 0 | 0.0 | May | 2 | 2 | 2 |
| ## 5255 | 0.2 | 0 | 0.6 | May | 2 | 2 | 1 |
| ## 5277 | 0.2 | 0 | 0.0 | May | 3 | 2 | 3 |
| ## 5287 | 0.2 | 0 | 0.0 | May | 1 | 1 | 3 |
| ## 5356 | 0.2 | 0 | 0.0 | May | 1 | 1 | 3 |
| ## 5408 | 0.2 | 0 | 0.0 | May | 2 | 4 | 1 |
| ## 6930 | 0.2 | 0 | 0.0 | June | 2 | 2 | 1 |
| ## 7152 | 0.2 | 0 | 0.0 | June | 2 | 2 | 1 |
| ## 7636 | 0.2 | 0 | 0.0 | June | 3 | 2 | 3 |
| ## 8545 | 0.2 | 0 | 0.0 | Nov | 3 | 2 | 3 |
| ## 9307 | 0.2 | 0 | 0.0 | Dec | 3 | 2 | 3 |
| ## 9495 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 1 |
| ## 9552 | 0.2 | 0 | 0.0 | Nov | 3 | 2 | 4 |
| ## 9569 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 8 |
| ## 9582 | 0.2 | 0 | 0.0 | Nov | 2 | 2 | 1 |
| ## 9719 | 0.2 | 0 | 0.0 | Nov | 3 | 2 | 7 |

| | | | | | | | |
|----------|-------------|-------------------|---------|---------|---|----|---|
| ## 9770 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 2 |
| ## 9879 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 6 |
| ## 9908 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 1 |
| ## 10147 | 0.2 | 0 | 0.0 | Dec | 8 | 13 | 9 |
| ## 10223 | 0.2 | 0 | 0.0 | Nov | 1 | 1 | 1 |
| ## 10270 | 0.2 | 0 | 0.0 | Nov | 1 | 1 | 3 |
| ## 10573 | 0.2 | 0 | 0.0 | Nov | 2 | 2 | 3 |
| ## 10632 | 0.2 | 0 | 0.0 | Nov | 2 | 2 | 1 |
| ## 10752 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 1 |
| ## 10796 | 0.2 | 0 | 0.0 | Nov | 1 | 1 | 4 |
| ## 10842 | 0.2 | 0 | 0.0 | Nov | 2 | 2 | 3 |
| ## 10989 | 0.2 | 0 | 0.0 | Nov | 2 | 4 | 3 |
| ## 11044 | 0.2 | 0 | 0.0 | Dec | 3 | 2 | 6 |
| ## 11206 | 0.2 | 0 | 0.0 | Dec | 8 | 13 | 9 |
| ## 11405 | 0.2 | 0 | 0.0 | Nov | 3 | 2 | 1 |
| ## 11524 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 1 |
| ## 11582 | 0.2 | 0 | 0.0 | Dec | 8 | 13 | 9 |
| ## 11625 | 0.2 | 0 | 0.0 | Nov | 3 | 2 | 1 |
| ## 11659 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 1 |
| ## 11734 | 0.2 | 0 | 0.0 | Nov | 2 | 2 | 1 |
| ## 11748 | 0.2 | 0 | 0.0 | Nov | 1 | 1 | 3 |
| ## 11802 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 4 |
| ## 11814 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 1 |
| ## 11828 | 0.2 | 0 | 0.0 | Dec | 2 | 2 | 1 |
| ## 11935 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 1 |
| ## 11939 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 4 |
| ## 12160 | 0.2 | 0 | 0.0 | Dec | 1 | 1 | 1 |
| ## 12181 | 0.2 | 0 | 0.0 | Dec | 1 | 13 | 9 |
| ## 12186 | 0.2 | 0 | 0.0 | Dec | 8 | 13 | 9 |
| ## | TrafficType | VisitorType | Weekend | Revenue | | | |
| ## 159 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 179 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 419 | 1 | Returning_Visitor | TRUE | FALSE | | | |
| ## 457 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 484 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 513 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 555 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 590 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 660 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 775 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 873 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 890 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 923 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 948 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 975 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1035 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1120 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1137 | 2 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1171 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1177 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1214 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1215 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1292 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 1326 | 3 | Returning_Visitor | FALSE | FALSE | | | |

| | 1 Returning_Visitor | FALSE | FALSE |
|---------|----------------------|-------|-------|
| ## 1357 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1367 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1382 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1391 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1395 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1437 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1454 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1516 | 3 Returning_Visitor | TRUE | FALSE |
| ## 1574 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1609 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1698 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1776 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1805 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1840 | 3 Returning_Visitor | FALSE | FALSE |
| ## 1867 | 9 Returning_Visitor | TRUE | FALSE |
| ## 1926 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1934 | 1 Returning_Visitor | FALSE | FALSE |
| ## 1950 | 1 Returning_Visitor | FALSE | FALSE |
| ## 2039 | 2 Returning_Visitor | FALSE | FALSE |
| ## 2057 | 1 Returning_Visitor | FALSE | FALSE |
| ## 2058 | 1 Returning_Visitor | FALSE | FALSE |
| ## 2236 | 3 Returning_Visitor | FALSE | FALSE |
| ## 2622 | 3 Returning_Visitor | FALSE | FALSE |
| ## 2740 | 1 Returning_Visitor | FALSE | FALSE |
| ## 3232 | 3 Returning_Visitor | FALSE | FALSE |
| ## 3273 | 3 Returning_Visitor | FALSE | FALSE |
| ## 3282 | 3 Returning_Visitor | FALSE | FALSE |
| ## 3578 | 4 Returning_Visitor | FALSE | FALSE |
| ## 3651 | 1 Returning_Visitor | FALSE | FALSE |
| ## 3664 | 3 Returning_Visitor | FALSE | FALSE |
| ## 3722 | 3 Returning_Visitor | FALSE | FALSE |
| ## 3892 | 4 Returning_Visitor | FALSE | FALSE |
| ## 4164 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4183 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4232 | 1 Returning_Visitor | FALSE | FALSE |
| ## 4344 | 13 Returning_Visitor | FALSE | FALSE |
| ## 4375 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4404 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4427 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4464 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4490 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4553 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4818 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4884 | 3 Returning_Visitor | FALSE | FALSE |
| ## 4914 | 1 Returning_Visitor | FALSE | FALSE |
| ## 5039 | 3 Returning_Visitor | FALSE | FALSE |
| ## 5044 | 3 Returning_Visitor | FALSE | FALSE |
| ## 5057 | 3 Returning_Visitor | FALSE | FALSE |
| ## 5119 | 4 Returning_Visitor | TRUE | FALSE |
| ## 5199 | 13 Returning_Visitor | FALSE | FALSE |
| ## 5200 | 3 Returning_Visitor | FALSE | FALSE |
| ## 5255 | 1 Returning_Visitor | FALSE | FALSE |
| ## 5277 | 13 Returning_Visitor | FALSE | FALSE |
| ## 5287 | 15 Returning_Visitor | FALSE | FALSE |

```

## 5356      3 Returning_Visitor FALSE FALSE
## 5408      6 Returning_Visitor FALSE FALSE
## 6930      1 Returning_Visitor FALSE FALSE
## 7152      1 Returning_Visitor FALSE FALSE
## 7636     13 Returning_Visitor FALSE FALSE
## 8545      3 Returning_Visitor FALSE FALSE
## 9307      1 Returning_Visitor TRUE FALSE
## 9495      3 Returning_Visitor FALSE FALSE
## 9552      3 Returning_Visitor FALSE FALSE
## 9569      1 Returning_Visitor FALSE FALSE
## 9582      1 Returning_Visitor FALSE FALSE
## 9719     13 Returning_Visitor FALSE FALSE
## 9770      1 Returning_Visitor FALSE FALSE
## 9879     13 Returning_Visitor FALSE FALSE
## 9908     13 Returning_Visitor FALSE FALSE
## 10147     20 Other FALSE FALSE
## 10223      1 Returning_Visitor FALSE FALSE
## 10270      2 Returning_Visitor FALSE FALSE
## 10573      1 Returning_Visitor FALSE FALSE
## 10632      1 Returning_Visitor FALSE FALSE
## 10752      1 Returning_Visitor TRUE FALSE
## 10796      1 Returning_Visitor FALSE FALSE
## 10842      1 Returning_Visitor FALSE FALSE
## 10989      3 Returning_Visitor FALSE FALSE
## 11044      1 Returning_Visitor FALSE FALSE
## 11206     20 Other FALSE FALSE
## 11405     13 Returning_Visitor FALSE FALSE
## 11524     13 Returning_Visitor FALSE FALSE
## 11582     20 Other FALSE FALSE
## 11625      1 Returning_Visitor FALSE FALSE
## 11659      1 Returning_Visitor TRUE FALSE
## 11734      1 Returning_Visitor FALSE FALSE
## 11748      3 Returning_Visitor FALSE FALSE
## 11802      1 Returning_Visitor TRUE FALSE
## 11814      1 Returning_Visitor FALSE FALSE
## 11828      1 Returning_Visitor FALSE FALSE
## 11935      2 New_Visitor FALSE FALSE
## 11939      1 Returning_Visitor TRUE FALSE
## 12160      3 Returning_Visitor FALSE FALSE
## 12181     20 Returning_Visitor FALSE FALSE
## 12186     20 Other FALSE FALSE

```

Our dataset has 119 duplicated entries.

```

# Checking negative values in the dataset

neg <- ec_df[ec_df[,6] < 0,]
neg

```

```

##      Administrative Administrative_Duration Informational
## 3                  0                   -1              0
## 7                  0                   -1              0

```

| | | | | |
|----------|------------------------|----------------|-------------------------|-------------|
| ## 8 | 1 | -1 | 0 | |
| ## 17 | 0 | -1 | 0 | |
| ## 22 | 0 | -1 | 0 | |
| ## 25 | 0 | -1 | 0 | |
| ## 50 | 0 | -1 | 0 | |
| ## 51 | 0 | -1 | 0 | |
| ## 65 | 0 | -1 | 0 | |
| ## 133 | 0 | -1 | 0 | |
| ## 141 | 0 | -1 | 0 | |
| ## 182 | 0 | -1 | 0 | |
| ## 183 | 0 | -1 | 0 | |
| ## 253 | 0 | -1 | 0 | |
| ## 384 | 0 | -1 | 0 | |
| ## 533 | 0 | -1 | 0 | |
| ## 541 | 0 | -1 | 0 | |
| ## 563 | 0 | -1 | 0 | |
| ## 592 | 0 | -1 | 0 | |
| ## 639 | 0 | -1 | 0 | |
| ## NA | NA | NA | NA | |
| ## NA.1 | NA | NA | NA | |
| ## NA.2 | NA | NA | NA | |
| ## NA.3 | NA | NA | NA | |
| ## NA.4 | NA | NA | NA | |
| ## NA.5 | NA | NA | NA | |
| ## NA.6 | NA | NA | NA | |
| ## NA.7 | NA | NA | NA | |
| ## NA.8 | NA | NA | NA | |
| ## NA.9 | NA | NA | NA | |
| ## NA.10 | NA | NA | NA | |
| ## NA.11 | NA | NA | NA | |
| ## NA.12 | NA | NA | NA | |
| ## 2047 | 0 | -1 | 0 | |
| ## 2053 | 0 | -1 | 0 | |
| ## 2062 | 0 | -1 | 0 | |
| ## NA.13 | NA | NA | NA | |
| ## 4800 | 0 | -1 | 0 | |
| ## 4916 | 0 | -1 | 0 | |
| ## 5096 | 0 | -1 | 0 | |
| ## 5097 | 0 | -1 | 0 | |
| ## 5108 | 0 | -1 | 0 | |
| ## 5125 | 1 | -1 | 0 | |
| ## 6261 | 0 | -1 | 0 | |
| ## 7211 | 0 | -1 | 0 | |
| ## 8053 | 0 | -1 | 0 | |
| ## 8637 | 0 | -1 | 0 | |
| ## | Informational_Duration | ProductRelated | ProductRelated_Duration | BounceRates |
| ## 3 | | -1 | 1 | -1 0.2 |
| ## 7 | | -1 | 1 | -1 0.2 |
| ## 8 | | -1 | 1 | -1 0.2 |
| ## 17 | | -1 | 1 | -1 0.2 |
| ## 22 | | -1 | 1 | -1 0.2 |
| ## 25 | | -1 | 1 | -1 0.2 |
| ## 50 | | -1 | 1 | -1 0.2 |
| ## 51 | | -1 | 1 | -1 0.2 |

