Unsupervised

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Defining the Question

A. Specifying the Data Analytic Question

Determine customer's behavior from data collected

B. Defining the Metric for Success

Prediction will be considered a success when proper insights drawn from the analysis and visualization are given

c. Understanding Context

"Administrative", "Administrative Duration", "Informational", "Informational Duration", "Product Related" and "Product Related Duration" represents the number of different types of pages visited by the visitor in that session and total time spent in each of these page

"Bounce Rate" refers to the percentage of visitors who enter the site from that page and then leave

"Page Value" feature represents the average value for a web page that a user visited before completing an e-commerce transaction

"Special Day" feature indicates the closeness of the site visiting time to a specific special day

D. Experimental Design

Reading the data Checking the data Cleaning dataset Univariate Analysis Bivariate Analysis Implementing Solution Challenging Solution Conclusions

E. Data Relevance

The dataset for this project can be found here http://bit.ly/EcommerceCustomersDataset

2. Reading the Data

```r
library(readr)
library(caret)
```

```
## Loading required package: ggplot2

## Loading required package: lattice
```

```r
library(factoextra)
```

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

```r
library(ggplot2)
library(tidyverse)
```

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

## v tibble  3.1.6     v dplyr   1.0.8
## v tidyr   1.2.0     v stringr 1.4.0
## v purrr   0.3.4     v forcats 0.5.1

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

```r
library(dplyr)
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```r
library(e1071)
library(cluster)
library(kernlab)
```

```
##
## Attaching package: 'kernlab'

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

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

```r
library(tidyr)
library(tinytex)
```

```r
library(readr)
data <- read_csv("http://bit.ly/EcommerceCustomersDataset")
```

```
## Rows: 12330 Columns: 18
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (2): Month, VisitorType
## dbl (14): Administrative, Administrative_Duration, Informational, Informatio...
## lgl  (2): Weekend, Revenue
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
head(data)
```

```
## # A tibble: 6 x 18
##   Administrative Administrative_D~ Informational Informational_D~ ProductRelated
##            <dbl>             <dbl>         <dbl>            <dbl>          <dbl>
## 1              0                 0             0                0              1
## 2              0                 0             0                0              2
## 3              0                -1             0               -1              1
## 4              0                 0             0                0              2
## 5              0                 0             0                0             10
## 6              0                 0             0                0             19
## # ... with 13 more variables: ProductRelated_Duration <dbl>, BounceRates <dbl>,
## #   ExitRates <dbl>, PageValues <dbl>, SpecialDay <dbl>, Month <chr>,
## #   OperatingSystems <dbl>, Browser <dbl>, Region <dbl>, TrafficType <dbl>,
## #   VisitorType <chr>, Weekend <lgl>, Revenue <lgl>
```

3. Checking the Data

```r
# tail of dataset

head(data)
```


```
## # A tibble: 6 x 18
##   Administrative Administrative_D~ Informational Informational_D~ ProductRelated
##            <dbl>             <dbl>         <dbl>            <dbl>          <dbl>
## 1              0                 0             0                0              1
## 2              0                 0             0                0              2
## 3              0                -1             0               -1              1
## 4              0                 0             0                0              2
## 5              0                 0             0                0             10
## 6              0                 0             0                0             19
## # ... with 13 more variables: ProductRelated_Duration <dbl>, BounceRates <dbl>,
## #   ExitRates <dbl>, PageValues <dbl>, SpecialDay <dbl>, Month <chr>,
## #   OperatingSystems <dbl>, Browser <dbl>, Region <dbl>, TrafficType <dbl>,
## #   VisitorType <chr>, Weekend <lgl>, Revenue <lgl>
```

```r
# tail of dataset

tail(data)
```

```
## # A tibble: 6 x 18
##   Administrative Administrative_D~ Informational Informational_D~ ProductRelated
##            <dbl>             <dbl>         <dbl>            <dbl>          <dbl>
## 1              0                 0             1                0             16
## 2              3               145             0                0             53
## 3              0                 0             0                0              5
## 4              0                 0             0                0              6
## 5              4                75             0                0             15
## 6              0                 0             0                0              3
## # ... with 13 more variables: ProductRelated_Duration <dbl>, BounceRates <dbl>,
## #   ExitRates <dbl>, PageValues <dbl>, SpecialDay <dbl>, Month <chr>,
## #   OperatingSystems <dbl>, Browser <dbl>, Region <dbl>, TrafficType <dbl>,
## #   VisitorType <chr>, Weekend <lgl>, Revenue <lgl>
```

```r
#checking size of dataframe

dim(data)
```

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

There are 12330 records and 18 variables

```r
#cheking columns

colnames(data)
```

```
##  [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"
```

4. Cleaning dataset

```r
# Identifying missing data in dataset

colSums(is.na(data))
```

```
##          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
```

There is presence of missing values

```r
# Dropping null values
data <- na.omit(data)
colSums(is.na(data))
```

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

Rows with missing values have been removed, decided to remove them since I noticed that the missing values positions were exactly the same for each variable with missing data

```r
#checking size of dataframe

dim(data)
```

```
## [1] 12316    18
```

there is now 12316 records

```r
#checking unique values of VisitorType variable

unique(data$VisitorType)
```

```
## [1] "Returning_Visitor" "New_Visitor"       "Other"
```

```r
#checking unique values of Weekend variable

unique(data$Weekend)
```

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

```r
#finding duplicates

duplicates <- data[duplicated(data),]
duplicates
```

```
## # A tibble: 117 x 18
##    Administrative Administrative_~ Informational Informational_D~ ProductRelated
##             <dbl>            <dbl>         <dbl>            <dbl>          <dbl>
##  1              0                0             0                0              1
##  2              0                0             0                0              1
##  3              0                0             0                0              1
##  4              0                0             0                0              1
##  5              0                0             0                0              1
##  6              0                0             0                0              1
##  7              0                0             0                0              1
##  8              0                0             0                0              1
##  9              0                0             0                0              2
## 10              0                0             0                0              1
## # ... with 107 more rows, and 13 more variables: ProductRelated_Duration <dbl>,
## #   BounceRates <dbl>, ExitRates <dbl>, PageValues <dbl>, SpecialDay <dbl>,
## #   Month <chr>, OperatingSystems <dbl>, Browser <dbl>, Region <dbl>,
## #   TrafficType <dbl>, VisitorType <chr>, Weekend <lgl>, Revenue <lgl>
```

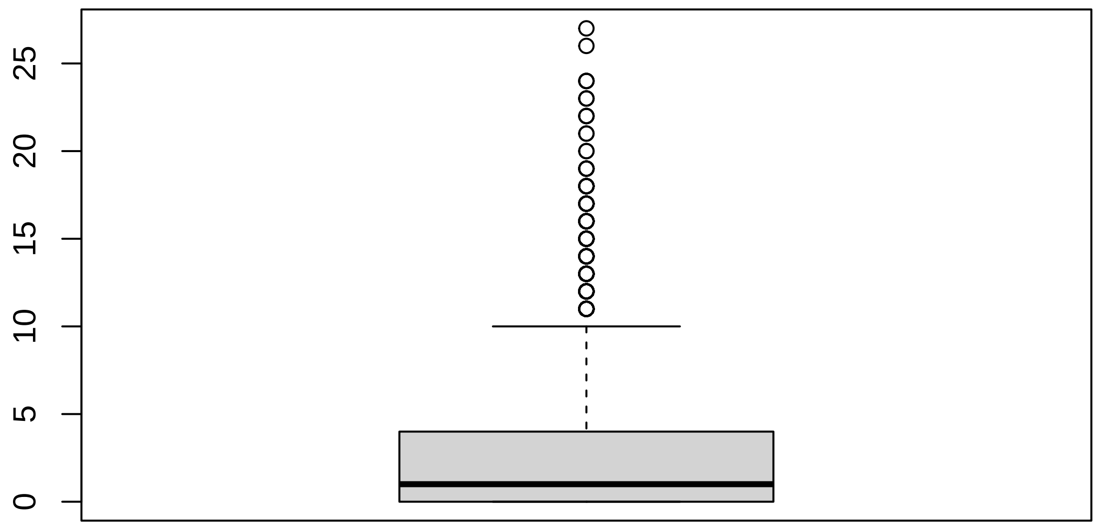
There is presence of duplicates

