

Cluster Analysis of Customers with R

QA

Problem Definition

1. Research Question Perform cluster analysis to identify customer groups on a Russian brand, Kira Plastinina to help the sales team understand the customer characteristics.

2. Metrics of success Identification of customer groups characteristics.

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 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.

4. Recording the experimental design

1. Data Sourcing
2. Check the Data
3. Perform Data Cleaning
4. Perform Exploratory Data Analysis
5. Implement the Solution
6. Challenge the Solution
7. Follow up Questions

1. Data Sourcing

[<http://bit.ly/EcommerceCustomersDataset>]

Data Loading and Inspection

```
# Load libraries
library(readr)
```

```
## Warning: package 'readr' was built under R version 4.0.4
```

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.0.4
```

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

```
## v ggplot2 3.3.3      v dplyr  1.0.5
## v tibble  3.1.0      v stringr 1.4.0
## v tidyr   1.1.3      v forcats 0.5.1
## v purrr   0.3.4

## Warning: package 'ggplot2' was built under R version 4.0.4

## Warning: package 'tibble' was built under R version 4.0.4

## Warning: package 'tidyr' was built under R version 4.0.4

## Warning: package 'purrr' was built under R version 4.0.4

## Warning: package 'dplyr' was built under R version 4.0.4

## Warning: package 'stringr' was built under R version 4.0.4

## Warning: package 'forcats' was built under R version 4.0.4

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

```
library(psych)
```

```
## Warning: package 'psych' was built under R version 4.0.4

##
## Attaching package: 'psych'

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

```
library(corrplot)
```

```
## Warning: package 'corrplot' was built under R version 4.0.4

## corrplot 0.84 loaded
```

```
library(BBmisc)
```

```
## Warning: package 'BBmisc' was built under R version 4.0.4

##
## Attaching package: 'BBmisc'
```

```
## The following objects are masked from 'package:dplyr':  
##  
##   coalesce, collapse
```

```
## The following object is masked from 'package:base':  
##  
##   isFALSE
```

```
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.0.4
```

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

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

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

```
library(cluster)  
library(factoextra)
```

```
## Warning: package 'factoextra' was built under R version 4.0.4
```

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

```
library(NbClust)
```

```
df <- read_csv("C:\\Users\\Lenovo\\Downloads\\online_shoppers_intention.csv")
```

```
##  
## -- Column specification -----  
## cols(  
##   Administrative = col_double(),  
##   Administrative_Duration = col_double(),  
##   Informational = col_double(),  
##   Informational_Duration = col_double(),  
##   ProductRelated = col_double(),  
##   ProductRelated_Duration = col_double(),  
##   BounceRates = col_double(),  
##   ExitRates = col_double(),  
##   PageValues = col_double(),  
##   SpecialDay = col_double(),  
##   Month = col_character(),  
##   OperatingSystems = col_double(),  
##   Browser = col_double(),  
##   Region = col_double(),  
##   TrafficType = col_double(),
```

```
## VisitorType = col_character(),
## Weekend = col_logical(),
## Revenue = col_logical()
## )
```

```
# Preview data
head(df)
```

```
## # 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>
```

2. Check the Data

```
# Shape of data
dim(df);
```

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

```
# Column datatypes
str(df);
```

```
## spec_tbl_df [12,330 x 18] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
##  $ Administrative      : num [1:12330] 0 0 0 0 0 0 0 1 0 0 ...
##  $ Administrative_Duration: num [1:12330] 0 0 -1 0 0 0 -1 -1 0 0 ...
##  $ Informational        : num [1:12330] 0 0 0 0 0 0 0 0 0 0 ...
##  $ Informational_Duration: num [1:12330] 0 0 -1 0 0 0 -1 -1 0 0 ...
##  $ ProductRelated       : num [1:12330] 1 2 1 2 10 19 1 1 2 3 ...
##  $ ProductRelated_Duration: num [1:12330] 0 64 -1 2.67 627.5 ...
##  $ BounceRates           : num [1:12330] 0.2 0 0.2 0.05 0.02 ...
##  $ ExitRates             : num [1:12330] 0.2 0.1 0.2 0.14 0.05 ...
##  $ PageValues            : num [1:12330] 0 0 0 0 0 0 0 0 0 0 ...
##  $ SpecialDay            : num [1:12330] 0 0 0 0 0 0 0.4 0 0.8 0.4 ...
##  $ Month                 : chr [1:12330] "Feb" "Feb" "Feb" "Feb" ...
##  $ OperatingSystems      : num [1:12330] 1 2 4 3 3 2 2 1 2 2 ...
##  $ Browser               : num [1:12330] 1 2 1 2 3 2 4 2 2 4 ...
##  $ Region                : num [1:12330] 1 1 9 2 1 1 3 1 2 1 ...
##  $ TrafficType           : num [1:12330] 1 2 3 4 4 3 3 5 3 2 ...
##  $ VisitorType           : chr [1:12330] "Returning_Visitor" "Returning_Visitor" "Returning_Visitor"
##  $ Weekend               : logi [1:12330] FALSE FALSE FALSE FALSE TRUE FALSE ...
```

```
## $ Revenue          : logi [1:12330] FALSE FALSE FALSE FALSE FALSE FALSE ...
## - attr(*, "spec")=
## .. cols(
## ..   Administrative = col_double(),
## ..   Administrative_Duration = col_double(),
## ..   Informational = col_double(),
## ..   Informational_Duration = col_double(),
## ..   ProductRelated = col_double(),
## ..   ProductRelated_Duration = col_double(),
## ..   BounceRates = col_double(),
## ..   ExitRates = col_double(),
## ..   PageValues = col_double(),
## ..   SpecialDay = col_double(),
## ..   Month = col_character(),
## ..   OperatingSystems = col_double(),
## ..   Browser = col_double(),
## ..   Region = col_double(),
## ..   TrafficType = col_double(),
## ..   VisitorType = col_character(),
## ..   Weekend = col_logical(),
## ..   Revenue = col_logical()
## .. )
```