| | | | | | | | |
|----------|------------|------------|------------|-------|------------------|---------|--------|
| ## 65 | | -1 | 1 | | -1 | 0.2 | |
| ## 133 | | -1 | 1 | | -1 | 0.2 | |
| ## 141 | | -1 | 1 | | -1 | 0.2 | |
| ## 182 | | -1 | 1 | | -1 | 0.2 | |
| ## 183 | | -1 | 1 | | -1 | 0.2 | |
| ## 253 | | -1 | 1 | | -1 | 0.2 | |
| ## 384 | | -1 | 1 | | -1 | 0.2 | |
| ## 533 | | -1 | 1 | | -1 | 0.2 | |
| ## 541 | | -1 | 1 | | -1 | 0.2 | |
| ## 563 | | -1 | 1 | | -1 | 0.0 | |
| ## 592 | | -1 | 1 | | -1 | 0.2 | |
| ## 639 | | -1 | 1 | | -1 | 0.2 | |
| ## NA | | NA | NA | | NA | NA | |
| ## NA.1 | | NA | NA | | NA | NA | |
| ## NA.2 | | NA | NA | | NA | NA | |
| ## NA.3 | | NA | NA | | NA | NA | |
| ## NA.4 | | NA | NA | | NA | NA | |
| ## NA.5 | | NA | NA | | NA | NA | |
| ## NA.6 | | NA | NA | | NA | NA | |
| ## NA.7 | | NA | NA | | NA | NA | |
| ## NA.8 | | NA | NA | | NA | NA | |
| ## NA.9 | | NA | NA | | NA | NA | |
| ## NA.10 | | NA | NA | | NA | NA | |
| ## NA.11 | | NA | NA | | NA | NA | |
| ## NA.12 | | NA | NA | | NA | NA | |
| ## 2047 | | -1 | 1 | | -1 | 0.0 | |
| ## 2053 | | -1 | 1 | | -1 | 0.2 | |
| ## 2062 | | -1 | 1 | | -1 | 0.2 | |
| ## NA.13 | | NA | NA | | NA | NA | |
| ## 4800 | | -1 | 1 | | -1 | 0.2 | |
| ## 4916 | | -1 | 1 | | -1 | 0.2 | |
| ## 5096 | | -1 | 1 | | -1 | 0.2 | |
| ## 5097 | | -1 | 1 | | -1 | 0.2 | |
| ## 5108 | | -1 | 1 | | -1 | 0.2 | |
| ## 5125 | | -1 | 1 | | -1 | 0.0 | |
| ## 6261 | | -1 | 1 | | -1 | 0.2 | |
| ## 7211 | | -1 | 1 | | -1 | 0.2 | |
| ## 8053 | | -1 | 1 | | -1 | 0.2 | |
| ## 8637 | | -1 | 1 | | -1 | 0.2 | |
| ## | ExitRates | PageValues | SpecialDay | Month | OperatingSystems | Browser | Region |
| ## 3 | 0.20000000 | 0 | 0.0 | Feb | 4 | 1 | 9 |
| ## 7 | 0.20000000 | 0 | 0.4 | Feb | 2 | 4 | 3 |
| ## 8 | 0.20000000 | 0 | 0.0 | Feb | 1 | 2 | 1 |
| ## 17 | 0.20000000 | 0 | 0.0 | Feb | 1 | 1 | 4 |
| ## 22 | 0.20000000 | 0 | 0.0 | Feb | 3 | 3 | 1 |
| ## 25 | 0.20000000 | 0 | 0.0 | Feb | 2 | 2 | 4 |
| ## 50 | 0.20000000 | 0 | 0.6 | Feb | 2 | 2 | 3 |
| ## 51 | 0.20000000 | 0 | 0.0 | Feb | 1 | 1 | 3 |
| ## 65 | 0.20000000 | 0 | 0.0 | Feb | 2 | 2 | 4 |
| ## 133 | 0.20000000 | 0 | 0.0 | Feb | 3 | 2 | 3 |
| ## 141 | 0.20000000 | 0 | 0.0 | Feb | 2 | 2 | 7 |
| ## 182 | 0.20000000 | 0 | 0.6 | Feb | 4 | 2 | 1 |
| ## 183 | 0.20000000 | 0 | 0.0 | Feb | 2 | 4 | 1 |
| ## 253 | 0.20000000 | 0 | 0.0 | Mar | 1 | 1 | 1 |

| | | | | | | | |
|----------|-------------|-------------------|---------|---------|----|----|----|
| ## 384 | 0.20000000 | 0 | 0.0 | Mar | 2 | 2 | 2 |
| ## 533 | 0.20000000 | 0 | 0.0 | Mar | 3 | 2 | 7 |
| ## 541 | 0.20000000 | 0 | 0.0 | Mar | 3 | 2 | 3 |
| ## 563 | 0.06666667 | 0 | 0.0 | Mar | 2 | 2 | 7 |
| ## 592 | 0.20000000 | 0 | 0.0 | Mar | 1 | 1 | 3 |
| ## 639 | 0.20000000 | 0 | 0.0 | Mar | 3 | 2 | 3 |
| ## NA | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.1 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.2 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.3 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.4 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.5 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.6 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.7 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.8 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.9 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.10 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.11 | NA | NA | NA | <NA> | NA | NA | NA |
| ## NA.12 | NA | NA | NA | <NA> | NA | NA | NA |
| ## 2047 | 0.10000000 | 0 | 0.0 | Mar | 2 | 2 | 2 |
| ## 2053 | 0.20000000 | 0 | 0.0 | Mar | 2 | 5 | 2 |
| ## 2062 | 0.20000000 | 0 | 0.0 | Mar | 2 | 5 | 1 |
| ## NA.13 | NA | NA | NA | <NA> | NA | NA | NA |
| ## 4800 | 0.20000000 | 0 | 0.0 | May | 3 | 2 | 5 |
| ## 4916 | 0.20000000 | 0 | 0.0 | May | 2 | 2 | 9 |
| ## 5096 | 0.20000000 | 0 | 0.0 | May | 1 | 1 | 1 |
| ## 5097 | 0.20000000 | 0 | 0.0 | May | 2 | 4 | 4 |
| ## 5108 | 0.20000000 | 0 | 0.0 | May | 2 | 10 | 5 |
| ## 5125 | 0.06666667 | 0 | 0.0 | May | 3 | 2 | 1 |
| ## 6261 | 0.20000000 | 0 | 0.0 | Nov | 2 | 2 | 1 |
| ## 7211 | 0.20000000 | 0 | 0.0 | Jul | 1 | 1 | 3 |
| ## 8053 | 0.20000000 | 0 | 0.0 | Nov | 1 | 1 | 9 |
| ## 8637 | 0.20000000 | 0 | 0.0 | Nov | 1 | 8 | 2 |
| ## | TrafficType | VisitorType | Weekend | Revenue | | | |
| ## 3 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 7 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 8 | 5 | Returning_Visitor | TRUE | FALSE | | | |
| ## 17 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 22 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 25 | 1 | Returning_Visitor | TRUE | FALSE | | | |
| ## 50 | 2 | Returning_Visitor | FALSE | FALSE | | | |
| ## 51 | 4 | Returning_Visitor | TRUE | FALSE | | | |
| ## 65 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 133 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 141 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 182 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 183 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 253 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 384 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 533 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 541 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 563 | 1 | Returning_Visitor | FALSE | FALSE | | | |
| ## 592 | 3 | Returning_Visitor | FALSE | FALSE | | | |
| ## 639 | 3 | Returning_Visitor | FALSE | FALSE | | | |

```

## NA          NA      <NA>      NA      NA
## NA.1        NA      <NA>      NA      NA
## NA.2        NA      <NA>      NA      NA
## NA.3        NA      <NA>      NA      NA
## NA.4        NA      <NA>      NA      NA
## NA.5        NA      <NA>      NA      NA
## NA.6        NA      <NA>      NA      NA
## NA.7        NA      <NA>      NA      NA
## NA.8        NA      <NA>      NA      NA
## NA.9        NA      <NA>      NA      NA
## NA.10       NA      <NA>      NA      NA
## NA.11       NA      <NA>      NA      NA
## NA.12       NA      <NA>      NA      NA
## 2047        6 Returning_Visitor FALSE  FALSE
## 2053        3 Returning_Visitor FALSE  FALSE
## 2062        3 Returning_Visitor FALSE  FALSE
## NA.13       NA      <NA>      NA      NA
## 4800        6 Returning_Visitor FALSE  FALSE
## 4916        3 Returning_Visitor FALSE  FALSE
## 5096        20 Returning_Visitor FALSE FALSE
## 5097        3 Returning_Visitor FALSE FALSE
## 5108        1 Returning_Visitor FALSE FALSE
## 5125        4 Returning_Visitor FALSE FALSE
## 6261        13 Returning_Visitor FALSE FALSE
## 7211        1 Returning_Visitor FALSE FALSE
## 8053        2 Returning_Visitor FALSE FALSE
## 8637        1 Returning_Visitor FALSE FALSE

```

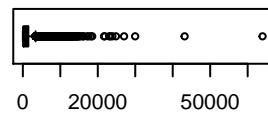
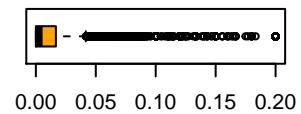
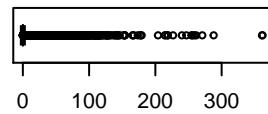
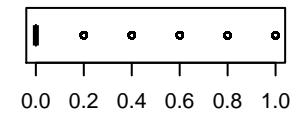
Our dataframe has 47 rows of negative values. Only 3 columns have negative data i.e. the duration of each of the different types of the pages visited by the visitor. This is not possible as the time spent on each of these pages cannot be negative.

Outlier Detection

```

par(mfrow=c(3,3))
boxplot(ec_df$ProductRelated_Duration, horizontal = TRUE, main = toupper("Product Related Duration"), col = "red")
boxplot(ec_df$BounceRates, horizontal = TRUE, main = toupper("Bounce Rates"), col = "orange")
boxplot(ec_df$ExitRates, horizontal = TRUE, main = toupper("Exit Rates"), col = "black")
boxplot(ec_df$PageValues, horizontal = TRUE, main = toupper("Page Values"), col = "darkblue")
boxplot(ec_df$SpecialDay, horizontal = TRUE, main = toupper("Special Day"), col = "red")
boxplot(ec_df$Administrative, horizontal = TRUE, main = toupper("Administrative"), col = "skyblue")
boxplot(ec_df$Administrative_Duration, horizontal = TRUE, main = toupper("Administrative Duration"), col = "brown")
boxplot(ec_df$Informational, horizontal = TRUE, main = toupper("Informational"), col = "grey")
boxplot(ec_df$Informational_Duration, horizontal = TRUE, main = toupper("Informational Duration"), col = "teal")

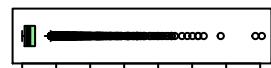
```

PRODUCT RELATED DURATIO**BOUNCE RATES****PAGE VALUES****SPECIAL DAY****ADMINISTRATIVE DURATION****INFORMATIONAL**

Plotting boxplots to show presence of outliers

```
boxplot(ec_df$ProductRelated, horizontal = TRUE, main = toupper("Product Related"), col = "lightgreen")
```

PRODUCT RELATED



Outliers are present on all the numeric columns. However, we'll not remove these outliers as they can prove to have vital information.

Data Cleaning

```
# Changing the data type for the last 8 columns to factor as they are categorical
cols <- c('Month' , 'OperatingSystems', 'Browser', 'Region', 'TrafficType', 'VisitorType', 'Weekend', 'Revenue')
ec_df[,cols] <- lapply(ec_df[,cols] , factor)
```

```
# Checking the datatypes for each column to see if the changes have been made
columns = colnames(ec_df)
for (column in seq(length(colnames(ec_df)))){
  print(columns[column])
  print(class(ec_df[, column]))
  cat('\n')
}
```

```
## [1] "Administrative"
## [1] "integer"
##
```

```

## [1] "Administrative_Duration"
## [1] "numeric"
##
## [1] "Informational"
## [1] "integer"
##
## [1] "Informational_Duration"
## [1] "numeric"
##
## [1] "ProductRelated"
## [1] "integer"
##
## [1] "ProductRelated_Duration"
## [1] "numeric"
##
## [1] "BounceRates"
## [1] "numeric"
##
## [1] "ExitRates"
## [1] "numeric"
##
## [1] "PageValues"
## [1] "numeric"
##
## [1] "SpecialDay"
## [1] "numeric"
##
## [1] "Month"
## [1] "factor"
##
## [1] "OperatingSystems"
## [1] "factor"
##
## [1] "Browser"
## [1] "factor"
##
## [1] "Region"
## [1] "factor"
##
## [1] "TrafficType"
## [1] "factor"
##
## [1] "VisitorType"
## [1] "factor"
##
## [1] "Weekend"
## [1] "factor"
##
## [1] "Revenue"
## [1] "factor"

## Handling null values
## We'll remove all the missing values as they are only 112 entries and they are not a huge part of the

```

```

#Removing null values
ec_df <- na.omit(ec_df)
#Checking if the null values have been removed
sum(is.na(ec_df))

## [1] 0

## Handling duplicated rows
# We'll remove all the duplicated rows as duplicates are an extreme case of nonrandom sampling, and they
# Removing duplicated rows

ec_df <- ec_df[!duplicated(ec_df),]

# Normalizing the dataframe
# Our dataframe had a few negative values and these would negatively affect our modelling. We therefore
#Creating a function for normalization of our data

normalize <- function(x) {
  return ((x - min(x)) / (max(x) - min(x)))
}

#Normalizing the 3 columns
ec_df$Administrative_Duration<-normalize(ec_df$Administrative_Duration)
ec_df$Informational_Duration<-normalize(ec_df$Informational_Duration)
ec_df$ProductRelated_Duration<-normalize(ec_df$ProductRelated_Duration)

#Checking if the negative values in the dataframe have been normalized
ec_df[ec_df[,6] < 0,]

## [1] Administrative          Administrative_Duration Informational
## [4] Informational_Duration ProductRelated           ProductRelated_Duration
## [7] BounceRates              ExitRates                PageValues
## [10] SpecialDay               Month                  OperatingSystems
## [13] Browser                 Region                 TrafficType
## [16] VisitorType              Weekend                Revenue
## <0 rows> (or 0-length row.names)

#Checking the dimension of our new dataframe
dim(ec_df)

## [1] 12199   18

```

Our new data frame has no duplicates, no missing data, has 0 negative values in the columns and has 12,199 rows and 18 columns, 10 of which are numerical and 8 categorical.