```r
data[!duplicated(data), ]
```

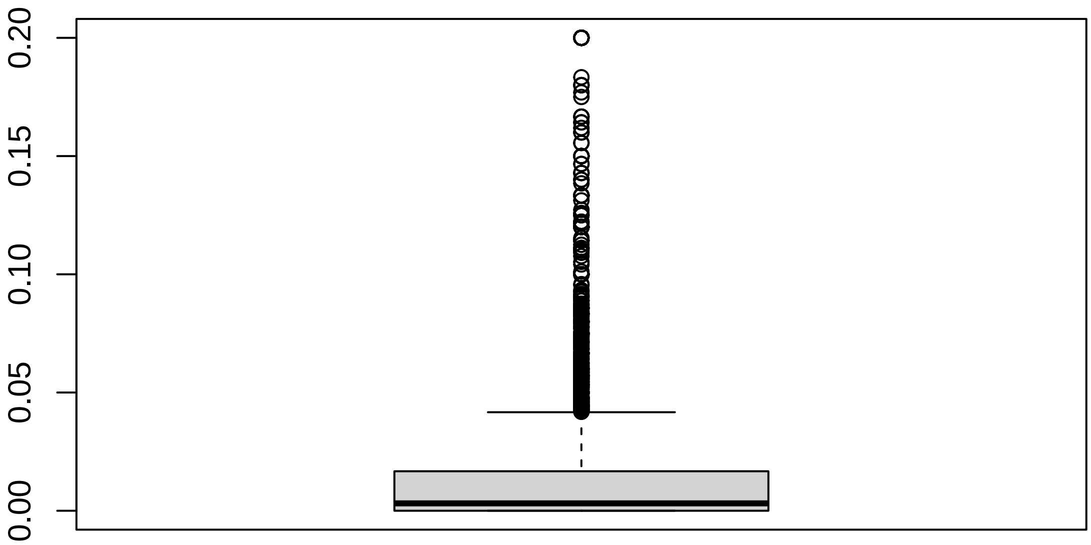
```
## # A tibble: 12,199 x 18
##    Administrative Administrative_~ Informational Informational_D~ ProductRelated
##             <dbl>            <dbl>         <dbl>            <dbl>          <dbl>
##  1              0                0             0                0              1
##  2              0                0             0                0              2
##  3              0               -1             0               -1              1
##  4              0                0             0                0              2
##  5              0                0             0                0             10
##  6              0                0             0                0             19
##  7              0               -1             0               -1              1
##  8              1               -1             0               -1              1
##  9              0                0             0                0              2
## 10              0                0             0                0              3
## # ... with 12,189 more rows, and 13 more variables:
## #   ProductRelated_Duration <dbl>, BounceRates <dbl>, ExitRates <dbl>,
## #   PageValues <dbl>, SpecialDay <dbl>, Month <chr>, OperatingSystems <dbl>,
## #   Browser <dbl>, Region <dbl>, TrafficType <dbl>, VisitorType <chr>,
## #   Weekend <lgl>, Revenue <lgl>
```

Duplicates have been removed we now have 12,199 records

```r
#finding outliers in the column

boxplot(data$Administrative)
```

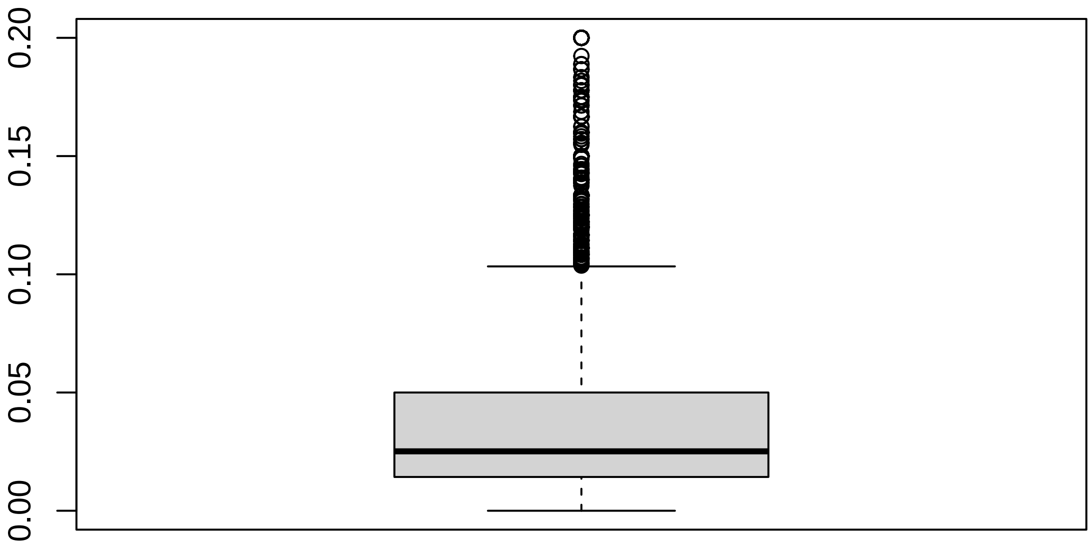



```r
#finding outliers in the Bounce Rates column

boxplot(data$BounceRates)
```



There is presence of alot of outliers

```
#finding outliers in the Exit Rates column

boxplot(data$ExitRates)
```



presence of outliers

Outliers won't be removed since this is real data representing actual observations that are crucial for our analysis

5. Exploratory data analysis

5.1 Univariate Analysis

```
# getting the summary of our numerical columns

summary(data)
```

```
##  Administrative   Administrative_Duration Informational
##  Min.   : 0.000   Min.   :  -1.00         Min.   : 0.000
##  1st Qu.: 0.000   1st Qu.:   0.00         1st Qu.: 0.000
##  Median : 1.000   Median :   8.00         Median : 0.000
##  Mean   : 2.318   Mean   :  80.91         Mean   : 0.504
##  3rd Qu.: 4.000   3rd Qu.:  93.50         3rd Qu.: 0.000
##  Max.   :27.000   Max.   :3398.75         Max.   :24.000
##  Informational_Duration ProductRelated   ProductRelated_Duration
##  Min.   :  -1.00        Min.   :  0.00   Min.   :   -1.0
##  1st Qu.:   0.00        1st Qu.:  7.00   1st Qu.:  185.0
##  Median :   0.00        Median : 18.00   Median :  599.8
```

```
##  Mean   :  34.51        Mean   : 31.76   Mean   : 1196.0
##  3rd Qu.:   0.00        3rd Qu.: 38.00   3rd Qu.: 1466.5
##  Max.   :2549.38        Max.   :705.00   Max.   :63973.5
##   BounceRates         ExitRates         PageValues        SpecialDay
##  Min.   :0.000000   Min.   :0.00000   Min.   :  0.000   Min.   :0.0000
##  1st Qu.:0.000000   1st Qu.:0.01429   1st Qu.:  0.000   1st Qu.:0.0000
##  Median :0.003119   Median :0.02512   Median :  0.000   Median :0.0000
##  Mean   :0.022152   Mean   :0.04300   Mean   :  5.896   Mean   :0.0615
##  3rd Qu.:0.016684   3rd Qu.:0.05000   3rd Qu.:  0.000   3rd Qu.:0.0000
##  Max.   :0.200000   Max.   :0.20000   Max.   :361.764   Max.   :1.0000
##     Month           OperatingSystems    Browser           Region
##  Length:12316       Min.   :1.000    Min.   : 1.000   Min.   :1.000
##  Class :character   1st Qu.:2.000    1st Qu.: 2.000   1st Qu.:1.000
##  Mode  :character   Median :2.000    Median : 2.000   Median :3.000
##                     Mean   :2.124    Mean   : 2.358   Mean   :3.148
##                     3rd Qu.:3.000    3rd Qu.: 2.000   3rd Qu.:4.000
##                     Max.   :8.000    Max.   :13.000   Max.   :9.000
##   TrafficType    VisitorType          Weekend         Revenue
##  Min.   : 1.00   Length:12316       Mode :logical   Mode :logical
##  1st Qu.: 2.00   Class :character   FALSE:9451      FALSE:10408
##  Median : 2.00   Mode  :character   TRUE :2865      TRUE :1908
##  Mean   : 4.07
##  3rd Qu.: 4.00
##  Max.   :20.00
```

```
# finding range of Administrative_Duration variable
adm.range <- range(data$Administrative_Duration)
adm.range
```

```
## [1]   -1.00 3398.75
```

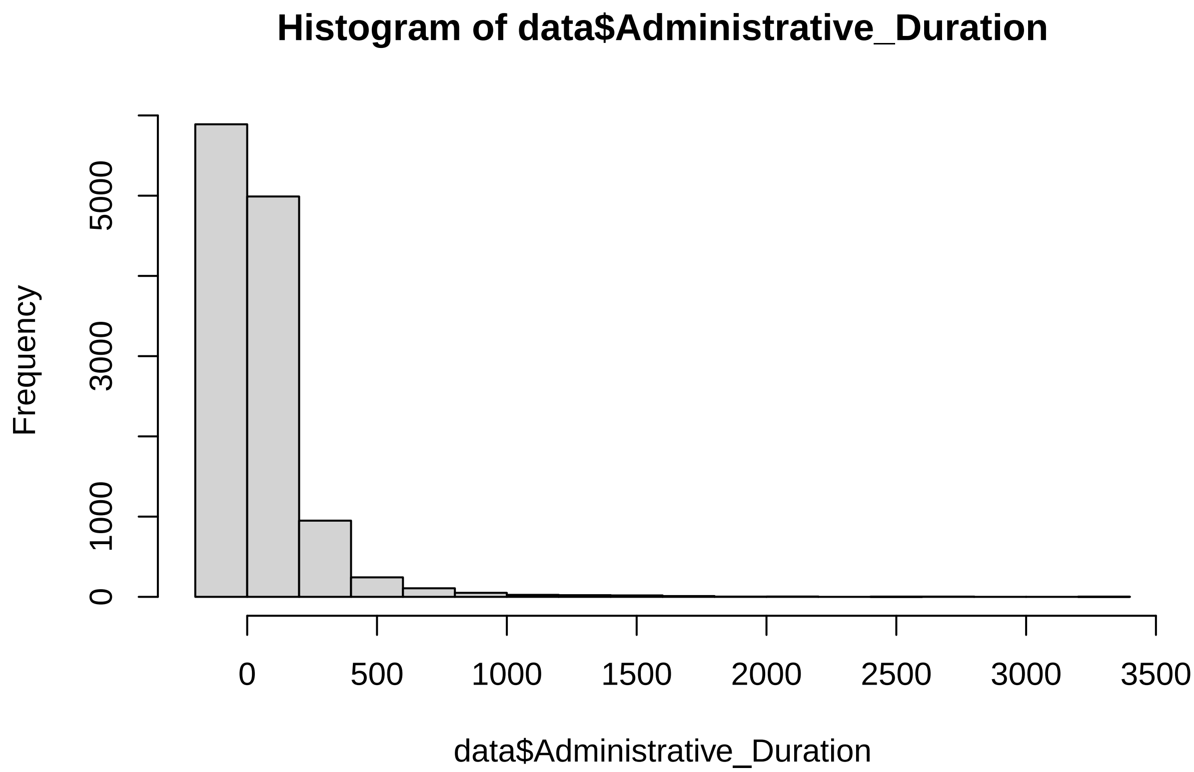
range from -1 to 3398.75