```
# Data Summary
summary(df)
```

```
## 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
## NA's   :14        NA's   :14        NA's   :14
## 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
## NA's   :14        NA's   :14        NA's   :14
## BounceRates      ExitRates      PageValues      SpecialDay
## Min.   :0.000000    Min.   :0.000000    Min.   : 0.000    Min.   :0.000000
## 1st Qu.:0.000000    1st Qu.:0.01429    1st Qu.: 0.000    1st Qu.:0.000000
## Median :0.003119    Median :0.02512    Median : 0.000    Median :0.000000
## Mean   :0.022152    Mean   :0.04300    Mean   : 5.889    Mean   :0.06143
## 3rd Qu.:0.016684    3rd Qu.:0.05000    3rd Qu.: 0.000    3rd Qu.:0.000000
## Max.   :0.200000    Max.   :0.20000    Max.   :361.764    Max.   :1.000000
## NA's   :14        NA's   :14
## Month            OperatingSystems    Browser      Region
## Length:12330     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    : 2.357      Mean    :3.147
##           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:12330 Mode :logical Mode :logical
## 1st Qu.: 2.00 Class :character FALSE:9462 FALSE:10422
## Median : 2.00 Mode :character TRUE :2868 TRUE :1908
## Mean      : 4.07
## 3rd Qu.: 4.00
## Max.      :20.00
##
```

The following columns contain some NA's: - Administrative - Administrative_Duration - Informational - Informational_Duration - ProductRelated - ProductRelated_Duration - BounceRates - ExitRates - PageValues

Worth noting: There are durations that have **-1** as values that may need to be dropped.

3. Data Cleaning

```
# Checking for duplicated data
anyDuplicated(df)
```

```
## [1] 159
```

There are 159 duplicated rows

```
# Dropping the Duplicated rows
df <- df[!duplicated(df),]
anyDuplicated((df))
```

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

BOOM! Duplicates gone

```
# Get number of rows with null values
df[!complete.cases(df),]
```

```
## # A tibble: 12 x 18
##   Administrative Administrative_~ Informational Informational_D~ ProductRelated
##   <dbl> <dbl> <dbl> <dbl> <dbl>
## 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      NA
## # ... 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>
```

It is the same rows with missing values!!! *Drop them!!!*

```
# Drop the NA rows
```

```
df <- df[complete.cases(df),]
```

```
# Investigating the -1 values in the duration columns
```

```
anomalies <- df %>% select(c(Administrative_Duration, Administrative, Informational_Duration, Informational_Duration))
anomalies
```

```
## # A tibble: 33 x 6
```

```
##   Administrative_Duration Administrative Informational_Duration Informational
##             <dbl>             <dbl>             <dbl>             <dbl>
## 1                 -1                 0                 -1                 0
## 2                 -1                 0                 -1                 0
## 3                 -1                 1                 -1                 0
## 4                 -1                 0                 -1                 0
## 5                 -1                 0                 -1                 0
## 6                 -1                 0                 -1                 0
## 7                 -1                 0                 -1                 0
## 8                 -1                 0                 -1                 0
## 9                 -1                 0                 -1                 0
## 10                -1                 0                 -1                 0
```

```
## # ... with 23 more rows, and 2 more variables: ProductRelated_Duration <dbl>,
## #   ProductRelated <dbl>
```

A total of 33 rows have the anomalies.

```
# Dropping the anomalies anomalous data
```

```
df <- df %>% filter(Administrative_Duration != -1, Informational_Duration != -1, ProductRelated_Duration != -1)
```

```
# describe each column
```

```
describe(df[, c(1:9)])
```

```
##           vars      n    mean      sd median trimmed      mad min
## Administrative      1 12164    2.35    3.33    1.00    1.66    1.48    0
## Administrative_Duration  2 12164   81.92  177.73   10.00   43.06   14.83    0
## Informational        3 12164    0.51    1.28    0.00    0.18    0.00    0
## Informational_Duration  4 12164   34.94  141.65    0.00    3.76    0.00    0
## ProductRelated       5 12164   32.15   44.63   18.00   23.14   19.27    0
## ProductRelated_Duration  6 12164 1210.99 1921.59  613.24  835.59  747.59    0
## BounceRates          7 12164    0.02    0.04    0.00    0.01    0.00    0
## ExitRates            8 12164    0.04    0.05    0.03    0.03    0.02    0
## PageValues           9 12164    5.97   18.68    0.00    1.34    0.00    0
```

	max	range	skew	kurtosis	se
Administrative	27.00	27.00	1.94	4.62	0.03
Administrative_Duration	3398.75	3398.75	5.58	49.97	1.61
Informational	24.00	24.00	4.01	26.56	0.01
Informational_Duration	2549.38	2549.38	7.53	75.23	1.28
ProductRelated	705.00	705.00	4.33	31.01	0.40
ProductRelated_Duration	63973.52	63973.52	7.25	136.43	17.42
BounceRates	0.20	0.20	3.21	9.71	0.00
ExitRates	0.20	0.20	2.26	4.79	0.00
PageValues	361.76	361.76	6.34	64.75	0.17

Observations - All the numerical columns data values are positively skewed - All the numerical columns data are leptokurtic