8. Exploratory Data Analysis

Univariate Analysis

```
# We'll get the minimum, maximum, median, mean and quantiles of each column by printing the summary statistics
(summary(ec_df))
```

Measures of Central Tendency

```
## Administrative Administrative_Duration Informational
## Min. : 0.00 Min. :0.0000000 Min. : 0.0000
## 1st Qu.: 0.00 1st Qu.:0.0002941 1st Qu.: 0.0000
## Median : 1.00 Median :0.0029414 Median : 0.0000
## Mean : 2.34 Mean :0.0243201 Mean : 0.5088
## 3rd Qu.: 4.00 3rd Qu.:0.0281638 3rd Qu.: 0.0000
## Max. :27.00 Max. :1.0000000 Max. :24.0000
##
## Informational_Duration ProductRelated ProductRelated_Duration
## Min. :0.0000000 Min. : 0.00 Min. :0.000000
## 1st Qu.:0.0003921 1st Qu.: 8.00 1st Qu.:0.003042
## Median :0.0003921 Median :18.00 Median :0.009543
## Mean :0.0140518 Mean : 32.06 Mean : 0.018891
## 3rd Qu.:0.0003921 3rd Qu.: 38.00 3rd Qu.:0.023112
## Max. :1.0000000 Max. :705.00 Max. :1.000000
##
## BounceRates ExitRates PageValues SpecialDay
## Min. :0.00000 Min. :0.00000 Min. : 0.000 Min. :0.00000
## 1st Qu.:0.00000 1st Qu.:0.01422 1st Qu.: 0.000 1st Qu.:0.00000
## Median :0.00293 Median :0.02500 Median : 0.000 Median :0.00000
## Mean :0.02045 Mean :0.04150 Mean : 5.952 Mean : 0.06197
## 3rd Qu.:0.01667 3rd Qu.:0.04848 3rd Qu.: 0.000 3rd Qu.:0.00000
## Max. :0.20000 Max. :0.20000 Max. :361.764 Max. :1.00000
##
## Month OperatingSystems Browser Region TrafficType
## May :3328 2 :6536 2 :7878 1 :4711 2 :3907
## Nov :2983 1 :2548 1 :2426 3 :2382 1 :2383
## Mar :1853 3 :2530 4 : 730 4 :1168 3 :2017
## Dec :1706 4 : 478 5 : 466 2 :1127 4 :1066
## Oct : 549 8 : 75 6 : 174 6 : 800 13 : 728
## Sep : 448 6 : 19 10 : 163 7 : 758 10 : 450
## (Other):1332 (Other): 13 (Other): 362 (Other):1253 (Other):1648
##
## VisitorType Weekend Revenue
## New_Visitor : 1693 FALSE:9343 FALSE:10291
## Other : 81 TRUE :2856 TRUE : 1908
## Returning_Visitor:10425
##
##
##
##
```

```
# We'll now get the mode of our columns by creating a function to calculate the mode.
```

```
getmode <- function(v){
  uniqv <- unique(v)
```

```

uniqv[which.max(tabulate(match(v,uniqv)))]
}

#Getting the mode of each of the continuous variables

getmode(ec_df$Administrative)

## [1] 0

getmode(ec_df$Administrative_Duration)

## [1] 0.0002941393

getmode(ec_df$Informational)

## [1] 0

getmode(ec_df$Informational_Duration)

## [1] 0.0003920992

getmode(ec_df$ProductRelated)

## [1] 1

getmode(ec_df$ProductRelated_Duration)

## [1] 1.563122e-05

getmode(ec_df$BounceRates)

## [1] 0

getmode(ec_df$ExitRates)

## [1] 0.2

getmode(ec_df$PageValues)

## [1] 0

getmode(ec_df$SpecialDay)

## [1] 0

```

The above output is the mode of each numerical column. The mode of most numerical columns is 0 except the Duration(time spent on each site), Exit Rates which has a mode of 0.2 and the Product Related which has a mode of 1.

This means most of the visitors did not visit different types of pages during a session hence the total time spent on these pages is 0 except for the product related page.

```
#Finding the measures of dispersion of numerical variables  
# Administrative
```

```
sd.Administrative <- sd(ec_df$Administrative)  
sd.Administrative
```

Measures of Dispersion

```
## [1] 3.330851
```

```
var.Administrative <- var(ec_df$Administrative)  
var.Administrative
```

```
## [1] 11.09457
```

```
range.Administrative <- range(ec_df$Administrative)  
range.Administrative
```

```
## [1] 0 27
```

```
skew.Administrative <- skewness(ec_df$Administrative)  
skew.Administrative
```

```
## [1] 1.946009
```

```
kurt.Administrative <- kurtosis(ec_df$Administrative)  
kurt.Administrative
```

```
## [1] 4.634854
```

```
# Administrative Duration
```

```
sd.Administrative_Duration <- sd(ec_df$Administrative_Duration)  
sd.Administrative_Duration
```

```
## [1] 0.05221801
```

```
var.Administrative_Duration <- var(ec_df$Administrative_Duration)  
var.Administrative_Duration
```

```
## [1] 0.00272672
```

```

range.Administrative_Duration <- range(ec_df$Administrative_Duration)
range.Administrative_Duration

## [1] 0 1

skew.Administrative_Duration <- skewness(ec_df$Administrative_Duration)
skew.Administrative_Duration

## [1] 5.589523

kurt.Administrative_Duration <- kurtosis(ec_df$Administrative_Duration)
kurt.Administrative_Duration

## [1] 50.08518

# Informational

sd.Informational <- sd(ec_df$Informational)
sd.Informational

## [1] 1.275817

var.Informational <- var(ec_df$Informational)
var.Informational

## [1] 1.62771

range.Informational <- range(ec_df$Informational)
range.Informational

## [1] 0 24

skew.Informational <- skewness(ec_df$Informational)
skew.Informational

## [1] 4.012958

kurt.Informational <- kurtosis(ec_df$Informational)
kurt.Informational

## [1] 26.63768

# Informational Duration

sd.Informational_Duration <- sd(ec_df$Informational_Duration)
sd.Informational_Duration

## [1] 0.05546576

```

```

var.Informational_Duration <- var(ec_df$Informational_Duration)
var.Informational_Duration

## [1] 0.003076451

range.Informational_Duration <- range(ec_df$Informational_Duration)
range.Informational_Duration

## [1] 0 1

skew.Informational_Duration <- skewness(ec_df$Informational_Duration)
skew.Informational_Duration

## [1] 7.536508

kurt.Informational_Duration <- kurtosis(ec_df$Informational_Duration)
kurt.Informational_Duration

## [1] 75.45122

# Product related

sd.ProductRelated <- sd(ec_df$ProductRelated)
sd.ProductRelated

## [1] 44.60091

var.ProductRelated <- var(ec_df$ProductRelated)
var.ProductRelated

## [1] 1989.241

range.ProductRelated <- range(ec_df$ProductRelated)
range.ProductRelated

## [1] 0 705

skew.ProductRelated <- skewness(ec_df$ProductRelated)
skew.ProductRelated

## [1] 4.331601

kurt.ProductRelated <- kurtosis(ec_df$ProductRelated)
kurt.ProductRelated

## [1] 31.04345

```

```

# Product Related Duration

sd.ProductRelated_Duration <- sd(ec_df$ProductRelated_Duration)
sd.ProductRelated_Duration

## [1] 0.03001081

var.ProductRelated_Duration <- var(ec_df$ProductRelated_Duration)
var.ProductRelated_Duration

## [1] 0.0009006489

range.ProductRelated_Duration <- range(ec_df$ProductRelated_Duration)
range.ProductRelated_Duration

## [1] 0 1

skew.ProductRelated_Duration <- skewness(ec_df$ProductRelated_Duration)
skew.ProductRelated_Duration

## [1] 7.250512

kurt.ProductRelated_Duration <- kurtosis(ec_df$ProductRelated_Duration)
kurt.ProductRelated_Duration

## [1] 136.5679

# Bounce Rates

sd.BounceRates <- sd(ec_df$BounceRates)
sd.BounceRates

## [1] 0.0454025

var.BounceRates <- var(ec_df$BounceRates)
var.BounceRates

## [1] 0.002061387

range.BounceRates <- range(ec_df$BounceRates)
range.BounceRates

## [1] 0.0 0.2

skew.BounceRates <- skewness(ec_df$BounceRates)
skew.BounceRates

## [1] 3.152486

```

```
kurt.BounceRates <- kurtosis(ec_df$BounceRates)
kurt.BounceRates
```

```
## [1] 9.253055
```

```
# Exit Rates
```

```
sd.ExitRates <- sd(ec_df$ExitRates)
sd.ExitRates
```

```
## [1] 0.04624716
```

```
var.ExitRates <- var(ec_df$ExitRates)
var.ExitRates
```

```
## [1] 0.0021388
```

```
range.ExitRates <- range(ec_df$ExitRates)
range.ExitRates
```

```
## [1] 0.0 0.2
```

```
skew.ExitRates <- skewness(ec_df$ExitRates)
skew.ExitRates
```

```
## [1] 2.232851
```

```
kurt.ExitRates <- kurtosis(ec_df$ExitRates)
kurt.ExitRates
```

```
## [1] 4.623003
```

```
# Page Values
```

```
sd.PageValues <- sd(ec_df$PageValues)
sd.PageValues
```

```
## [1] 18.65779
```

```
var.PageValues <- var(ec_df$PageValues)
var.PageValues
```

```
## [1] 348.1132
```

```
range.PageValues <- range(ec_df$PageValues)
range.PageValues
```

```
## [1] 0.0000 361.7637
```

```

skew.PageValues <- skewness(ec_df$PageValues)
skew.PageValues

## [1] 6.347882

kurt.PageValues <- kurtosis(ec_df$PageValues)
kurt.PageValues

## [1] 64.92917

# Special Day

sd.SpecialDay <- sd(ec_df$SpecialDay)
sd.SpecialDay

## [1] 0.1997106

var.SpecialDay <- var(ec_df$SpecialDay)
var.SpecialDay

## [1] 0.03988432

range.SpecialDay <- range(ec_df$SpecialDay)
range.SpecialDay

## [1] 0 1

skew.SpecialDay <- skewness(ec_df$SpecialDay)
skew.SpecialDay

## [1] 3.284077

kurt.SpecialDay <- kurtosis(ec_df$SpecialDay)
kurt.SpecialDay

## [1] 9.783958

```

The standard deviation, variance, skewness and kurtosis of each numeric variable is as listed in the above outputs.

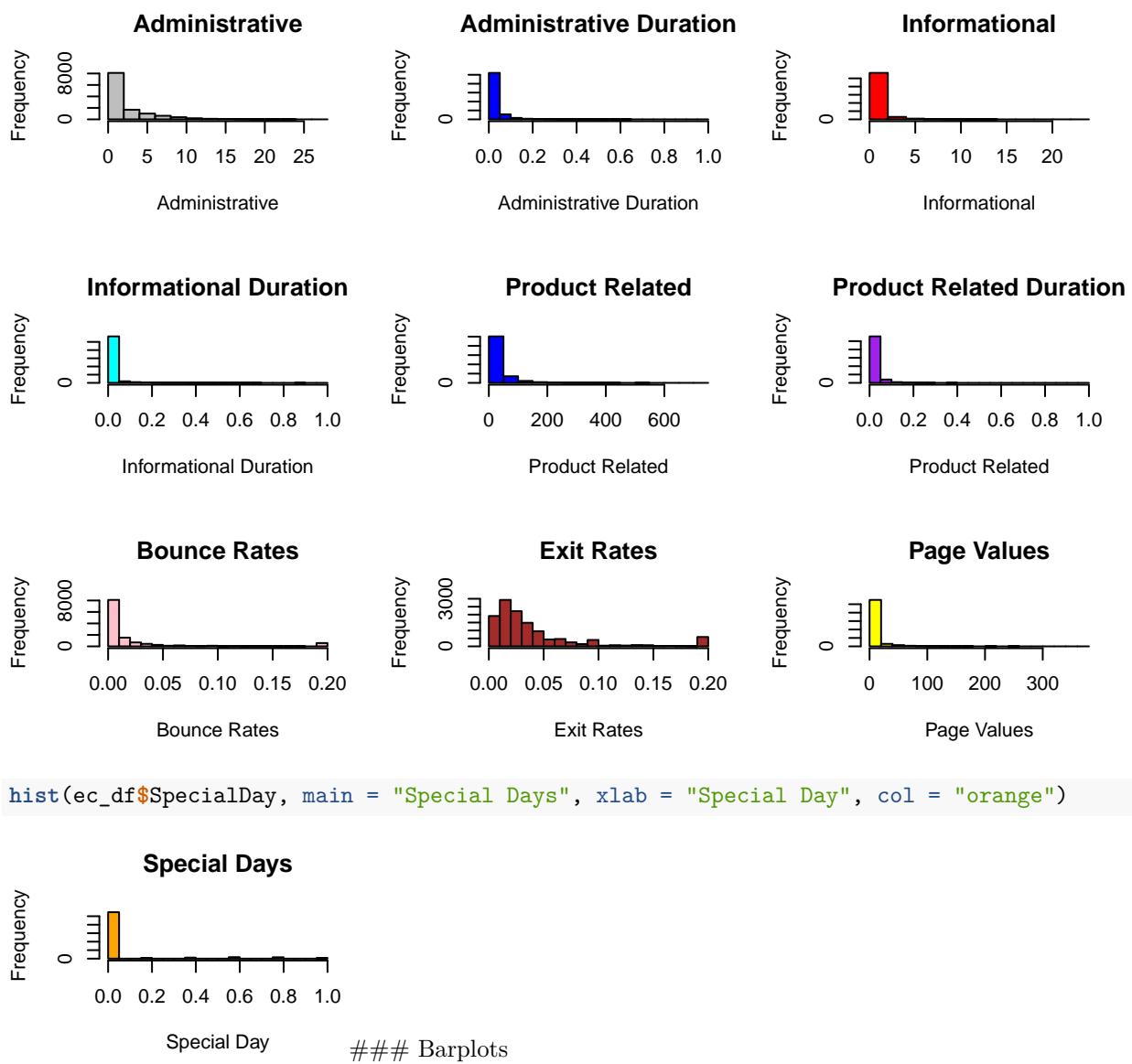
All the numeric variables are positively skewed implying their mean is greater than their mode.