```
#Variance of Informational_Duration variable
infd.variance <- var(data$Informational_Duration)
#
infd.variance
```

```
## [1] 19831.82
```

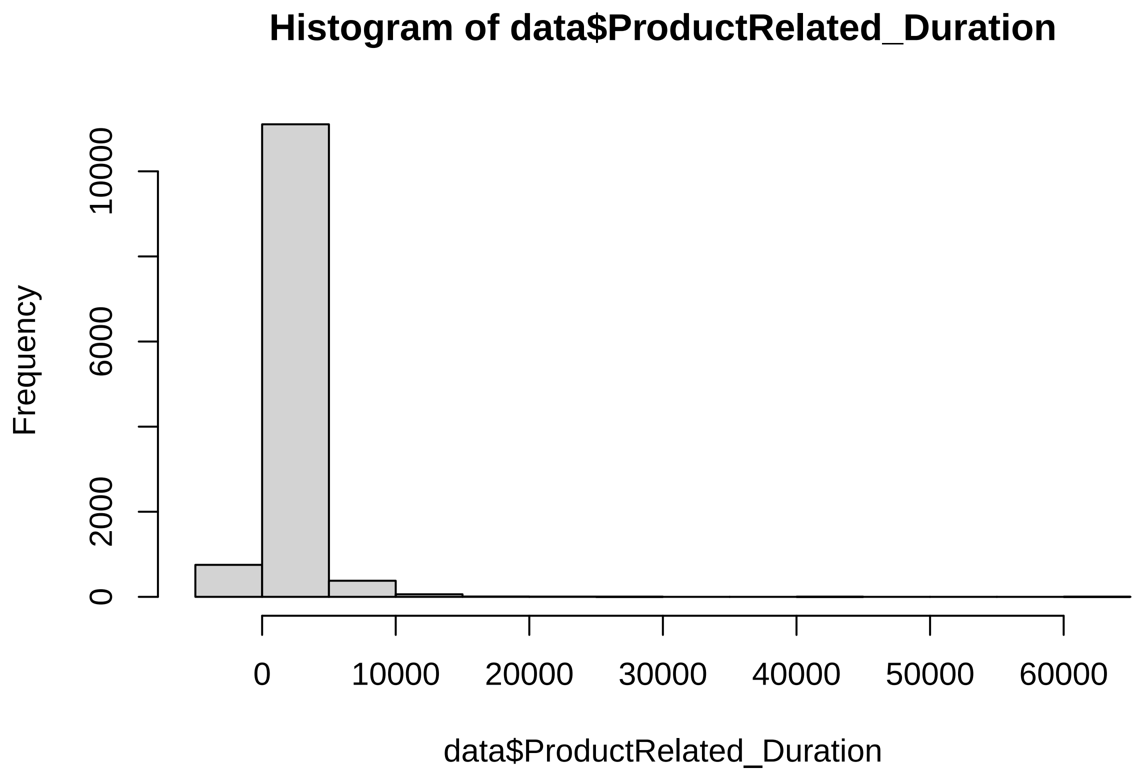
5.1.1 Visualizations

```
hist(data$Administrative_Duration)
```

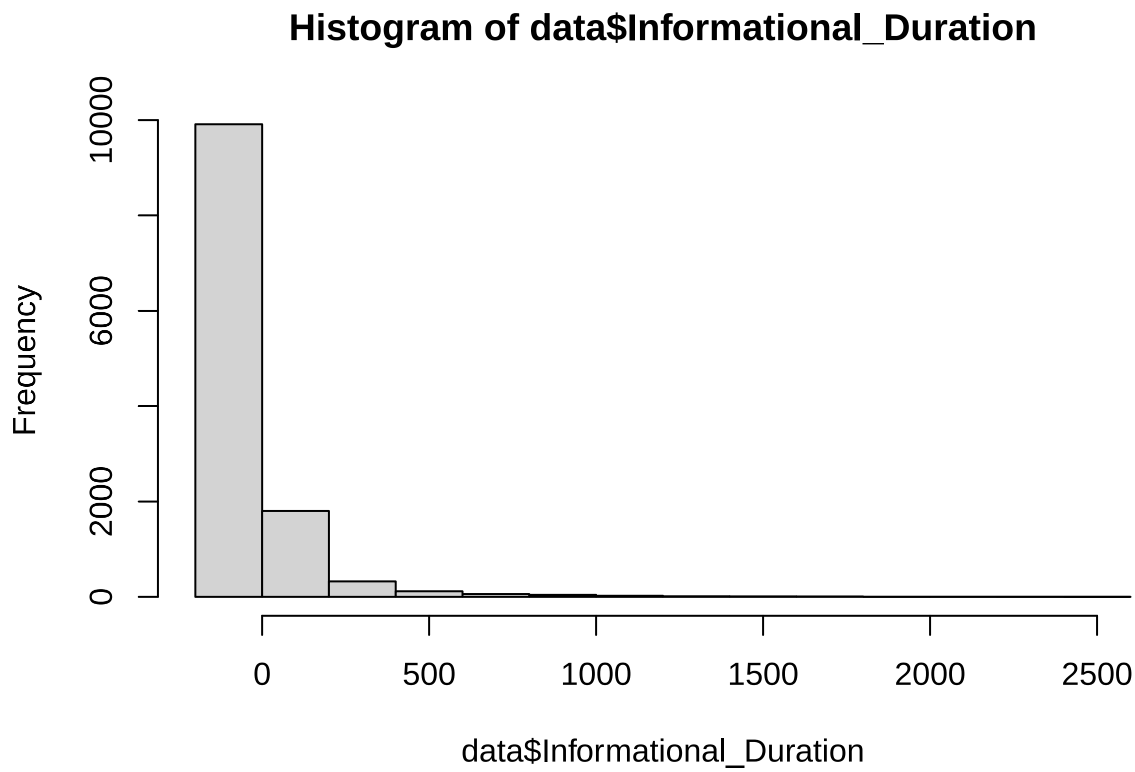


Distribution of the data is mostly skewed to the left as most values range at 0

```
hist(data$ProductRelated_Duration)
```

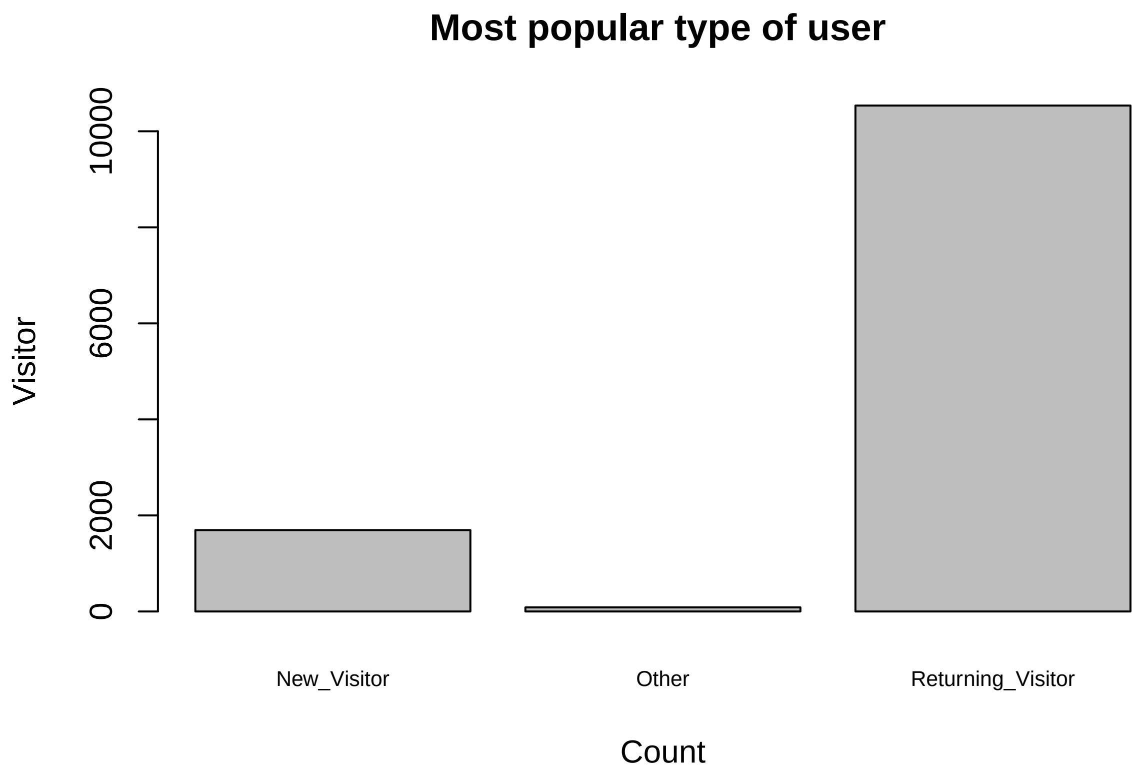