```
# Outlier function
outlier_detector <- function(x){
  out <- boxplot.stats(x)$out
  return((length(out)/ length(x)*100))
}
```

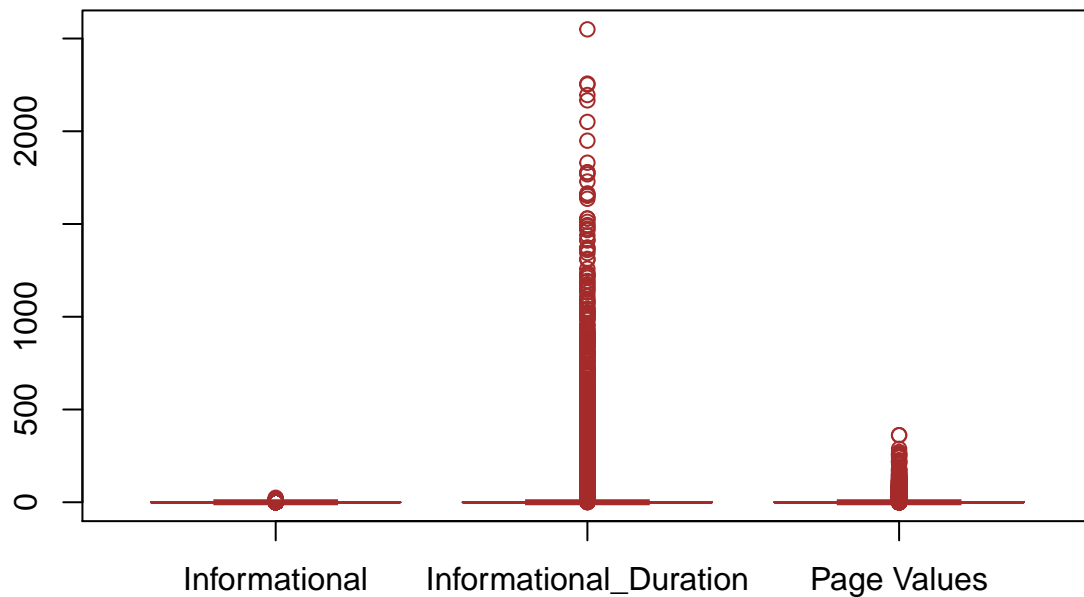
```
# Get outlier count per column
sapply(df[,c(1:9)], outlier_detector)
```

Administrative	Administrative_Duration	Informational
3.321276	9.363696	21.621177
Informational_Duration	ProductRelated	ProductRelated_Duration
19.763236	8.278527	7.809931
BounceRates	ExitRates	PageValues
11.649129	10.637948	22.443275

Observations - PageValues column has the most outliers at 22.14%

```
# Plot boxplots of columns with high % of outliers
boxplot(df$Informational, df$Informational_Duration, df$PageValues,
main = "Columns with high values of outliers",
names = c("Informational", "Informational_Duration", "Page Values"),
col = c("orange", "red"),
border = "brown",
notch = TRUE)
```


Columns with high values of outliers



Observations - All outliers are contained above the third quantile. - The outliers may be true values as sometimes durations spent on a page may be long

4. Exploratory Data Analysis

```
# Frequency distribution of categorical columns
sapply(df[, c(10:18)], table)
```

```
## $SpecialDay
##
##      0   0.2   0.4   0.6   0.8   1
## 10918  178  242  348  324  154
##
## $Month
##
##   Aug  Dec  Feb  Jul  June  Mar  May  Nov  Oct  Sep
##   433 1706  169  431  285 1842 3321 2980  549  448
##
## $OperatingSystems
##
##      1      2      3      4      5      6      7      8
## 2539 6519 2523  476      6     19      7     75
##
## $Browser
##
```

```
##      1      2      3      4      5      6      7      8      9     10     11     12     13
## 2418 7859  104   727  464   174   49   134     1   162     6    10    56
##
## $Region
##
##      1      2      3      4      5      6      7      8      9
## 4701 1122 2374 1164  315   800   755  431  502
##
## $TrafficType
##
##      1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16
## 2373 3905 2002 1064  259   440   40   343   41   450   247     1   727    13    36     3
##      17     18     19     20
##      1     10     17    192
##
## $VisitorType
##
##      New_Visitor      Other Returning_Visitor
##      1693          81          10390
##
## $Weekend
##
## FALSE  TRUE
##  9311  2853
##
## $Revenue
##
## FALSE  TRUE
## 10256  1908
```

Summary of frequency table - SpecialDay 0 has the highest count - May and November receives the highest traffic - Operating system 2 is the most used to visit the site - Browser 2 is most used by visitors - Most visitors to the site are from Region 1 - Most of the traffic to the website is of type 2 and 1 - Most of the visitors to the site are mostly returning visitors - Most visitors visit the site during the weekday - Most visits to the site do not earn revenue

```
# Number of visits to product related pages per month
product_stats <- df %>% select(ProductRelated, ProductRelated_Duration, Month)%>%group_by(Month)%>% sum
product_stats[order(product_stats$ProductRelated, decreasing = TRUE),]
```

```
## # A tibble: 10 x 3
##   Month ProductRelated ProductRelated_Duration
##   <chr>         <dbl>         <dbl>
## 1 Nov           46.3          1769.
## 2 Aug           38.3          1273.
## 3 Jul           36.5          1220.
## 4 June          36.4          1226.
## 5 Oct           33.6          1117.
## 6 Sep           33.1          1253.
## 7 Dec           28.3          1125.
## 8 May           26.8           995.
## 9 Mar           20.5           841.
## 10 Feb          12.1           513.
```

November had the highest number of visits to product related pages with the highest duration

```
# Distribution of revenue generating visits among visitors
df %>% select(VisitorType, Revenue)%>% group_by(VisitorType, Revenue)%>% summarise(visits = n())%>% filter(Revenue > 1000)
```

'summarise()' has grouped output by 'VisitorType'. You can override using the '.groups' argument.