The kurtosis of each of the numeric variable is greater than zero. This implies that our dataframe has outliers as we had seen in the boxplots plotted. The ProductRelated_Duration has a very high kurtosis implying that this column is heavy without outliers.

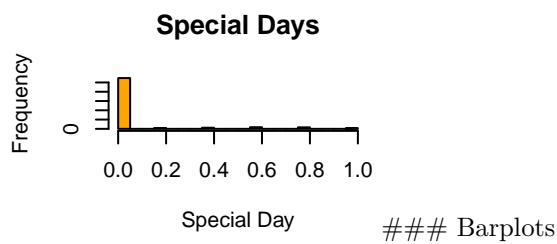
Histograms

```
## We'll plot histograms of each of the numerical data types to see their distribution.
```

```
#Plotting a histogram for the first 6 numerical variables
par(mfrow=c(3,3))
hist(ec_df$Administrative, main = "Administrative", xlab = "Administrative" ,col = "grey")
hist(ec_df$Administrative_Duration, main = "Administrative Duration", xlab = "Administrative Duration",
hist(ec_df$Informational, main = "Informational", xlab = "Informational", col = "red")
hist(ec_df$Informational_Duration, main = "Informational Duration", xlab = "Informational Duration", col = "green")
hist(ec_df$ProductRelated, main = "Product Related", xlab = "Product Related", col = "blue")
hist(ec_df$ProductRelated_Duration, main = "Product Related Duration", xlab = "Product Related" ,col = "orange")
hist(ec_df$BounceRates, main = "Bounce Rates", xlab = "Bounce Rates" ,col = "pink")
hist(ec_df$ExitRates, main = "Exit Rates", xlab = "Exit Rates", col = "brown")
hist(ec_df$PageValues, main = "Page Values", xlab = "Page Values", col = "yellow")
```

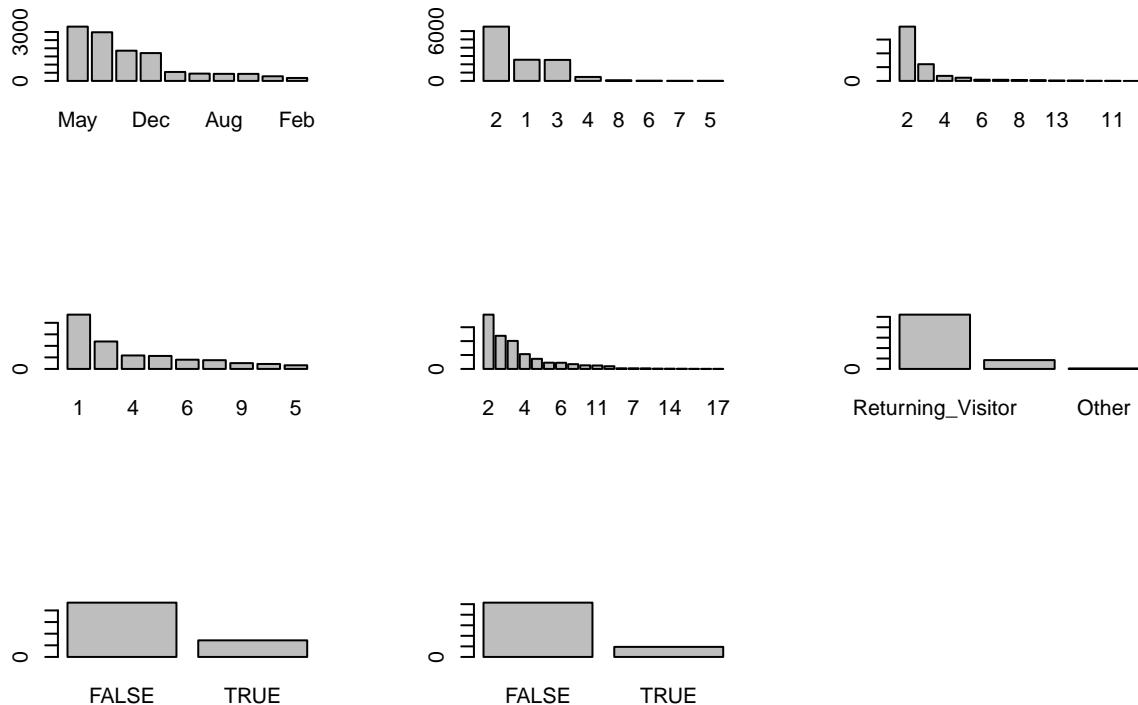


```
hist(ec_df$SpecialDay, main = "Special Days", xlab = "Special Day", col = "orange")
```



```
# We'll plot barplots of each of the categorical data types to see their distribution as well.
```

```
par(mfrow=c(3,3))
barplot(sort(table(ec_df$Month),decreasing=T))
barplot(sort(table(ec_df$OperatingSystems),decreasing=T))
barplot(sort(table(ec_df$Browser),decreasing=T))
barplot(sort(table(ec_df$Region),decreasing=T))
barplot(sort(table(ec_df$TrafficType),decreasing=T))
barplot(sort(table(ec_df$VisitorType),decreasing=T))
barplot(sort(table(ec_df$Weekend),decreasing=T))
barplot(sort(table(ec_df$Revenue),decreasing=T))
```

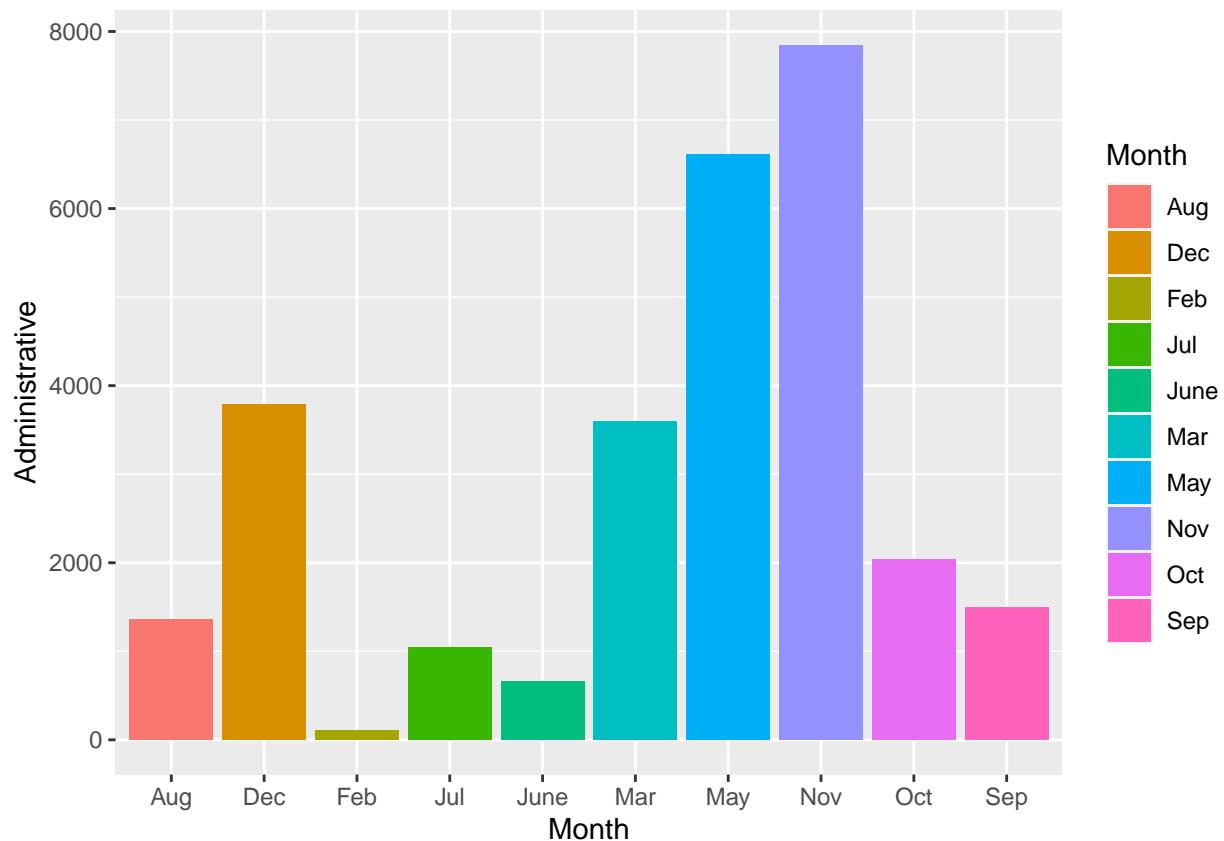


Majority of the data is from May, uses operating system 2, browser 2, traffic type 2 and are returning visitors to the site adding to which do not give revenue.

Bivariate Analysis

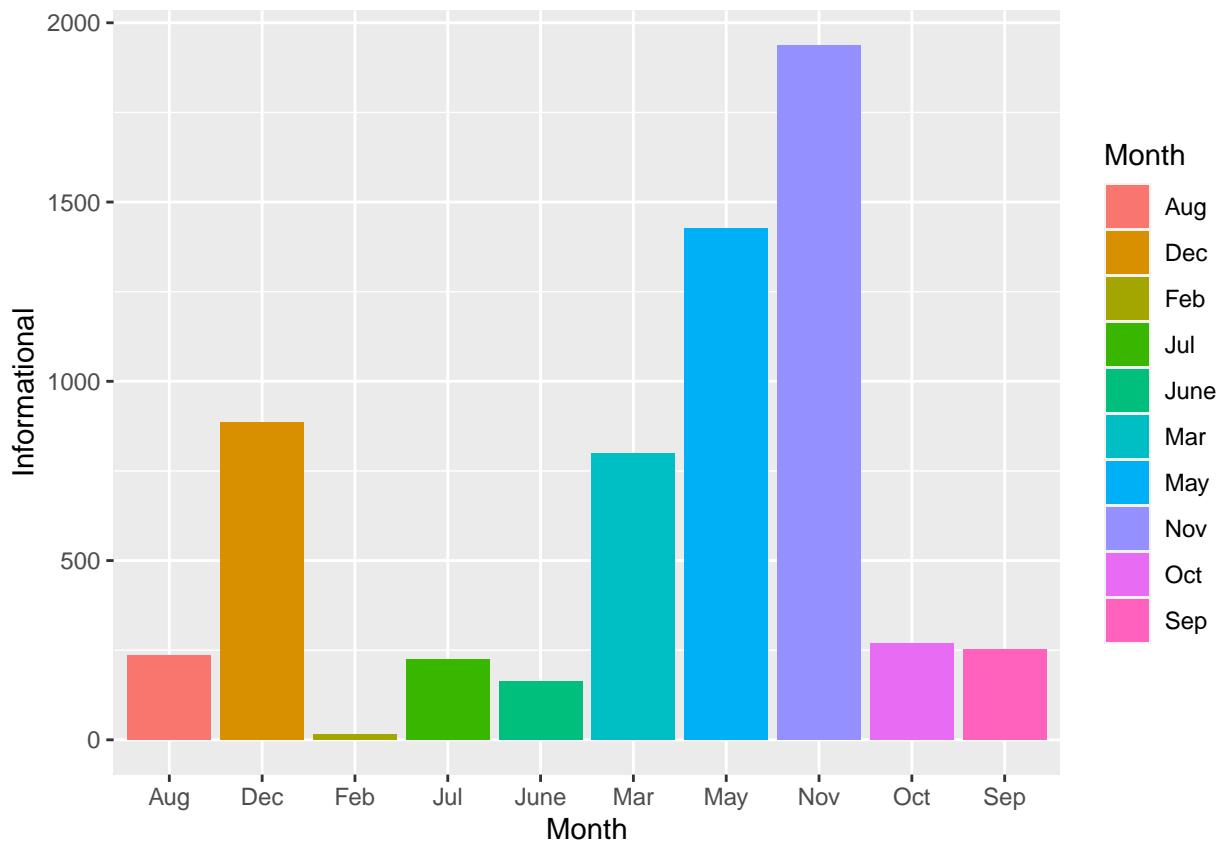
Barplots

```
# We'll plot bar plots to visualize how the numeric variables are distributed amongst the months.
# Administrative vs Month
ggplot(data = ec_df, aes(x = Month, y = Administrative)) + geom_col(aes(fill = Month))
```