```
hist(data$Informational_Duration)
```



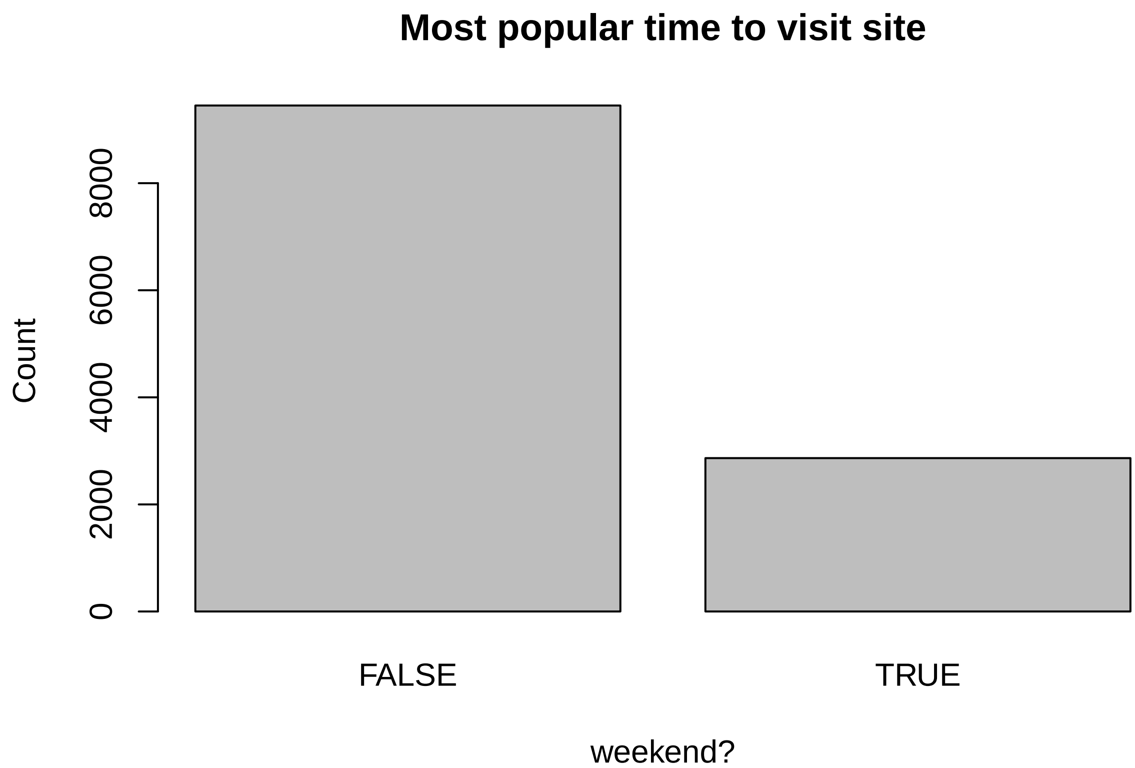
Distribution of the data is mostly skewed to the left as most values range at 0

```
# Most popular type of visitor
count <- table(data$VisitorType)
barplot(count,
        main='Most popular type of user ',
        xlab = 'Count',
        ylab = 'Visitor',
        cex.names = 0.7)
```



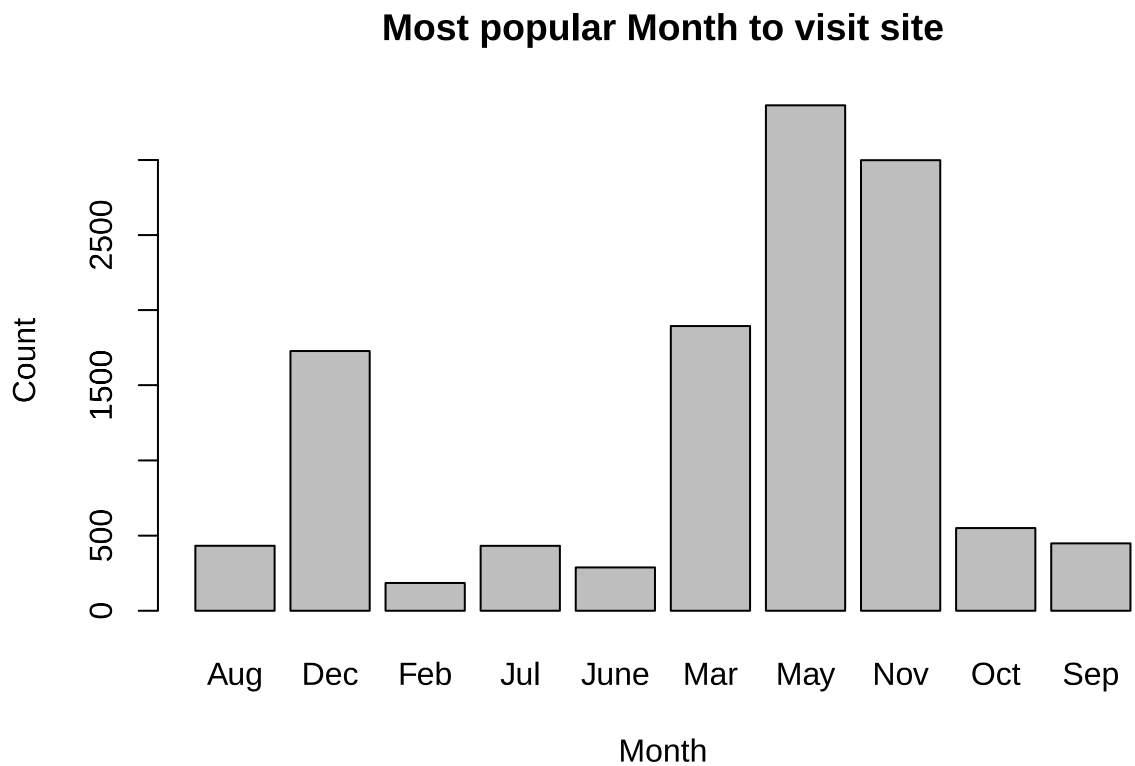
Most popular visitor are the returning visitors