```
## # A tibble: 3 x 3
## # Groups:   VisitorType [3]
##   VisitorType      Revenue visits
##   <chr>          <lgl>    <int>
## 1 New_Visitor    TRUE      422
## 2 Other          TRUE       16
## 3 Returning_Visitor TRUE     1470
```

Returning visitors have the generate the most revenue.

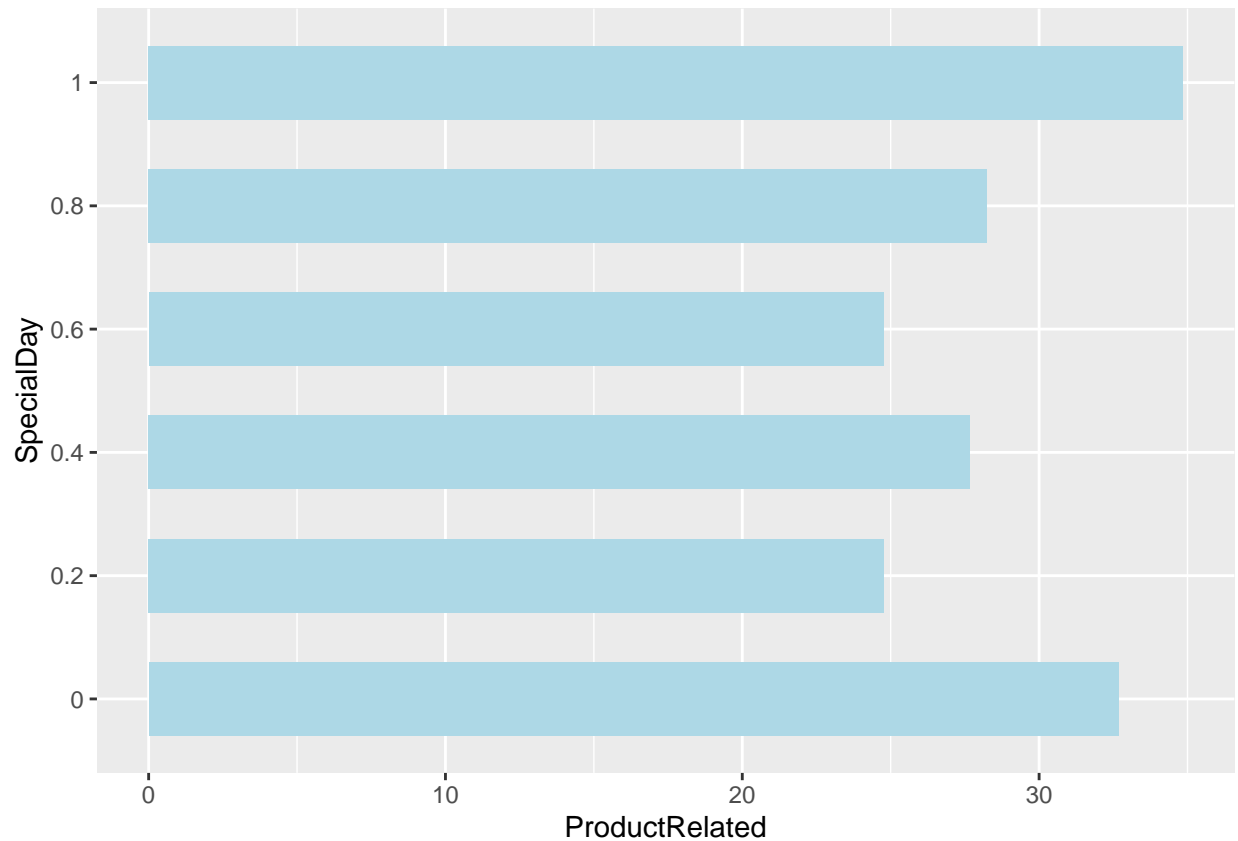
```
# Distribution of revenue generating visits among regions
df %>% select(Region, Revenue)%>% group_by(Region, Revenue)%>% summarise(visits = n())%>% filter(Revenue > 1000)
```

'summarise()' has grouped output by 'Region'. You can override using the '.groups' argument.

```
## # A tibble: 9 x 3
## # Groups:   Region [9]
##   Region Revenue visits
##   <dbl> <lgl>    <int>
## 1     1 TRUE      771
## 2     2 TRUE      188
## 3     3 TRUE      349
## 4     4 TRUE      175
## 5     5 TRUE       52
## 6     6 TRUE      112
## 7     7 TRUE      119
## 8     8 TRUE       56
## 9     9 TRUE       86
```

Visitors from Region 1 make most revenue generating visits