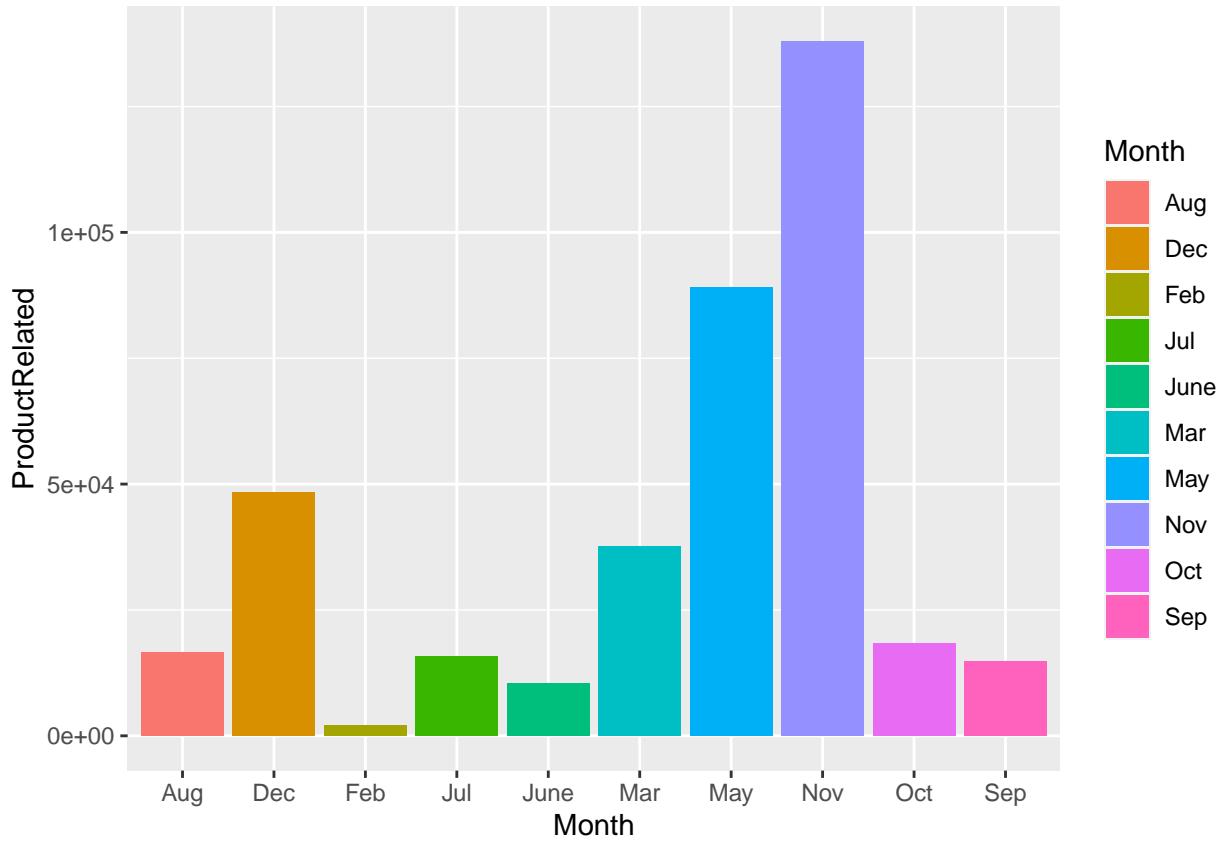
```
# Informational vs Month
```

```
ggplot(data = ec_df, aes(x = Month, y = Informational)) + geom_col(aes(fill = Month))
```



```
# Product Related Vs Month
```

```
ggplot(data = ec_df, aes(x = Month, y = ProductRelated)) + geom_col(aes(fill = Month))
```



November seems to be the month where most Numeric variables are distributed followed by May and February which have the least.

```
# The correlation of each numeric variable will help in understanding the association of these random variables
correlation <- round(cor(select_if(ec_df, is.numeric)), 2)
head(correlation)
```

Correlation

```
##                                     Administrative Administrative_Duration Informational
## Administrative                           1.00                      0.60          0.38
## Administrative_Duration                  0.60                      1.00          0.30
## Informational                          0.38                      0.30          1.00
## Informational_Duration                 0.25                      0.24          0.62
## ProductRelated                         0.43                      0.29          0.37
## ProductRelated_Duration                 0.37                      0.35          0.39
##                                     Informational_Duration ProductRelated
## Administrative                           0.25                      0.43
## Administrative_Duration                  0.24                      0.29
## Informational                          0.62                      0.37
## Informational_Duration                 1.00                      0.28
## ProductRelated                         0.28                      1.00
## ProductRelated_Duration                 0.35                      0.86
##                                     ProductRelated_Duration BounceRates ExitRates
```

```

## Administrative          0.37      -0.21      -0.31
## Administrative_Duration 0.35      -0.14      -0.20
## Informational           0.39      -0.11      -0.16
## Informational_Duration 0.35      -0.07      -0.10
## ProductRelated          0.86      -0.19      -0.29
## ProductRelated_Duration 1.00      -0.17      -0.25
##                               PageValues  SpecialDay
## Administrative           0.10      -0.10
## Administrative_Duration  0.07      -0.07
## Informational            0.05      -0.05
## Informational_Duration  0.03      -0.03
## ProductRelated           0.05      -0.03
## ProductRelated_Duration  0.05      -0.04

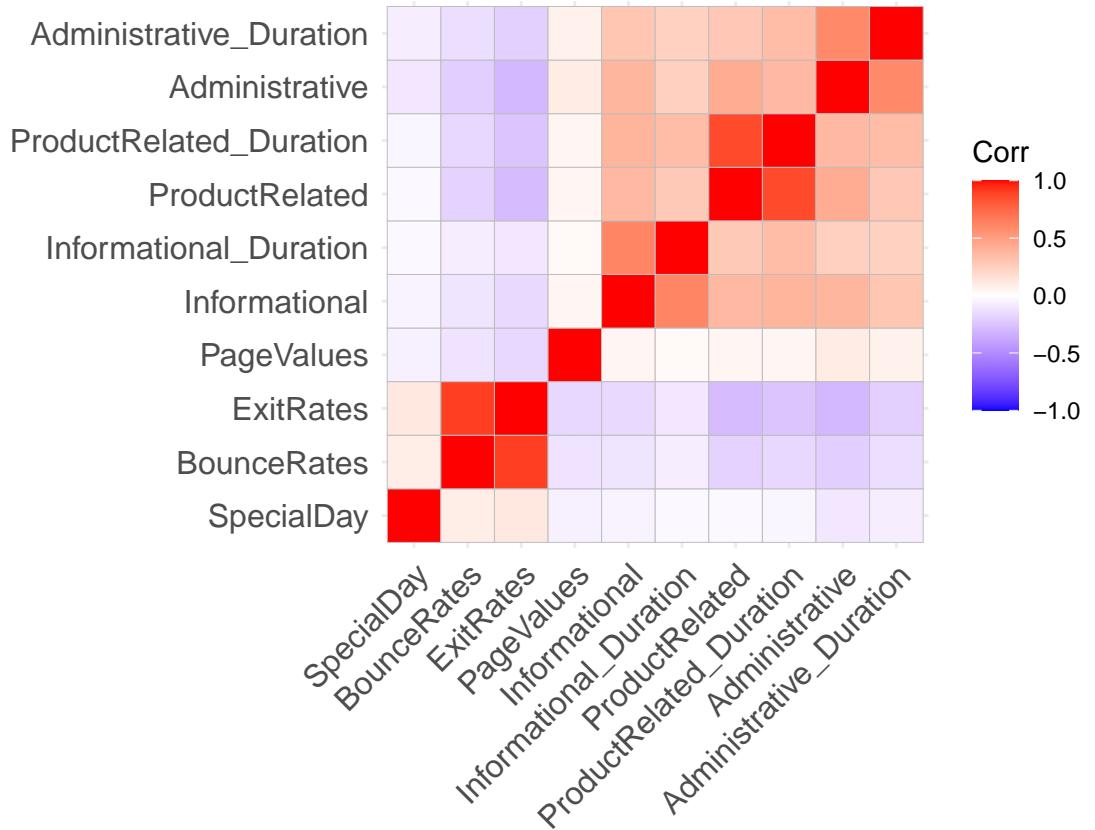
```

```

# We'll plot a heatmap to visualize the correlation matrix of our numeric variables.

ggcorrplot(correlation, hc.order = T)

```



Correlation Heat Map

Most variables are positively correlated with each other except the Bounce Rates and Special Day which are negatively correlated with all the other variables.

9. Implementing The Solution

We'll perform clustering stating insights drawn from your analysis and visualizations upon which we will provide comparisons between K-Means clustering vs Hierarchical clustering highlighting the strengths and limitations of each approach in the context of our analysis.

```
# We'll encode our categorical variables using one-hot (dummy) encoding which is applied to the feature
ec_df_new<- ec_df[,c(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17)]
ec_df.class<- ec_df[,"Revenue"]
# Creating a full set of dummy variables.
dmy <- dummyVars(~ ., data = ec_df_new, fullRank = T)
ec_df_dummy <- data.frame(predict(dmy, newdata = ec_df_new))
# Viewing the structure of our now encoded dataset
str(ec_df_dummy)
```



```
## 'data.frame':    12199 obs. of  68 variables:
##   $ Administrative          : num  0 0 0 0 0 0 0 1 0 0 ...
##   $ Administrative_Duration : num  0.000294 0.000294 0 0.000294 0.000294 ...
##   $ Informational           : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Informational_Duration : num  0.000392 0.000392 0 0.000392 0.000392 ...
##   $ ProductRelated          : num  1 2 1 2 10 19 1 1 2 3 ...
##   $ ProductRelated_Duration : num  1.56e-05 1.02e-03 0.00 5.73e-05 9.82e-03 ...
##   $ BounceRates              : num  0.2 0 0.2 0.05 0.02 ...
##   $ ExitRates                : num  0.2 0.1 0.2 0.14 0.05 ...
##   $ PageValues               : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ SpecialDay               : num  0 0 0 0 0 0 0.4 0 0.8 0.4 ...
##   $ Month.Dec                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.Feb                 : num  1 1 1 1 1 1 1 1 1 1 ...
##   $ Month.Jul                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.June                : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.Mar                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.May                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.Nov                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.Oct                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Month.Sep                 : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ OperatingSystems.2         : num  0 1 0 0 0 1 1 0 1 1 ...
##   $ OperatingSystems.3         : num  0 0 0 1 1 0 0 0 0 0 ...
##   $ OperatingSystems.4         : num  0 0 1 0 0 0 0 0 0 0 ...
##   $ OperatingSystems.5         : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ OperatingSystems.6         : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ OperatingSystems.7         : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ OperatingSystems.8         : num  0 0 0 0 0 0 0 0 0 0 ...
##   $ Browser.2                  : num  0 1 0 1 0 1 0 1 1 0 ...
##   $ Browser.3                  : num  0 0 0 0 1 0 0 0 0 0 ...
##   $ Browser.4                  : num  0 0 0 0 0 0 1 0 0 1 ...
##   $ Browser.5                  : num  0 0 0 0 0 0 0 0 0 0 ...
```

```

## $ Browser.6 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.7 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.8 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.9 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.10 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.11 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.12 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Browser.13 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.2 : num 0 0 0 1 0 0 0 0 1 0 ...
## $ Region.3 : num 0 0 0 0 0 0 1 0 0 0 ...
## $ Region.4 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.5 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.6 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.7 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.8 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ Region.9 : num 0 0 1 0 0 0 0 0 0 0 ...
## $ TrafficType.2 : num 0 1 0 0 0 0 0 0 0 1 ...
## $ TrafficType.3 : num 0 0 1 0 0 1 1 0 1 0 ...
## $ TrafficType.4 : num 0 0 0 1 1 0 0 0 0 0 ...
## $ TrafficType.5 : num 0 0 0 0 0 0 0 1 0 0 ...
## $ TrafficType.6 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.7 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.8 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.9 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.10 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.11 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.12 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.13 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.14 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.15 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.16 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.17 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.18 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.19 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TrafficType.20 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ VisitorType.Other : num 0 0 0 0 0 0 0 0 0 0 ...
## $ VisitorType.Returning_Visitor: num 1 1 1 1 1 1 1 1 1 1 ...
## $ Weekend.TRUE : num 0 0 0 0 1 0 0 1 0 0 ...