```
# Most visits are on weekends or not
count <- table(data$Weekend)
barplot(count,
        main='Most popular time to visit site',
        xlab = 'weekend?',
        ylab = 'Count')
```



Most visitors visit the site during the weekdays

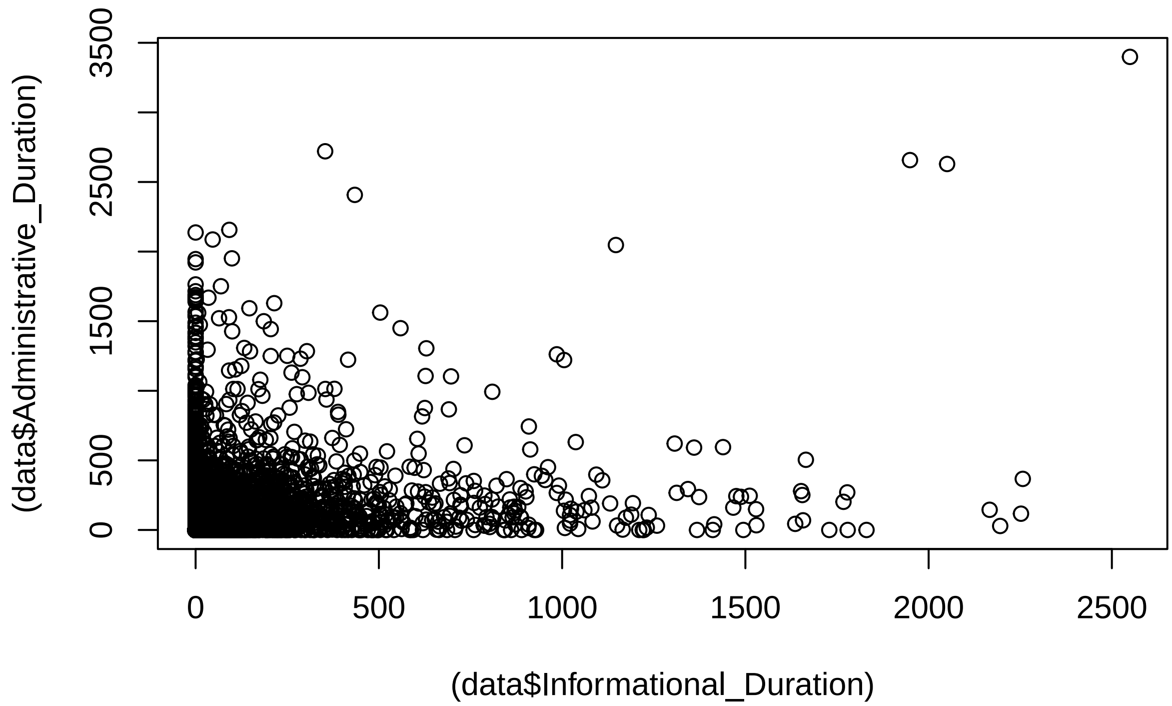
```r
# Most visits are on which month
count <- table(data$Month)
barplot(count,
        main='Most popular Month to visit site',
        xlab = 'Month',
        ylab = 'Count')
```



The month with the most visits was May

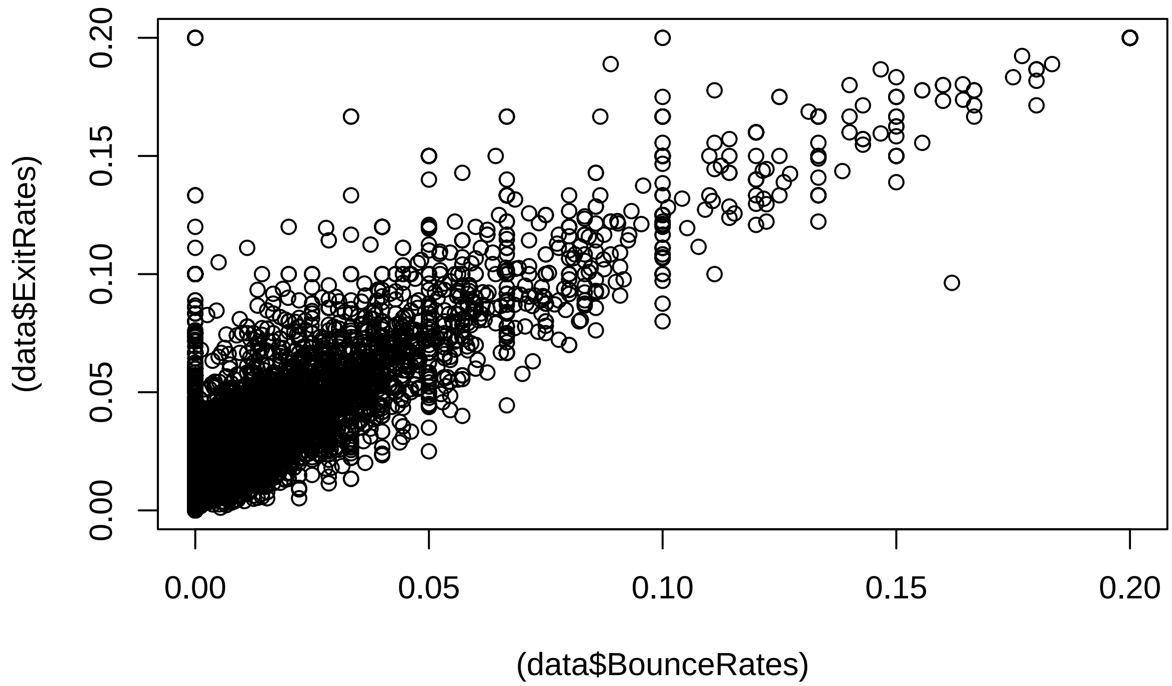
5.2 Bivariate Analysis

```
plot((data$Informational_Duration),  (data$Administrative_Duration))
```



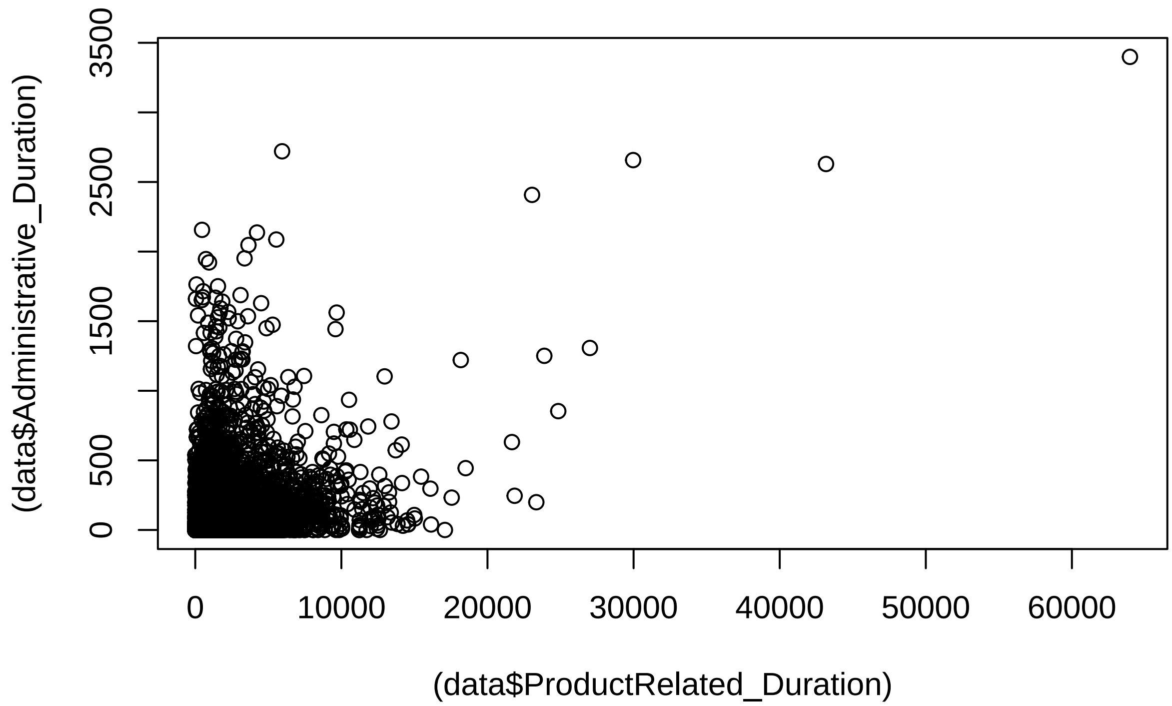
As the administrative duration increases the informational duration decreases

```
plot((data$BounceRates), (data$ExitRates))
```



As the exit rate increases so does the bounce rates

```
plot((data$ProductRelated_Duration),  (data$Administrative_Duration))
```



6. Implementing the solution

6.1 Encoding and Scaling

```
# Drop the label
data2 <- data[, -18]

# Encoding the categorical columns
data2$VisitorType <- ifelse(data2$VisitorType == 'Returning_Visitor', 1, ifelse(data2$VisitorType == 'N

data2$Weekend <- ifelse(data2$Weekend == 'FALSE', 0, 1)

#encoding the months column
#Change column to factor
data2$Month <- factor(data2$Month)

#Change factor to numeric
data2$Month<- as.numeric(data2$Month)
table(data2$Month)
```

```
##
##    1    2    3    4    5    6    7    8    9   10
##  433 1727  184  432  288 1894 3363 2998  549  448
```

Normalizing the dataset

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

6.2 K- means Clustering

```
# Applying the K-means clustering algorithm with no. of centroids(k)=4
#K was randomly picked
#
result <- kmeans(data2,4)

# Previewing the no. of records in each cluster
#
result$size
```

```
## [1] 2608  571   66 9071
```

The above results show how data has been split within the 4 clusters

```
# Getting the value of cluster center data  point
# ---
#
result$centers
```

```
##   Administrative Administrative_Duration Informational Informational_Duration
## 1       3.754985               138.32442     0.9401840               67.19907
## 2       5.889667               211.57876     1.7950963              145.22002
## 3       7.651515               416.47911     3.3787879              364.76162
## 4       1.640944                53.73071     0.2763753               15.73482
##   ProductRelated ProductRelated_Duration BounceRates  ExitRates PageValues
## 1       56.95130               2332.2961 0.007998933 0.02307835   8.564237
## 2      135.50788               6153.4724 0.006556316 0.02096564   6.916867
## 3      332.33333              15772.4934 0.005424551 0.01864796   4.108254
## 4       15.80487                451.2344 0.027325193 0.05029531   5.077537
##   SpecialDay    Month OperatingSystems  Browser   Region TrafficType
## 1 0.05475460 6.317101         2.131135 2.315951 3.204371    3.812117
## 2 0.05008757 6.761821         2.157618 2.332750 2.800350    3.537653
## 3 0.01212121 6.772727         2.045455 2.393939 2.484848    3.893939
## 4 0.06451328 6.078051         2.120604 2.370852 3.158527    4.179583
##   VisitorType   Weekend
## 1    1.064417 0.2365798
## 2    1.010508 0.2241681
## 3    1.015152 0.2727273
## 4    1.158086 0.2317275
```

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