```
# Get page values and visits to product pages based on proximity to a special day
special_product <- df %>% select(SpecialDay, PageValues, ProductRelated, ProductRelated_Duration)%>% group_by(SpecialDay, ProductRelated)
ggplot(special_product, aes(x = factor(SpecialDay), y=ProductRelated))+
  geom_bar(fill = 'lightblue', stat = "identity", width = 0.6) +
  labs(x = 'SpecialDay')+
  coord_flip()
```

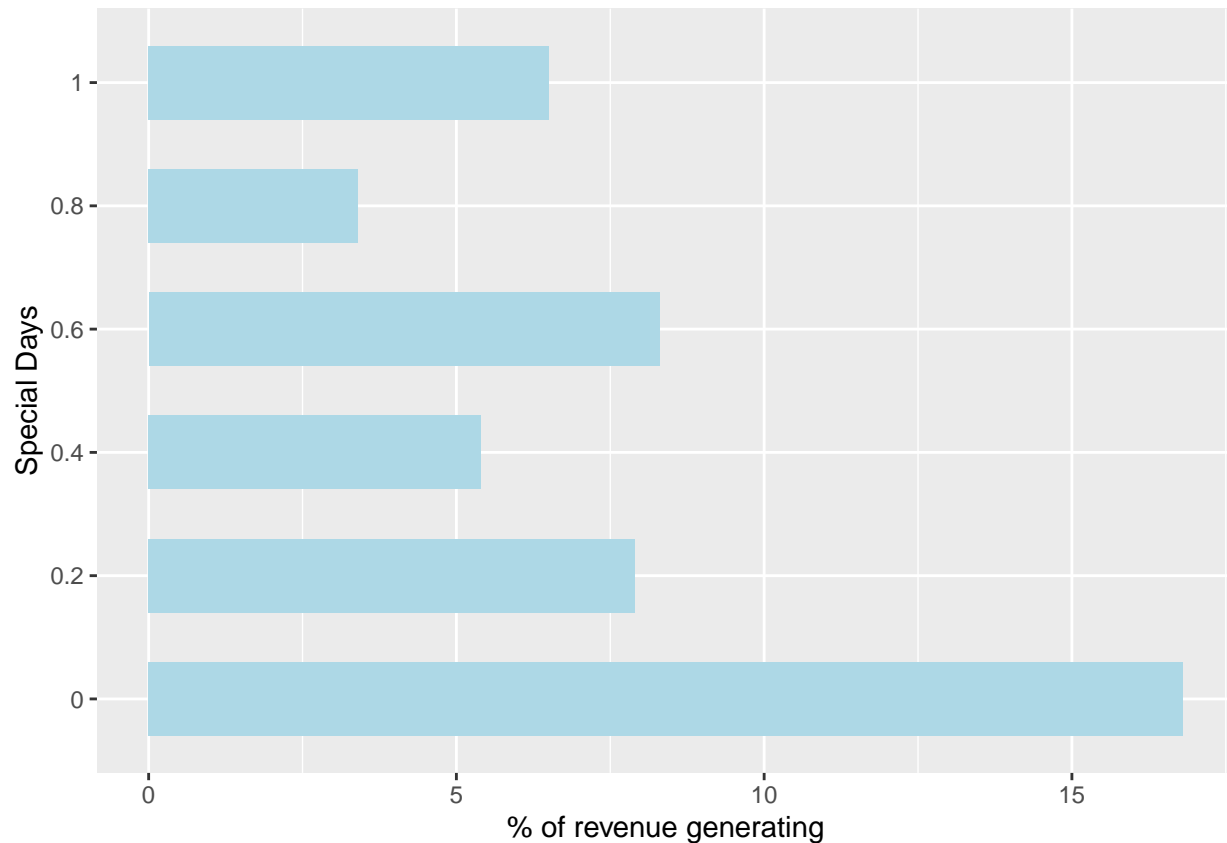


On special days customers visit the highest number of product related pages, with the highest mean number of pages visited.

```
# Distribution of revenue generating visits based on proximity to special days
revenue_special <- df %>% select(SpecialDay, Revenue)%>% group_by(SpecialDay, Revenue)%>% summarise(count = count(SpecialDay, Revenue))
```

'summarise()' has grouped output by 'SpecialDay'. You can override using the '.groups' argument.

```
revenue_special <- revenue_special[order(revenue_special$freq, decreasing = TRUE),]
ggplot(revenue_special, aes(x = factor(SpecialDay), y=freq))+
  geom_bar(fill = 'lightblue', stat = "identity", width = 0.6) +
  labs(y = '% of revenue generating', x = 'Special Days' )+
  coord_flip()
```



> Ordinary days have the highest percentage of visits that are income generating

Get bounce rates and exit rates among visitor groups

```
visitor_stats <- df %>% select(VisitorType, ExitRates, BounceRates)%>% group_by(VisitorType)%>% summarise(
  visitor_stats
```

```
## # A tibble: 3 x 3
```

```
##   VisitorType      ExitRates BounceRates
##   <chr>          <dbl>      <dbl>
## 1 New_Visitor    0.0206    0.00515
## 2 Other          0.0566    0.0306
## 3 Returning_Visitor 0.0443    0.0223
```

Observations - Other visitors have the highest exit rates and bounce rates - New_Visitor have the lowest exit and bounce rates

Page views and durations based on visitor type

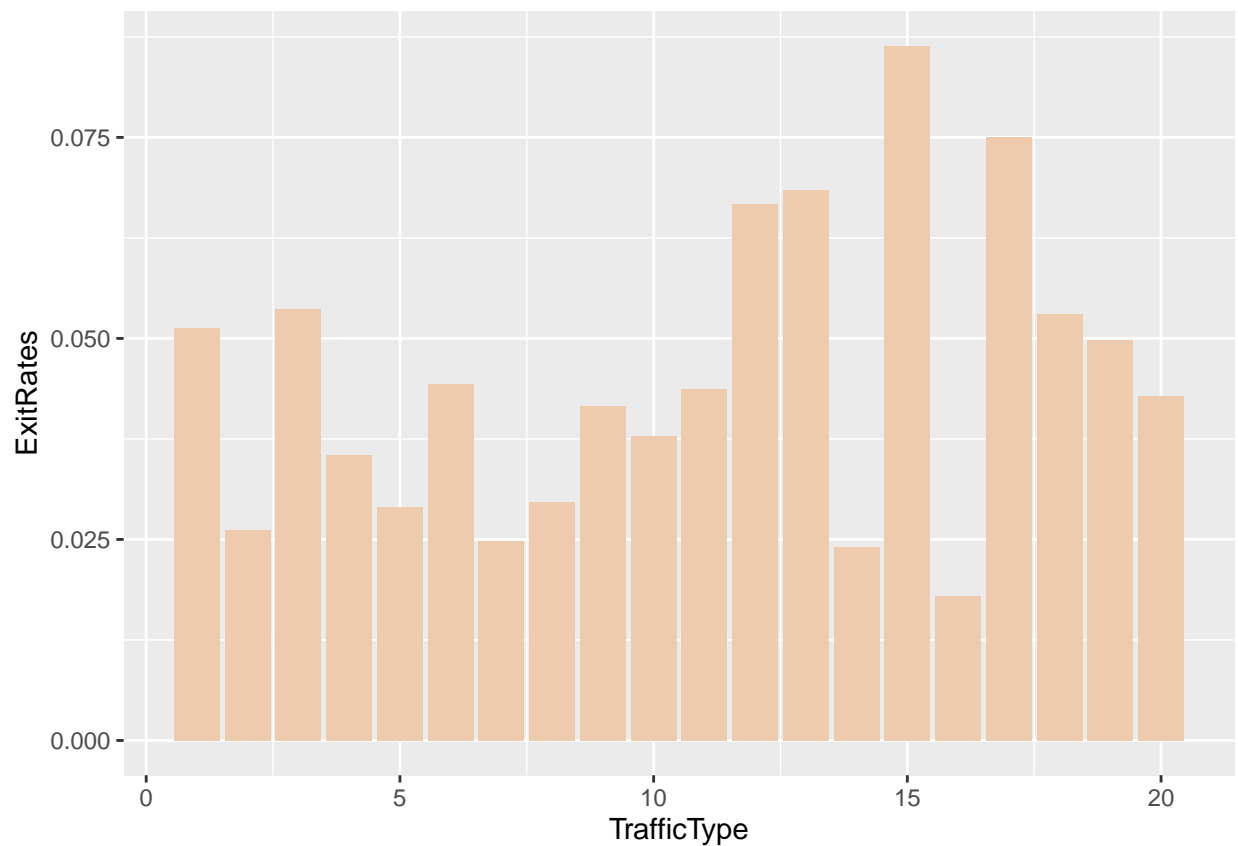
```
df %>% select(VisitorType, Administrative:ProductRelated_Duration)%>% group_by(VisitorType)%>% summarise(
```