```

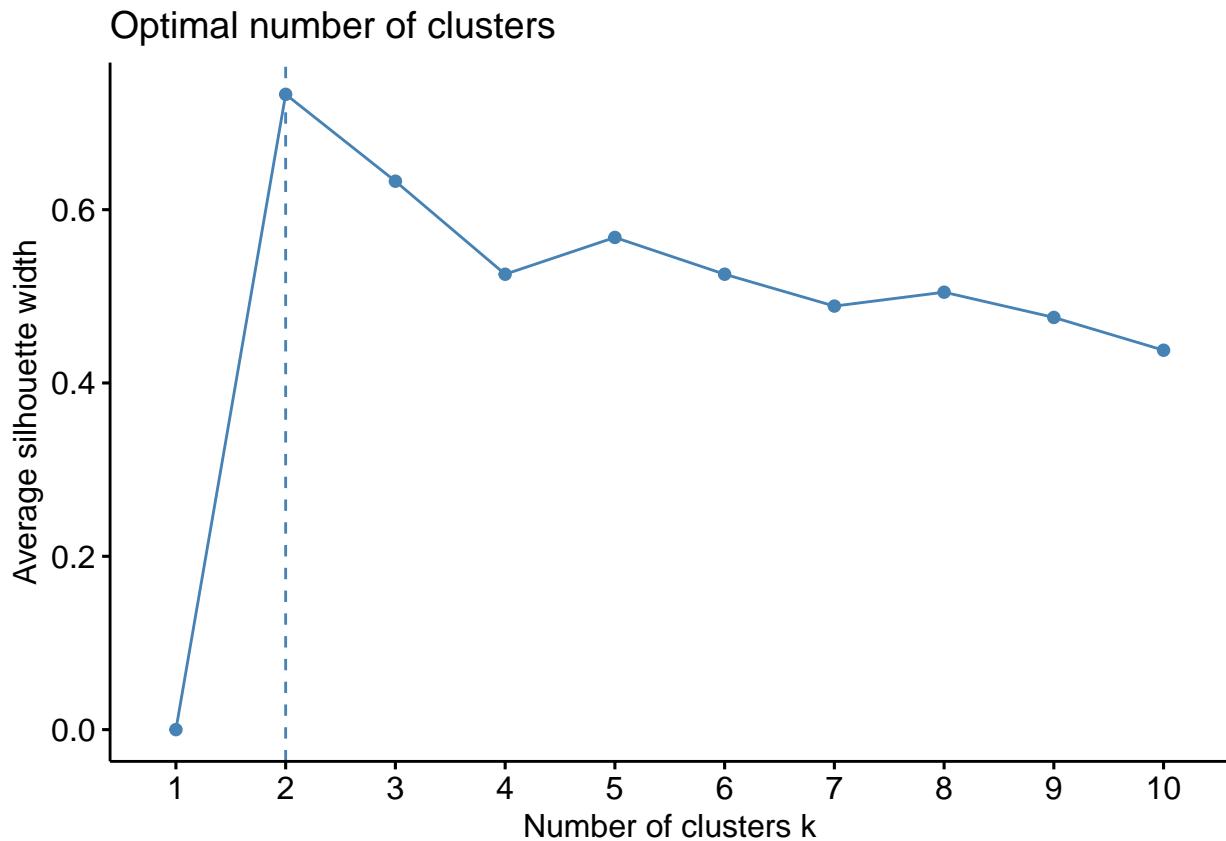
K-means Clustering

```

# Here, we'll perform K-Means clustering but before that we'll first find the optimal number of cluster

fviz_nbclust(ec_df_dummy, kmeans)

```



2 is the optimal number of clusters, therefore, we'll use 2 as our k.

```
#Computing k-means with k = 2
set.seed(123)
result <- kmeans(ec_df_dummy, 2)
#Previewing the no. of records in each cluster
result$size
```

```
## [1] 11211    988
```

```
"-----"
```

```
## [1] "-----"
```

```
# Getting the value of cluster center datapoint value(2 centers for k=2)
result$centers
```

```
##   Administrative Administrative_Duration Informational Informational_Duration
## 1      2.022032          0.02145295     0.3991615      0.01074667
## 2      5.948381          0.05685366     1.7530364      0.05155554
##   ProductRelated ProductRelated_Duration BounceRates ExitRates PageValues
## 1      21.89912          0.0132176 0.021728309 0.04352682  5.843768
## 2     147.33806          0.0832613 0.005904499 0.01846159  7.186305
##   SpecialDay Month.Dec Month.Feb Month.Jul Month.June Month.Mar Month.May
## 1 0.06313442 0.1422710 0.016055660 0.03434127 0.02274552 0.16251895 0.2820444
## 2 0.04878543 0.1123482 0.002024291 0.04757085 0.03036437 0.03137652 0.1680162
```

```

## Month.Nov Month.Oct Month.Sep OperatingSystems.2 OperatingSystems.3
## 1 0.2237981 0.04513424 0.03710641      0.5223441      0.2117563
## 2 0.4797571 0.04352227 0.03238866      0.6882591      0.1578947
## OperatingSystems.4 OperatingSystems.5 OperatingSystems.6 OperatingSystems.7
## 1          0.03906877    0.0005351887    0.001605566    0.0006243868
## 2          0.04048583    0.0000000000    0.001012146    0.0000000000
## OperatingSystems.8 Browser.2   Browser.3   Browser.4   Browser.5   Browser.6
## 1          0.006600660 0.6345553 0.009276603 0.06074391 0.03844438 0.01462849
## 2          0.001012146 0.7732794 0.001012146 0.04959514 0.03542510 0.01012146
## Browser.7   Browser.8   Browser.9   Browser.10  Browser.11  Browser.12
## 1 0.004103113 0.011952547 8.919811e-05 0.01329052 0.0005351887 0.0008919811
## 2 0.003036437 0.001012146 0.000000e+00 0.01417004 0.0000000000 0.0000000000
## Browser.13  Region.2   Region.3   Region.4   Region.5   Region.6   Region.7
## 1 0.004905896 0.09347962 0.1958790 0.09606636 0.02622424 0.06743377 0.06279547
## 2 0.001012146 0.07995951 0.1882591 0.09210526 0.02327935 0.04453441 0.05465587
## Region.8   Region.9   TrafficType.2  TrafficType.3  TrafficType.4  TrafficType.5
## 1 0.03585764 0.04192311 0.3119258 0.1691196 0.09026849 0.02256712
## 2 0.02935223 0.03542510 0.4149798 0.1224696 0.05465587 0.00708502
## TrafficType.6 TrafficType.7  TrafficType.8  TrafficType.9  TrafficType.10
## 1 0.03639283 0.003389528 0.02916778 0.003657122 0.03621443
## 2 0.03542510 0.002024291 0.01619433 0.0000000000 0.04453441
## TrafficType.11 TrafficType.12  TrafficType.13  TrafficType.14  TrafficType.15
## 1 0.02096156 8.919811e-05 0.05869236 0.0009811792 0.003121934
## 2 0.01214575 0.000000e+00 0.07085020 0.0020242915 0.001012146
## TrafficType.16 TrafficType.17  TrafficType.18  TrafficType.19  TrafficType.20
## 1 0.0002675943 8.919811e-05 0.0008919811 0.001427170 0.016769244
## 2 0.0000000000 0.000000e+00 0.0000000000 0.001012146 0.005060729
## VisitorType.Other VisitorType.Returning_Visitor Weekend.TRUE
## 1          0.007135849           0.8436357     0.2335206
## 2          0.001012146           0.9787449     0.2408907

```

```

## [1] "-----"

```

```

#Getting the cluster vector that shows the cluster where each record falls
result$cluster

```

```

## 1   2   3   4   5   6   7   8   9   10  11  12  13
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 14  15  16  17  18  19  20  21  22  23  24  25  26
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 27  28  29  30  31  32  33  34  35  36  37  38  39
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 40  41  42  43  44  45  46  47  48  49  50  51  52
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 53  54  55  56  57  58  59  60  61  62  63  64  65
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 66  67  68  69  70  71  72  73  74  75  76  77  78
## 1   2   1   1   1   1   1   1   1   1   1   1   1
## 79  80  81  82  83  84  85  86  87  88  89  90  91
## 1   1   1   1   1   1   1   1   1   1   1   1   1
## 92  93  94  95  96  97  98  99  100 101 102 103 104

```

| | | | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 157 | 158 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 180 | 181 | 182 | 183 | 184 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | |
| ## | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| ## | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | |
| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | |
| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 458 | 459 | |

| | | | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 485 | 486 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | |
| ## | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 553 | 554 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| ## | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 591 | 592 | 593 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | |
| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 659 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | |
| ## | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 776 | 777 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| ## | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | |

| | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 869 | 870 | 871 | 872 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 891 | 892 | 893 | 894 | 895 | 896 |
| ## | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 |
| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 |
| ## | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 |
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| ## | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1017 | 1018 | 1019 | 1020 | 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1030 | 1031 | 1032 | 1033 | 1034 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 | 1051 | 1052 | 1053 | 1054 | 1055 | 1056 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1067 | 1068 | 1069 | 1070 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 | 1081 | 1082 | 1083 |
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| ## | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1110 | 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1121 | 1122 | 1123 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1168 | 1169 | 1170 | 1172 | 1173 | 1174 | 1175 | 1176 | 1178 | 1179 | 1180 | 1181 | 1182 |

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##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1183 1184 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1209 1210 1211 1212 1213 1216 1217 1218 1219 1220 1221 1222 1223
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1224 1225 1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1237 1238 1239 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262
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## 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1289 1290 1291 1293 1294 1295 1296 1297 1298 1299 1300 1301 1302
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## 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313 1314 1315
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1327 1328 1329
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342
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## 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
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## 1510 1511 1512 1513 1514 1515 1517 1518 1519 1520 1521 1522 1523
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1536
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549

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|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
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| ## | 1855 | 1856 | 1857 | 1858 | 1859 | 1860 | 1861 | 1862 | 1863 | 1864 | 1865 | 1866 | 1868 | | |
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| ## | 1869 | 1870 | 1871 | 1872 | 1873 | 1874 | 1875 | 1876 | 1877 | 1878 | 1879 | 1880 | 1881 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1882 | 1883 | 1884 | 1885 | 1886 | 1887 | 1888 | 1889 | 1890 | 1891 | 1892 | 1893 | 1894 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1895 | 1896 | 1897 | 1898 | 1899 | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | | |

| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1908 | 1909 | 1910 | 1911 | 1912 | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1921 | 1922 | 1923 | 1924 | 1925 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1935 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | 1948 | | |
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| ## | 1949 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | | |
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| ## | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | | |
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| ## | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | | |
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| ## | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | | |
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| ## | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2041 | 2042 | 2043 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | | |
| ## | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | |
| ## | 2098 | 2099 | 2100 | 2101 | 2102 | 2103 | 2104 | 2105 | 2106 | 2107 | 2108 | 2109 | 2110 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | | |
| ## | 2111 | 2112 | 2113 | 2114 | 2115 | 2116 | 2117 | 2118 | 2119 | 2120 | 2121 | 2122 | 2123 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| ## | 2124 | 2125 | 2126 | 2127 | 2128 | 2129 | 2130 | 2131 | 2132 | 2133 | 2134 | 2135 | 2136 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | | |
| ## | 2137 | 2138 | 2139 | 2140 | 2141 | 2142 | 2143 | 2144 | 2145 | 2146 | 2147 | 2148 | 2149 | | |
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| ## | 2150 | 2151 | 2152 | 2153 | 2154 | 2155 | 2156 | 2157 | 2158 | 2159 | 2160 | 2161 | 2162 | | |
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| ## | 2163 | 2164 | 2165 | 2166 | 2167 | 2168 | 2169 | 2170 | 2171 | 2172 | 2173 | 2174 | 2175 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| ## | 2176 | 2177 | 2178 | 2179 | 2180 | 2181 | 2182 | 2183 | 2184 | 2185 | 2186 | 2187 | 2188 | | |
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| ## | 2202 | 2203 | 2204 | 2205 | 2206 | 2207 | 2208 | 2209 | 2210 | 2211 | 2212 | 2213 | 2214 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| ## | 2215 | 2216 | 2217 | 2218 | 2219 | 2220 | 2221 | 2222 | 2223 | 2224 | 2225 | 2226 | 2227 | | |
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| ## | 2228 | 2229 | 2230 | 2231 | 2232 | 2233 | 2234 | 2235 | 2237 | 2238 | 2239 | 2240 | 2241 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| ## | 2255 | 2256 | 2257 | 2258 | 2259 | 2260 | 2261 | 2262 | 2263 | 2264 | 2265 | 2266 | 2267 | | |

| | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| ## | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| ## | 2268 | 2269 | 2270 | 2271 | 2272 | 2273 | 2274 | 2275 | 2276 | 2277 | 2278 | 2279 | 2280 | |
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| ## | 2281 | 2282 | 2283 | 2284 | 2285 | 2286 | 2287 | 2288 | 2289 | 2290 | 2291 | 2292 | 2293 | |
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| ## | 2294 | 2295 | 2296 | 2297 | 2298 | 2299 | 2300 | 2301 | 2302 | 2303 | 2304 | 2305 | 2306 | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
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| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 4008 | 4009 | 4010 | 4011 | 4012 | 4013 | 4014 | 4015 | 4016 | 4017 | 4018 | 4019 | 4020 | | |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4099 | 4100 | 4101 | 4102 | 4103 | 4104 | 4105 | 4106 | 4107 | 4108 | 4109 | 4110 | 4111 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | | |
| ## | 4112 | 4113 | 4114 | 4115 | 4116 | 4117 | 4118 | 4119 | 4120 | 4121 | 4122 | 4123 | 4124 | | |
| ## | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | |
| ## | 4165 | 4166 | 4167 | 4168 | 4169 | 4170 | 4171 | 4172 | 4173 | 4174 | 4175 | 4176 | 4177 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4178 | 4179 | 4180 | 4181 | 4182 | 4184 | 4185 | 4186 | 4187 | 4188 | 4189 | 4190 | 4191 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4192 | 4193 | 4194 | 4195 | 4196 | 4197 | 4198 | 4199 | 4200 | 4201 | 4202 | 4203 | 4204 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4297 | 4298 | 4299 | 4300 | 4301 | 4302 | 4303 | 4304 | 4305 | 4306 | 4307 | 4308 | 4309 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 4363 | 4364 | 4365 | 4366 | 4367 | 4368 | 4369 | 4370 | 4371 | 4372 | 4373 | 4374 | 4376 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4377 | 4378 | 4379 | 4380 | 4381 | 4382 | 4383 | 4384 | 4385 | 4386 | 4387 | 4388 | 4389 | | |

| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | | |
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| ## | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
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| ## | 6762 | 6763 | 6764 | 6765 | 6766 | 6767 | 6768 | 6769 | 6770 | 6771 | 6772 | 6773 | 6774 | | |
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| ## | 6827 | 6828 | 6829 | 6830 | 6831 | 6832 | 6833 | 6834 | 6835 | 6836 | 6837 | 6838 | 6839 | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
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| | | | | | | | | | | | | | | |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| ## | 6866 | 6867 | 6868 | 6869 | 6870 | 6871 | 6872 | 6873 | 6874 | 6875 | 6876 | 6877 | 6878 | |
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| ## | 7206 | 7207 | 7208 | 7209 | 7210 | 7211 | 7212 | 7213 | 7214 | 7215 | 7216 | 7217 | 7218 | |

| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 7401 | 7402 | 7403 | 7404 | 7405 | 7406 | 7407 | 7408 | 7409 | 7410 | 7411 | 7412 | 7413 | | |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
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| ## | 7883 | 7884 | 7885 | 7886 | 7887 | 7888 | 7889 | 7890 | 7891 | 7892 | 7893 | 7894 | 7895 | | |
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| ## | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| ## | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|---|
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| ## | 8351 | 8352 | 8353 | 8354 | 8355 | 8356 | 8357 | 8358 | 8359 | 8360 | 8361 | 8362 | 8363 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| ## | 8364 | 8365 | 8366 | 8367 | 8368 | 8369 | 8370 | 8371 | 8372 | 8373 | 8374 | 8375 | 8376 | | |
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| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
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| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| ## | 8403 | 8404 | 8405 | 8406 | 8407 | 8408 | 8409 | 8410 | 8411 | 8412 | 8413 | 8414 | 8415 | | |
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | |
| ## | 8429 | 8430 | 8431 | 8432 | 8433 | 8434 | 8435 | 8436 | 8437 | 8438 | 8439 | 8440 | 8441 | | |
| ## | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | |
| ## | 8442 | 8443 | 8444 | 8445 | 8446 | 8447 | 8448 | 8449 | 8450 | 8451 | 8452 | 8453 | 8454 | | |
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| ## | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
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| ## | 8612 | 8613 | 8614 | 8615 | 8616 | 8617 | 8618 | 8619 | 8620 | 8621 | 8622 | 8623 | 8624 | | |

| | | | | | | | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|---|
| ## | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
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| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | |
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## 10156 10157 10158 10159 10160 10161 10162 10163 10164 10165 10166 10167 10168
##      1      1      1      2      2      1      1      1      1      1      1      1      1      1      1
## 10169 10170 10171 10172 10173 10174 10175 10176 10177 10178 10179 10180 10181
##      2      1      2      2      2      1      1      2      2      1      1      1      1      1      1
## 10182 10183 10184 10185 10186 10187 10188 10189 10190 10191 10192 10193 10194
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 10195 10196 10197 10198 10199 10200 10201 10202 10203 10204 10205 10206 10207
##      1      2      1      1      2      1      1      1      2      1      1      2      1      2      2
## 10208 10209 10210 10211 10212 10213 10214 10215 10216 10217 10218 10219 10220
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 10221 10222 10224 10225 10226 10227 10228 10229 10230 10231 10232 10233 10234
##      1      1      1      1      2      1      1      1      2      1      1      1      1      1      1
## 10235 10236 10237 10238 10239 10240 10241 10242 10243 10244 10245 10246 10247
##      1      1      1      1      2      1      1      1      2      1      2      1      2      1      1
## 10248 10249 10250 10251 10252 10253 10254 10255 10256 10257 10258 10259 10260
##      1      1      1      1      2      1      1      1      2      1      1      1      1      1      1
## 10261 10262 10263 10264 10265 10266 10267 10268 10269 10271 10272 10273 10274
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## 10288 10289 10290 10291 10292 10293 10294 10295 10296 10297 10298 10299 10300
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##      1      2      1      1      2      1      1      1      1      1      1      1      1      1      1
## 10314 10315 10316 10317 10318 10319 10320 10321 10322 10323 10324 10325 10326
##      2      1      1      1      1      2      2      1      1      1      1      1      1      1      1
## 10327 10328 10329 10330 10331 10332 10333 10334 10335 10336 10337 10338 10339
##      1      1      1      1      1      1      1      1      1      1      1      2      1      1      1
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## 10379 10380 10381 10382 10383 10384 10385 10386 10387 10388 10389 10390 10391

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##      1      1      1      2      1      1      1      1      1      1      1      1      1      1      1
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##      1      1      1      1      1      1      1      1      1      1      1      2      1      1      1
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##      1      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 10535 10536 10537 10538 10539 10540 10541 10542 10543 10544 10545 10546 10547
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## 10548 10549 10550 10551 10552 10553 10554 10555 10556 10557 10558 10559 10560
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## 10667 10668 10669 10670 10671 10672 10673 10674 10675 10676 10677 10678 10679
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## 10693 10694 10695 10696 10697 10698 10699 10700 10701 10702 10703 10704 10705
##      2      1      1      1      1      1      1      1      1      1      1      1      1      1      1
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## 10719 10720 10721 10722 10723 10724 10725 10726 10727 10728 10729 10730 10731
##      1      1      2      1      1      1      1      1      1      1      1      1      1      1      1
## 10732 10733 10734 10735 10736 10737 10738 10739 10740 10741 10742 10743 10744

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##   1   2   1   2   1   1   1   1   1   1   1   1   1   1   1
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## 10772 10773 10774 10775 10776 10777 10778 10779 10780 10781 10782 10783 10784
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## 10825 10826 10827 10828 10829 10830 10831 10832 10833 10834 10835 10836 10837
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## 10930 10931 10932 10933 10934 10935 10936 10937 10938 10939 10940 10941 10942
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## 11745 11746 11747 11749 11750 11751 11752 11753 11754 11755 11756 11757 11758
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##      2      2      2      2      1      1      2      1      1      1      1      1      1      2      1
## 11866 11867 11868 11869 11870 11871 11872 11873 11874 11875 11876 11877 11878
##      1      2      1      1      1      1      2      1      1      1      1      1      1      1      1
## 11879 11880 11881 11882 11883 11884 11885 11886 11887 11888 11889 11890 11891
##      1      1      1      1      1      1      1      1      1      1      1      2      1      1
## 11892 11893 11894 11895 11896 11897 11898 11899 11900 11901 11902 11903 11904
##      1      1      1      1      2      1      1      1      1      1      1      2      1      1
## 11905 11906 11907 11908 11909 11910 11911 11912 11913 11914 11915 11916 11917
##      2      2      1      2      1      1      1      1      2      1      1      1      1      2
## 11918 11919 11920 11921 11922 11923 11924 11925 11926 11927 11928 11929 11930
##      2      1      1      2      1      2      1      1      1      1      1      1      1      1
## 11931 11932 11933 11934 11936 11937 11938 11940 11941 11942 11943 11944 11945
##      1      2      1      1      1      2      1      1      1      1      1      1      1      1
## 11946 11947 11948 11949 11950 11951 11952 11953 11954 11955 11956 11957 11958
##      1      1      1      1      2      1      1      1      1      1      1      1      1      1
## 11959 11960 11961 11962 11963 11964 11965 11966 11967 11968 11969 11970 11971
##      1      1      1      2      1      1      1      2      1      1      1      1      1      1
## 11972 11973 11974 11975 11976 11977 11978 11979 11980 11981 11982 11983 11984
##      1      1      1      1      1      1      2      1      1      1      1      1      1      1
## 11985 11986 11987 11988 11989 11990 11991 11992 11993 11994 11995 11996 11997
##      1      1      2      1      2      1      1      1      2      1      1      2      1      1
## 11998 11999 12000 12001 12002 12003 12004 12005 12006 12007 12008 12009 12010
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 12011 12012 12013 12014 12015 12016 12017 12018 12019 12020 12021 12022 12023
##      1      1      1      1      1      1      1      1      1      2      1      1      1      1
## 12024 12025 12026 12027 12028 12029 12030 12031 12032 12033 12034 12035 12036
##      1      1      1      1      2      1      1      1      1      1      1      1      1      1
## 12037 12038 12039 12040 12041 12042 12043 12044 12045 12046 12047 12048 12049
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 12050 12051 12052 12053 12054 12055 12056 12057 12058 12059 12060 12061 12062
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 12063 12064 12065 12066 12067 12068 12069 12070 12071 12072 12073 12074 12075
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 12076 12077 12078 12079 12080 12081 12082 12083 12084 12085 12086 12087 12088
##      1      1      1      1      1      1      1      1      1      1      1      1      1      1
## 12089 12090 12091 12092 12093 12094 12095 12096 12097 12098 12099 12100 12101
##      1      2      1      1      1      1      1      1      2      2      1      1      1      1
## 12102 12103 12104 12105 12106 12107 12108 12109 12110 12111 12112 12113 12114
##      1      2      1      1      1      2      1      1      1      1      1      1      1      1
## 12115 12116 12117 12118 12119 12120 12121 12122 12123 12124 12125 12126 12127
##      1      1      1      1      1      1      2      1      1      1      1      1      1      1
## 12128 12129 12130 12131 12132 12133 12134 12135 12136 12137 12138 12139 12140
##      1      1      2      1      1      1      1      1      1      1      1      1      1      2
## 12141 12142 12143 12144 12145 12146 12147 12148 12149 12150 12151 12152 12153
##      1      2      1      2      1      1      1      1      2      1      1      1      1      2
## 12154 12155 12156 12157 12158 12159 12161 12162 12163 12164 12165 12166 12167

```