```
##    [1] 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4 1 4 4 4 4 4 4 4 4 4 1 4 4 4 4 4 1
##   [37] 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4 2 4 4 4 4 4
##   [73] 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4 1 4 4 1 4 4 4 4
##  [109] 4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4
##  [145] 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
##  [181] 4 4 4 4 4 4 4 1 1 1 4 1 4 4 4 1 1 1 4 1 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
##  [217] 4 4 4 4 4 4 4 4 1 4 1 4 1 1 4 1 4 1 4 4 1 4 4 4 4 4 1 1 4 4 4 4 4 1 1 2
##  [253] 4 4 4 1 4 1 4 4 4 4 1 4 4 2 4 4 1 4 4 4 4 4 4 4 4 1 4 4 4 4 1 4 4 4 4 1
##  [289] 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 1 4 1 4 4 4 4 1 4 4 4
##  [325] 1 4 4 4 4 4 4 4 4 1 1 4 4 4 4 4 4 4 4 1 4 4 4 1 4 4 4 4 4 1 4 1 4 4 1 4
##  [361] 4 4 4 1 4 4 4 1 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 1 4 4 4 4 4 1 4 4 1 4 1
##  [397] 4 1 4 4 1 4 4 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 2 4 4 4 4 4 4 1
##  [433] 4 4 4 4 4 4 4 4 1 1 4 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 1 4 4 4 4 1 4 4 4
##  [469] 4 4 2 4 4 4 4 4 1 1 4 4 1 4 4 4 4 4 4 4 1 1 4 4 4 4 4 4 4 4 4 1 4 4 1 1
##  [505] 4 4 4 4 4 4 3 1 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4
##  [541] 4 4 4 4 1 4 4 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 4 4 4 4 1 1
##  [577] 4 4 1 4 4 4 1 4 4 4 4 1 4 4 4 4 1 4 1 4 4 4 4 4 1 1 4 4 1 4 4 4 4 4 1 2
##  [613] 1 1 4 4 4 1 4 2 4 4 4 4 4 4 4 4 4 1 1 4 1 1 4 4 4 4 4 4 4 4 4 4 4 4 4 1
##  [649] 4 1 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 1
##  [685] 4 4 4 4 4 1 4 4 1 4 4 1 1 1 1 4 4 1 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
##  [721] 4 4 2 4 4 4 4 4 4 4 4 4 4 4 1 1 4 1 4 1 1 4 4 4 4 4 4 4 4 4 1 1 4 4 4 4
##  [757] 4 4 4 4 1 1 4 4 4 4 4 4 4 2 1 4 1 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4
##  [793] 1 4 4 4 1 4 4 3 4 4 4 4 4 4 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 2 1 4
##  [829] 1 4 4 4 4 4 1 4 4 4 4 4 4 4 1 1 4 1 4 4 1 4 4 4 4 2 4 4 4 4 4 4 4 4 4 4
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##  [901] 4 4 4 4 4 1 1 4 4 4 4 4 1 4 4 1 4 4 4 4 4 4 4 4 1 1 4 4 4 4 4 1 1 4 4 4
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## [12277] 4 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4 4 1 4 4 2 3 1 4 4 4 1 4 4 4 4 4 4 4 1
## [12313] 4 4 4 4
```

6.2.1 Vizualizing cluster

```
fviz_cluster(result, data = data2)
```

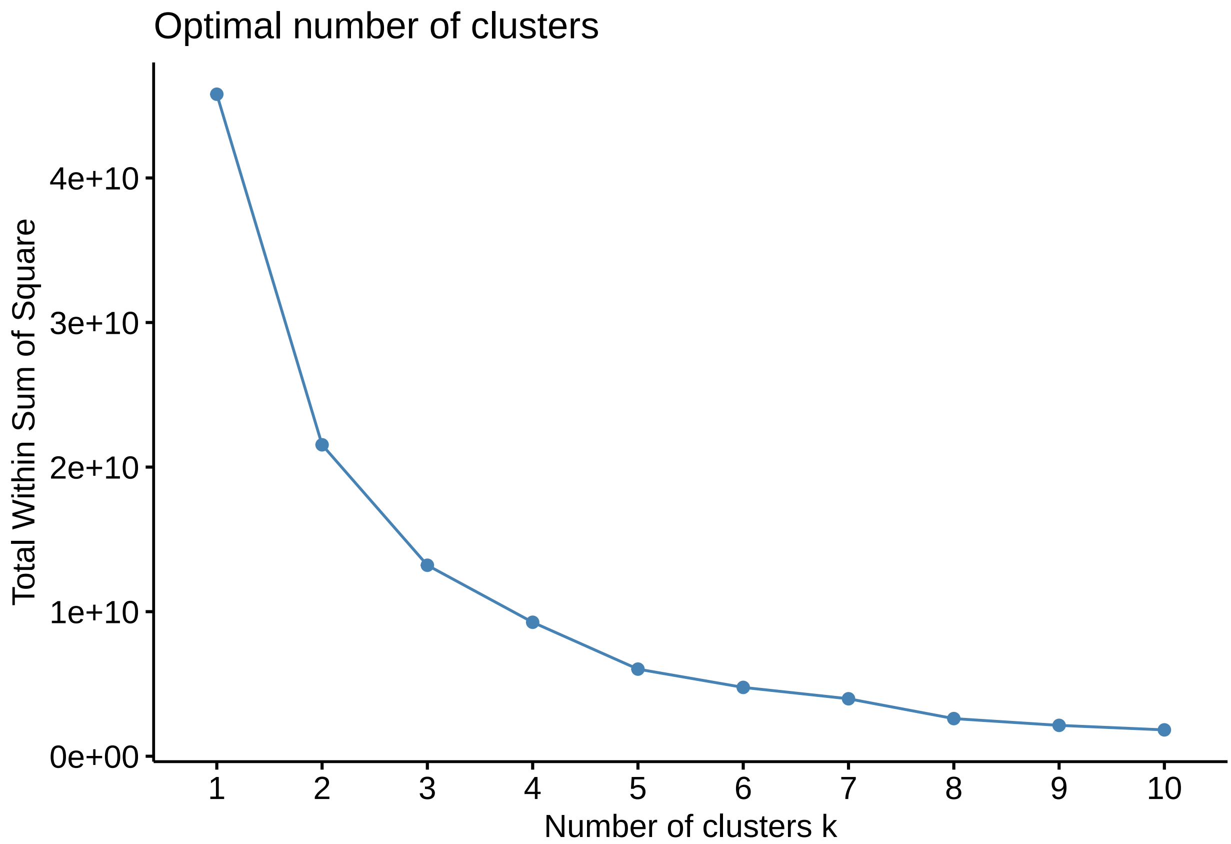
our cluster K=4 doesn't look that good, so lets try finding a better K value to see if the model will improve

6.2.2 Improving model/challenging soln

Determining the optimal number of clusters through various methods

a. Elbow Curve

```
# Determining Optimal clusters (k) Using Elbow method
fviz_nbclust(x = data2,FUNcluster = kmeans, method = 'wss')
```

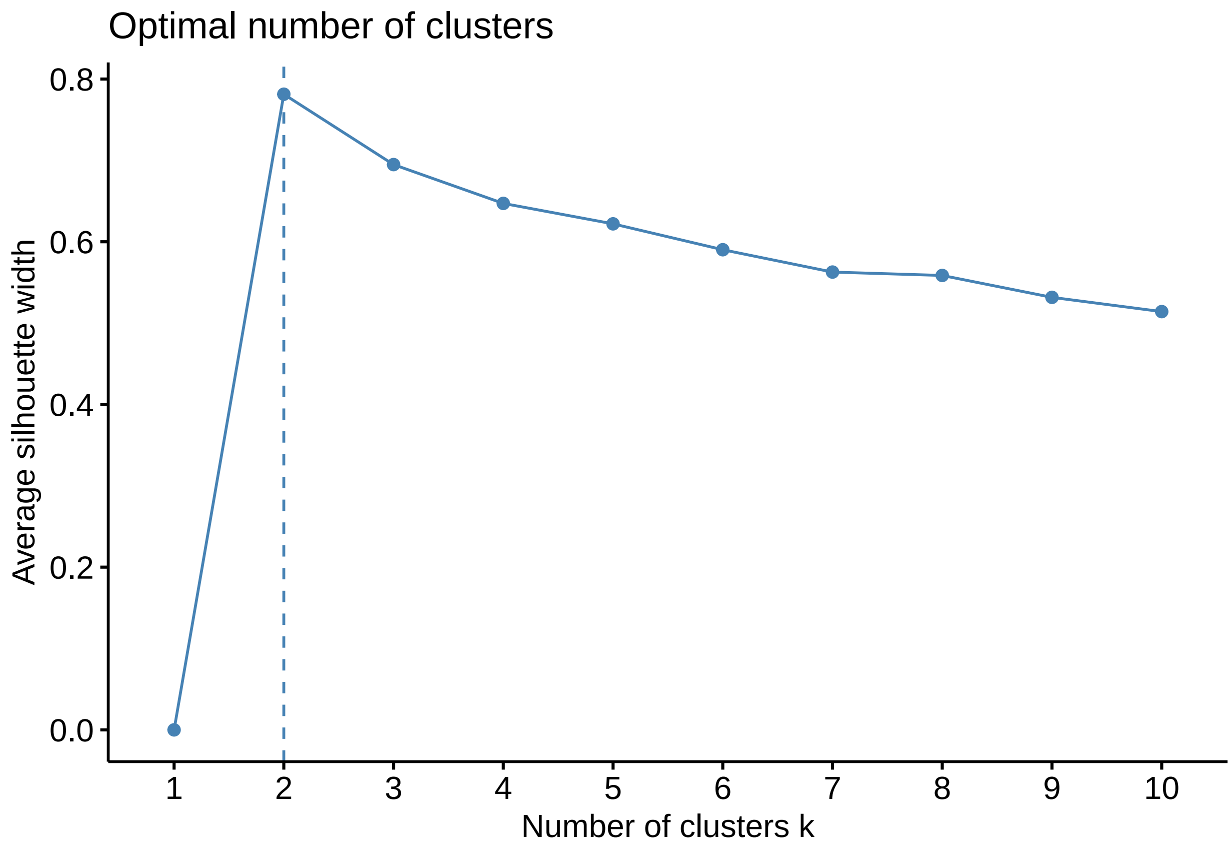


The above method suggests we use K = 2

b. Silhouette