```
## # A tibble: 3 x 7
```

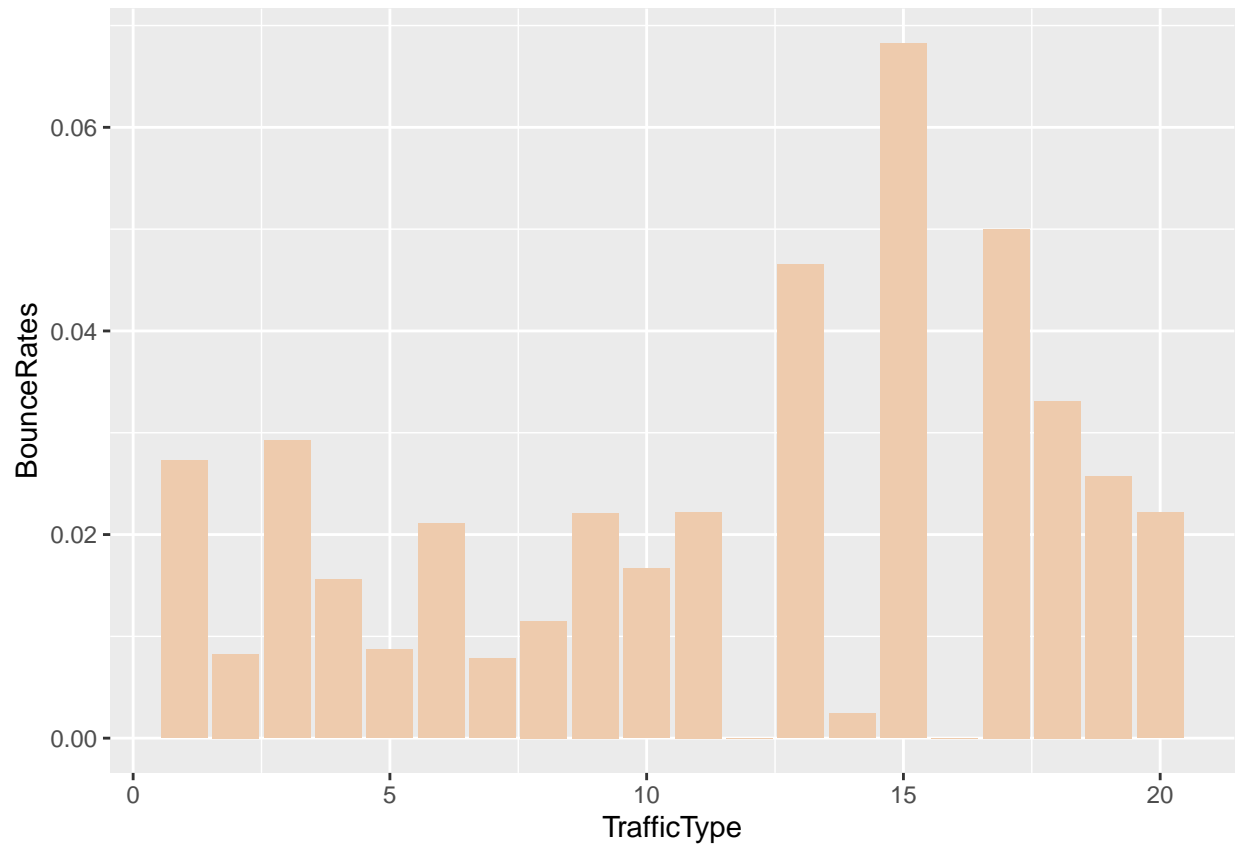
```
##   VisitorType      Administrative Administrative_D~ Informational Informational_Du~
##   <chr>          <dbl>          <dbl>          <dbl>          <dbl>
## 1 New_Visitor    2.55          92.0          0.334          19.2
## 2 Other          1.54          65.8          0.185          12.3
## 3 Returning_Vi~  2.32          80.4          0.542          37.7
## # ... with 2 more variables: ProductRelated <dbl>,
## #   ProductRelated_Duration <dbl>
```

Observations - On average that New_Vistor have the longest Administrative_Duration followed by Returning_Visitor and lastly Other - Returning_Visitor have on average the longest Informational_Duration and ProductRelated_Duration