```

##      1      1      1      1      1      1      1      2      1      1      1      1      1      2
## 12168 12169 12170 12171 12172 12173 12174 12175 12176 12177 12178 12179 12180
##      1      1      1      1      2      1      1      1      1      1      1      1      2      2
## 12182 12183 12184 12185 12187 12188 12189 12190 12191 12192 12193 12194 12195
##      1      1      1      1      1      1      2      1      2      2      2      1      1      1
## 12196 12197 12198 12199 12200 12201 12202 12203 12204 12205 12206 12207 12208
##      1      1      1      1      1      1      1      1      1      1      1      1      1      2
## 12209 12210 12211 12212 12213 12214 12215 12216 12217 12218 12219 12220 12221
##      1      1      1      1      1      1      1      1      1      2      1      1      1      1
## 12222 12223 12224 12225 12226 12227 12228 12229 12230 12231 12232 12233 12234
##      1      1      1      1      1      1      1      1      1      2      1      1      1      1
## 12235 12236 12237 12238 12239 12240 12241 12242 12243 12244 12245 12246 12247
##      1      1      2      2      1      1      1      1      1      1      1      2      1      1
## 12248 12249 12250 12251 12252 12253 12254 12255 12256 12257 12258 12259 12260
##      1      1      1      2      1      1      1      1      1      2      1      1      1      1
## 12261 12262 12263 12264 12265 12266 12267 12268 12269 12270 12271 12272 12273
##      2      1      1      1      1      1      1      1      1      1      1      2      1      1
## 12274 12275 12276 12277 12278 12279 12280 12281 12282 12283 12284 12285 12286
##      1      1      1      1      1      2      1      1      1      1      2      1      1      2
## 12287 12288 12289 12290 12291 12292 12293 12294 12295 12296 12297 12298 12299
##      1      2      1      1      1      1      1      1      1      1      1      1      1      1
## 12300 12301 12302 12303 12304 12305 12306 12307 12308 12309 12310 12311 12312
##      1      1      1      1      1      1      1      1      1      1      1      1      1      2
## 12313 12314 12315 12316 12317 12318 12319 12320 12321 12322 12323 12324 12325
##      2      1      1      1      1      1      2      1      1      1      1      1      1      1
## 12326 12327 12328 12329 12330
##      1      1      1      1      1

```

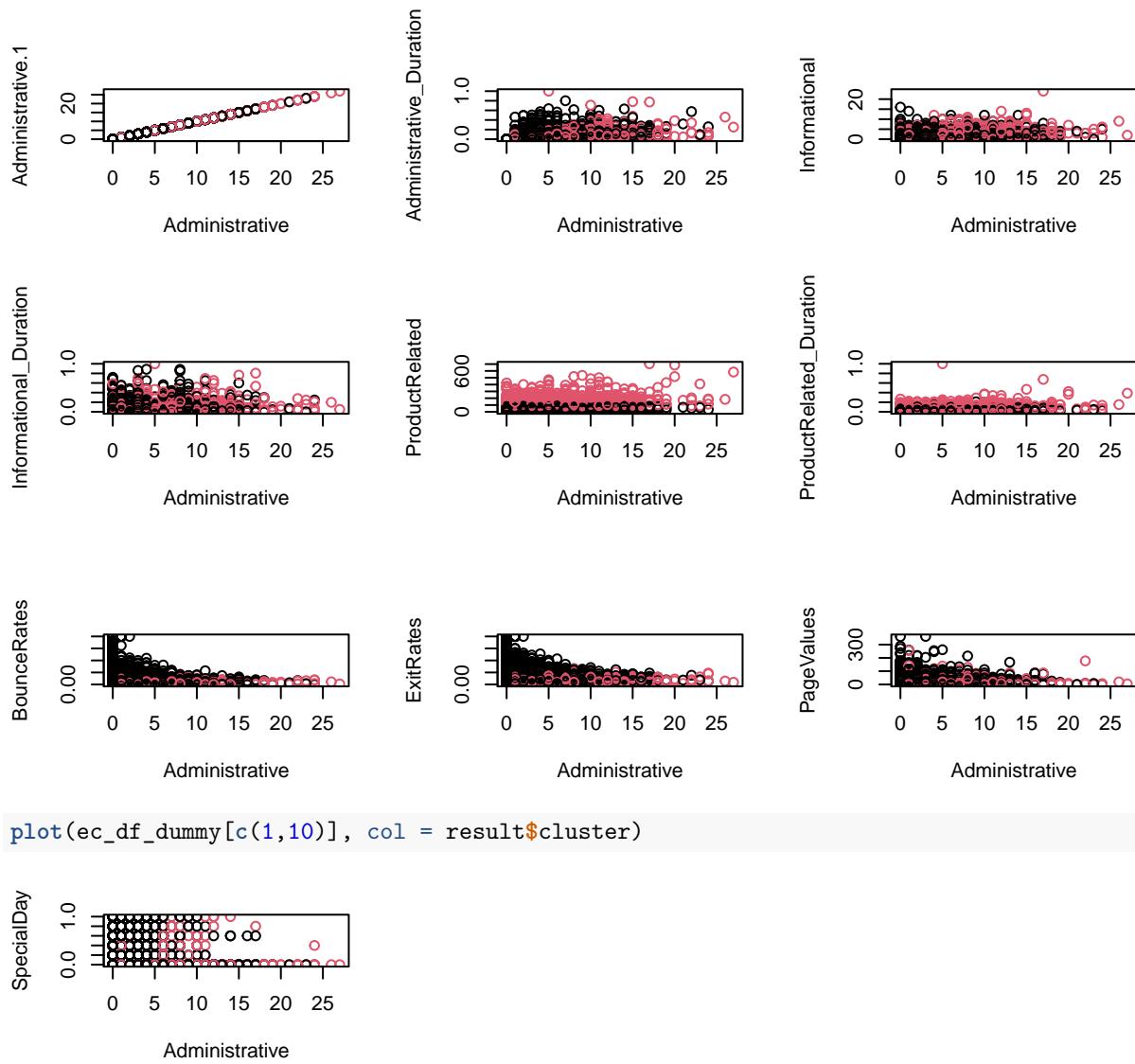
```
#Viewing the size of the cluster
```

```
result$size
```

```
## [1] 11211 988
```

```
# Visualizing how the data points of the numeric columns have been distributed
```

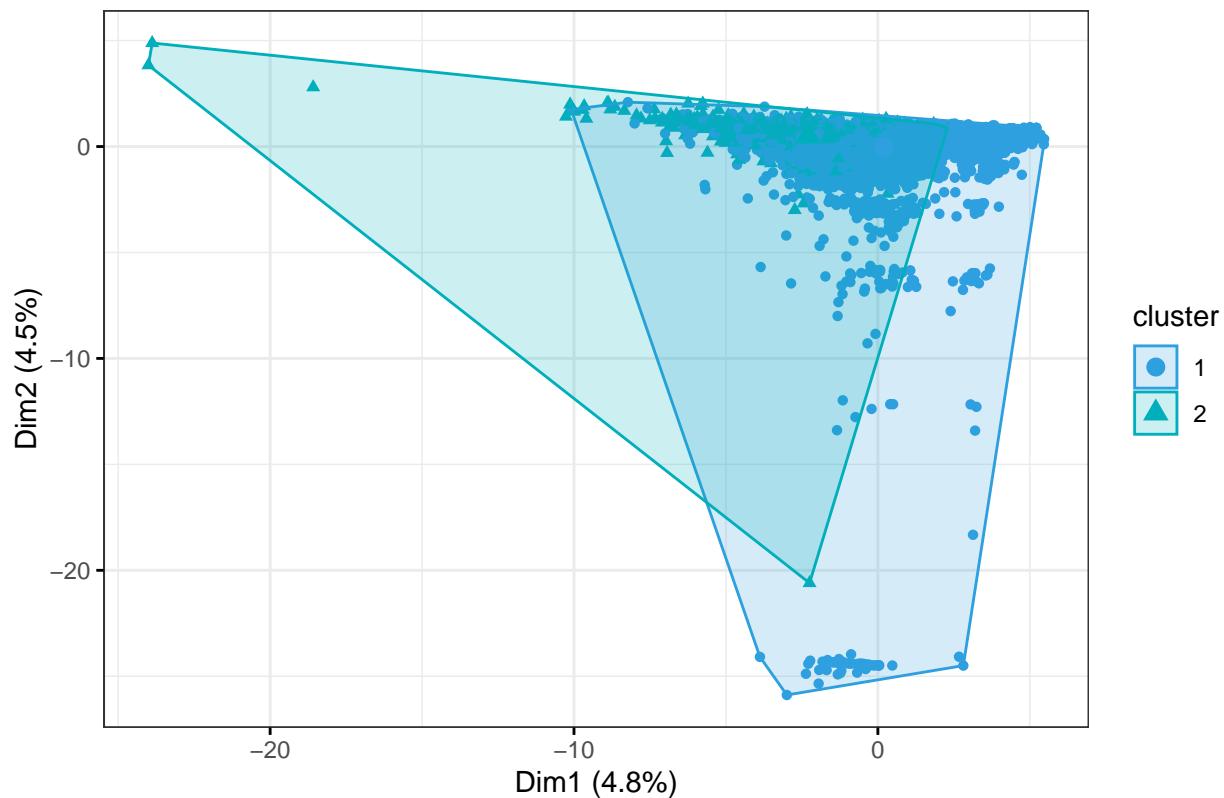
```
par(mfrow=c(3,3))
plot(ec_df_dummy[c(1,1)], col = result$cluster)
plot(ec_df_dummy[c(1,2)], col = result$cluster)
plot(ec_df_dummy[c(1,3)], col = result$cluster)
plot(ec_df_dummy[c(1,4)], col = result$cluster)
plot(ec_df_dummy[c(1,5)], col = result$cluster)
plot(ec_df_dummy[c(1,6)], col = result$cluster)
plot(ec_df_dummy[c(1,7)], col = result$cluster)
plot(ec_df_dummy[c(1,8)], col = result$cluster)
plot(ec_df_dummy[c(1,9)], col = result$cluster)
```



```
plot(ec_df_dummy[c(1,10)], col = result$cluster)
```

```
# Visualizing our results by using fviz_cluster
fviz_cluster(result, data = ec_df_dummy[, -5],
palette = c("#2E9FDF", "#00AFBB"),
geom = "point",
ellipse.type = "convex",
ggtheme = theme_bw()
)
```

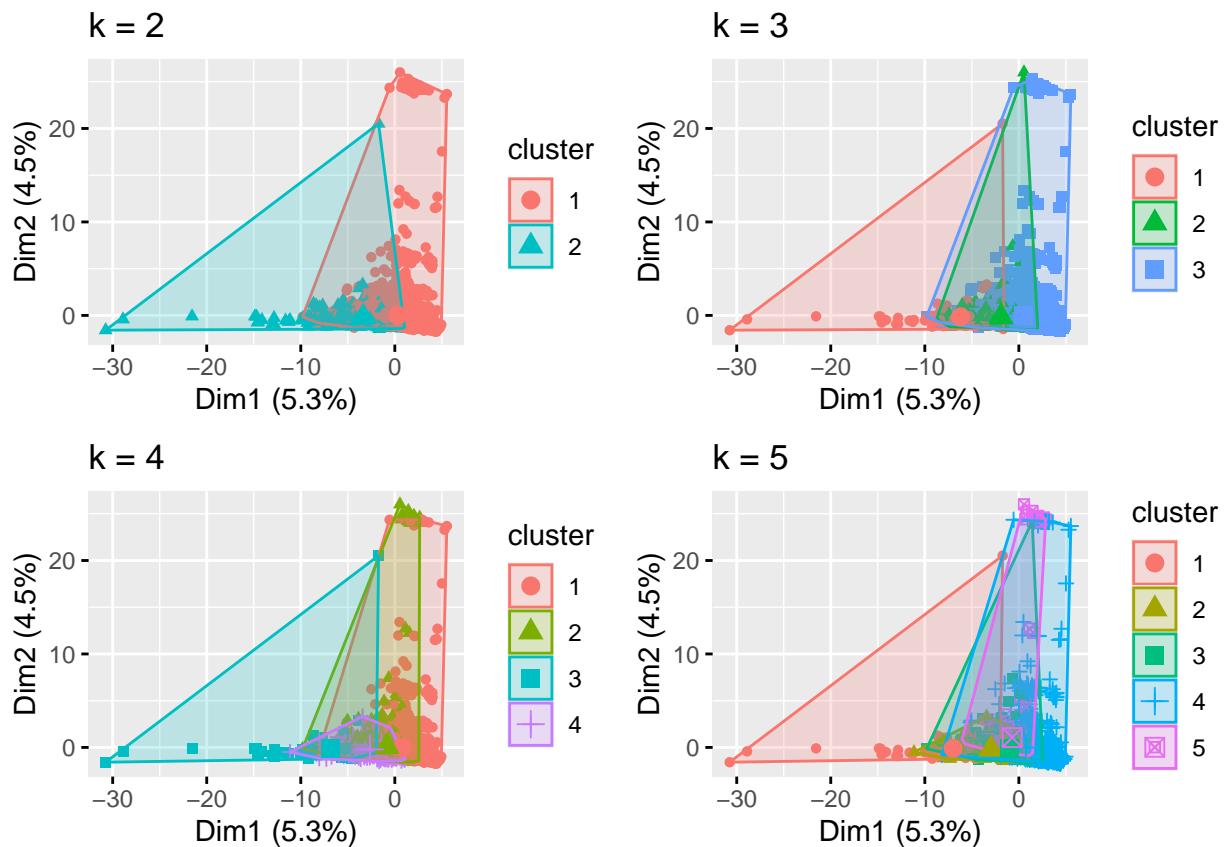
Cluster plot



```
#Using several different values of k and examining the differences in the results.
k3 <- kmeans(ec_df_dummy, 3)
k4 <- kmeans(ec_df_dummy, 4)
k5 <- kmeans(ec_df_dummy, 5)
```

```
# plots to compare
p1 <- fviz_cluster(result, geom = "point", data = ec_df_dummy) + ggtitle("k = 2")
p2 <- fviz_cluster(k3, geom = "point", data = ec_df_dummy) + ggtitle("k = 3")
p3 <- fviz_cluster(k4, geom = "point", data = ec_df_dummy) + ggtitle("k = 4")
p4 <- fviz_cluster(k5, geom = "point", data = ec_df_dummy) + ggtitle("k = 5")
```

```
grid.arrange(p1, p2, p3, p4, nrow = )
```



```
ec_tab <- table(result$cluster, ec_df.class)
ec_tab
```

This is a visual assessment that gives us different clusters and the the $k = 2$ proves to be the best in our case.

```
##     ec_df.class
##     FALSE TRUE
## 1    9588 1623
## 2    703   285

#Evaluating our model using the accuracy score
accuracy <- function(x){sum(diag(x))/(sum(rowSums(x)))* 100}
accuracy(ec_tab)
```

```
## [1] 80.93286
```

```
# We now use the R function hclust() for hierarchical clustering
# First we use the dist() function to compute the Euclidean distance between observations,
```

```

set.seed(500)
hcluster <- dist(ec_df_dummy, method = "euclidean")
#Performing hierarchical clustering using the Ward's method
res.hc <- hclust(hcluster, method = "ward.D2" )

#Plotting the obtained dendrogram
plot(res.hc, cex = 0.6, hang = -1)

```

Cluster Dendrogram



Hierachical Clustering

hcluster
hclust (*, "ward.D2")

Our model has achieved an accuracy of 80.93%

Challenging the solution

We will be able to see how many observations were assigned in each cluster by cutting the dendrogram in order to create the desired number of clusters then change the cluster results obtained back in the original dataframe under a column as we then count how many observations were assigned to each cluster in order to improve this model.

Conclusion and Recommendations

The K-means cluster is a more recommended model compared to the Hierarchical Clustering as we were able to find the optimal number of clusters by using the silhouette plot

The K-means is also less computationally expensive than hierarchical clustering and can be run on large datasets within a reasonable time frame as we have seen compared to the dendrogram from the hierarchical clustering.