```
# Determining Optimal clusters (k) Using Average Silhouette Method

fviz_nbclust(x = data2,FUNcluster = kmeans, method = 'silhouette' )
```



The above method suggests we use K = 2

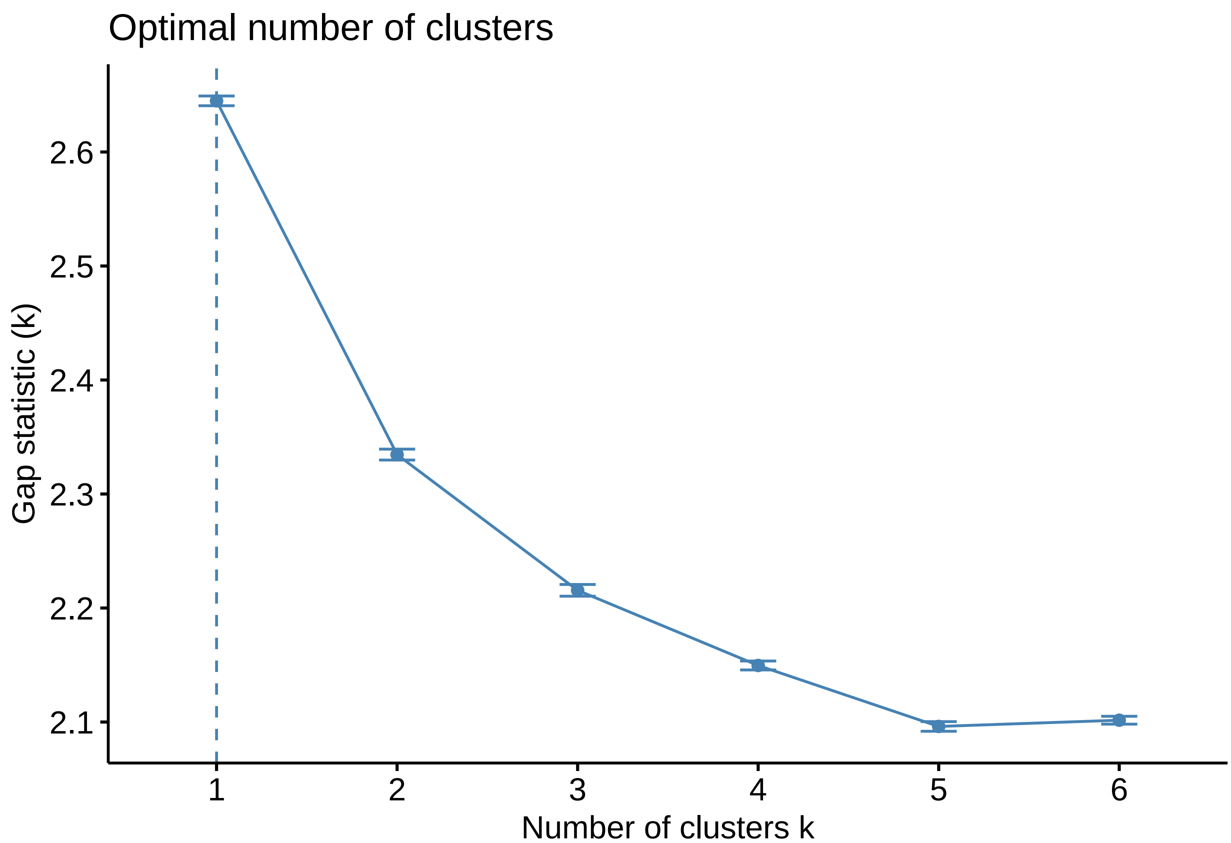
c. Gap Statistic

```r
# compute gap statistic
set.seed(150)
gap_stat <- clusGap(x = data2, FUN = kmeans, K.max = 6, nstart = 15, B = 30 )

# Print the result
print(gap_stat, method = "firstmax")
```

```
## Clustering Gap statistic ["clusGap"] from call:
## clusGap(x = data2, FUNcluster = kmeans, K.max = 6, B = 30, nstart = 15)
## B=30 simulated reference sets, k = 1..6; spaceH0="scaledPCA"
##  --> Number of clusters (method 'firstmax'): 1
##          logW   E.logW      gap      SE.sim
## [1,] 15.36406 18.00891 2.644847 0.004275541
## [2,] 15.00091 17.33548 2.334574 0.004789601
## [3,] 14.73986 16.95536 2.215495 0.005148495
## [4,] 14.54755 16.69714 2.149593 0.003912246
## [5,] 14.41068 16.50680 2.096118 0.004236018
## [6,] 14.25775 16.35933 2.101581 0.003444861
```

```r
# plot the result to determine the optimal number of clusters.
fviz_gap_stat(gap_stat)
```



The above method suggests K = 1, this isn't a good suggestion since it damages the idea of clustering

Adjustments were made to the values i.e K.max, nstart and B, it was noted that using a value exceeding 10 for the K.max gives a warning, and high values also didn't work for the nstart and B

2 options suggested for K = 2

```r
# Compute k-means clustering with k = 2
set.seed(150)
final <- kmeans(data2, centers = 2, nstart = 25)
print(final)
```

```
## K-means clustering with 2 clusters of sizes 933, 11383
##
## Cluster means:
##   Administrative Administrative_Duration Informational Informational_Duration
## 1       5.624866               207.73068      1.755627               146.3098
## 2       2.046736                70.51109      0.401388                25.3425
##   ProductRelated ProductRelated_Duration BounceRates  ExitRates PageValues
## 1      135.47481               6093.2140 0.006524418 0.02077043   7.345740
## 2       23.26329                794.6432 0.023433404 0.04482478   5.777121
##   SpecialDay    Month OperatingSystems  Browser   Region TrafficType
## 1 0.04587353 6.659164         2.145766 2.366559 2.900322    3.592712
## 2 0.06277783 6.123518         2.122375 2.356848 3.168321    4.109637
```

```
##   VisitorType   Weekend
## 1    1.015005 0.2336549
## 2    1.140121 0.2325398
##
## Clustering vector:
##      [1] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
##     [37] 2 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2
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##    [217] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1
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## [12313] 2 2 2 2
## 
## Within cluster sum of squares by cluster:
## [1] 13749250056  7792396189
##  (between_SS / total_SS =  53.0 %)
## 
## Available components:
## 
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```
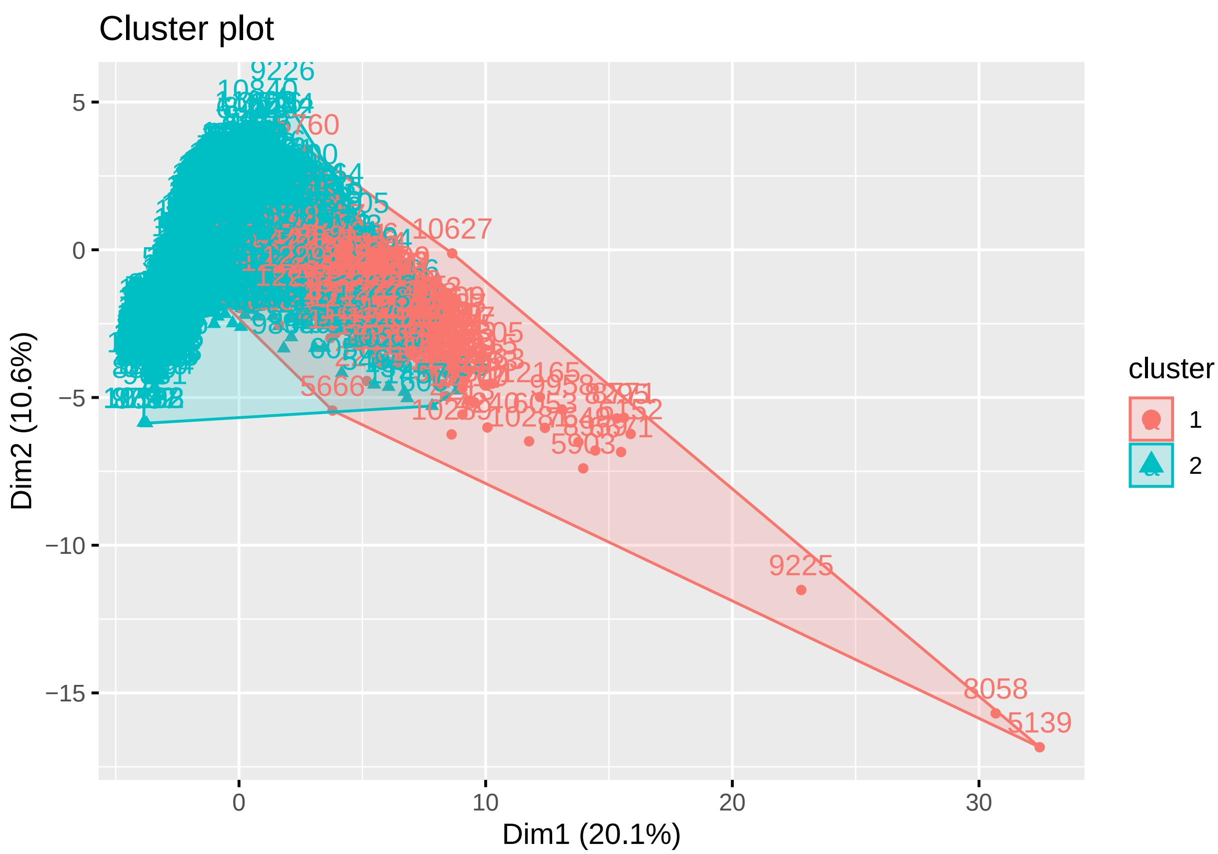