```
traffic_stats <- df %>% select(TrafficType, ExitRates, BounceRates)%>% group_by(TrafficType)%>% summariz
par(mfrow = c(1,2))
ggplot(traffic_stats, aes(x=TrafficType, y = ExitRates))+
  geom_bar(stat = "identity", fill="peachpuff2")
```

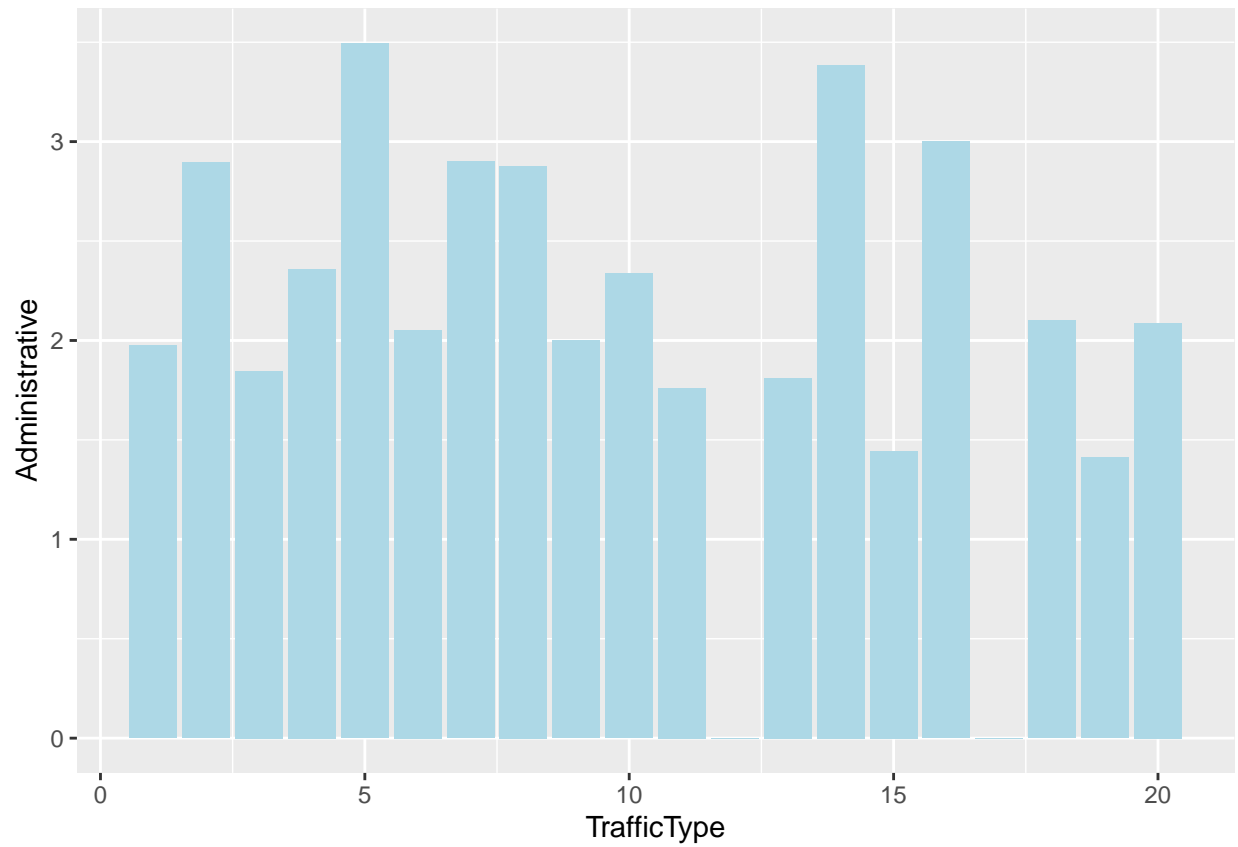