The between_SS / total_SS = 53.0 %(0.53), total_ss is a measure of the total variance in your data set that is explained by the clustering i.e reduction in sums of squares

Ideally the BSS/TSS ratio should approach 1

```
fviz_cluster(final, data = data2)
```



The visualization above is better than what we previosly had

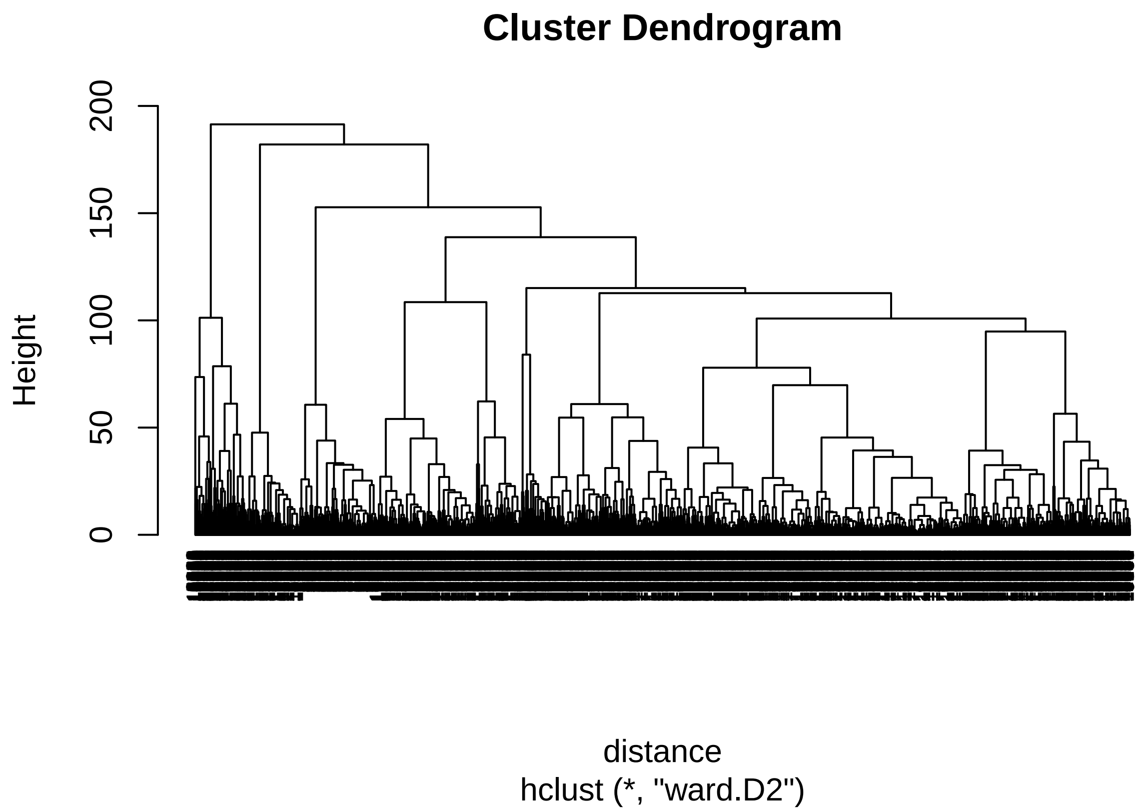
6.3 Hierachical Clustering

```
# scale the values
data3 <- scale(data2)
```

```
# specify the distance method
distance <- dist(data3, method = 'euclidean')
```

```
# Perform clustering on the datatframe
hier_clust <- hclust(distance, method = 'ward.D2')
```

```
plot(hier_clust, cex = 0.6, hang = -1)
```

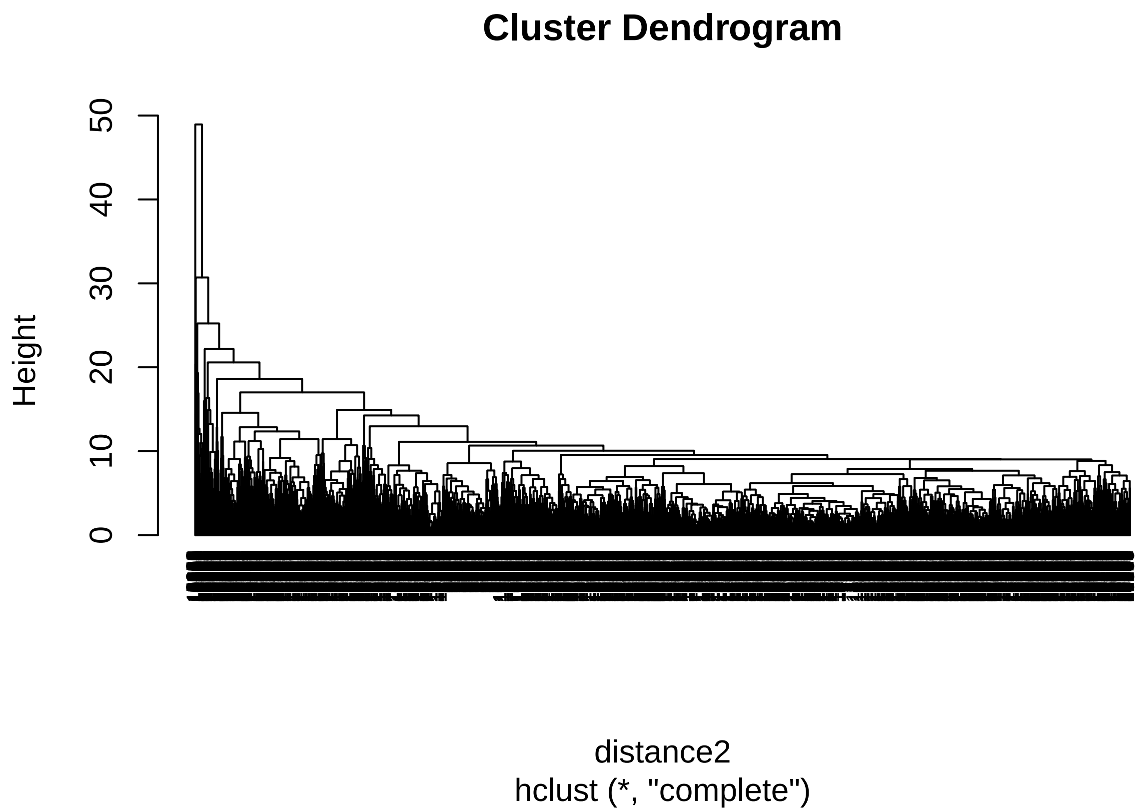


6.3.1 challenging first hierachical model

we will do this by using a different method i.e complete

```
# specify the distance method
distance2 <- dist(data3, method = 'euclidean')

# Perform clustering on the datatframe
hier_clust2 <- hclust(distance2, method = 'complete')
```

```
plot(hier_clust2, cex = 0.6, hang = -1)
```



Comparing the first model using method as Ward.D2 and the second model using complete, Ward.D2 worked so much better

7. Conclusions and Recommendations

K_means clustering and Hierarchical clustering are great algorithms to use in unsupervised datasets

In our modeling with K_means clustering using K = 2 gave a better visualization of our dataset

For the Hierarchical clustering model using the ward.d2 method gave way better visualization

Comparing both algorithms hierarchical clustering gave better results and is easier to implement as compared to K_means