```
ggplot(traffic_stats, aes(x=TrafficType, y = BounceRates))+
  geom_bar(stat = "identity", fill="peachpuff2")
```

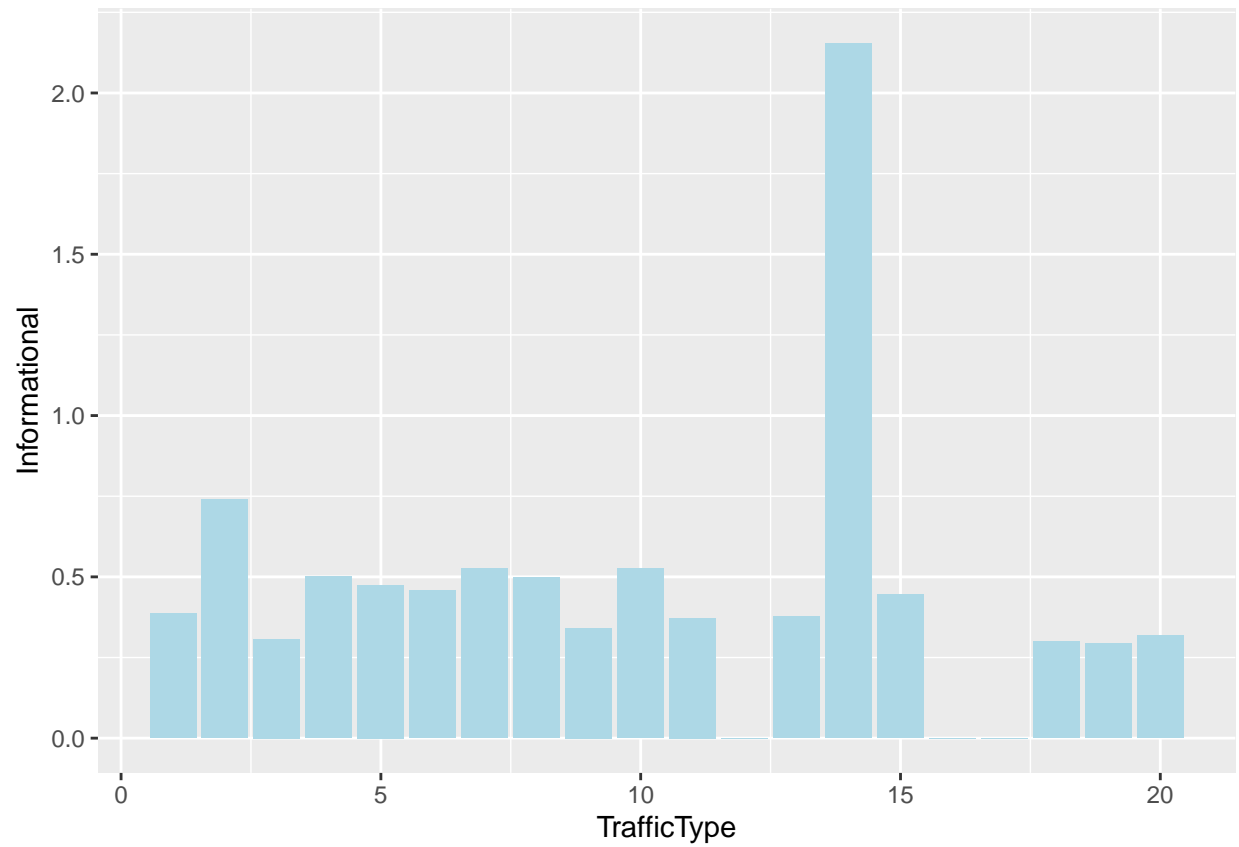


> Traffic of type 15 have the highest bounce rates and average rates on average

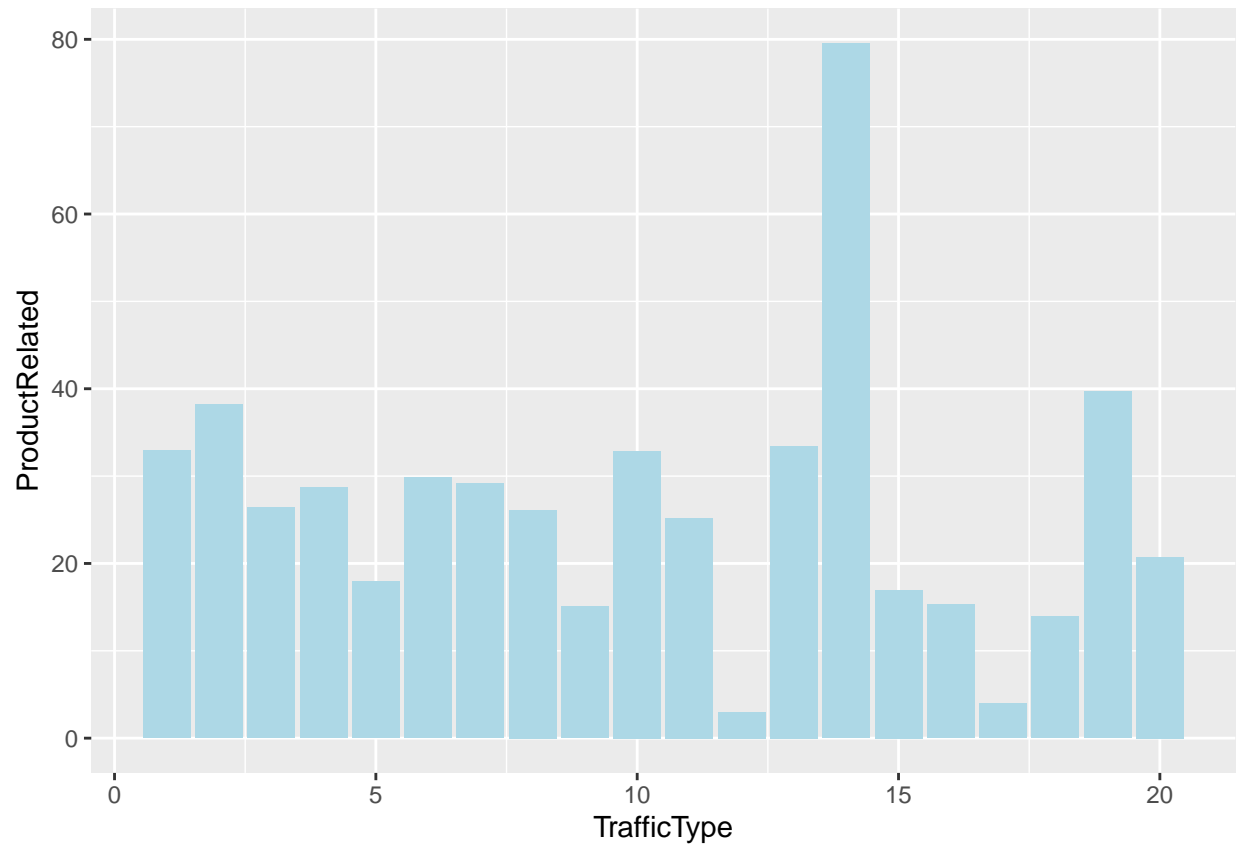
```
traffic_page_stats <- df %>% select(TrafficType, Administrative:ProductRelated_Duration)%>% group_by(TrafficType)
par(mfrow = c(1,3))
ggplot(traffic_page_stats, aes(x=TrafficType, y = Administrative))+
  geom_bar(stat = "identity", fill="lightblue")
```



```
ggplot(traffic_page_stats, aes(x=TrafficType, y = Informational))+  
  geom_bar(stat = "identity", fill="lightblue")
```

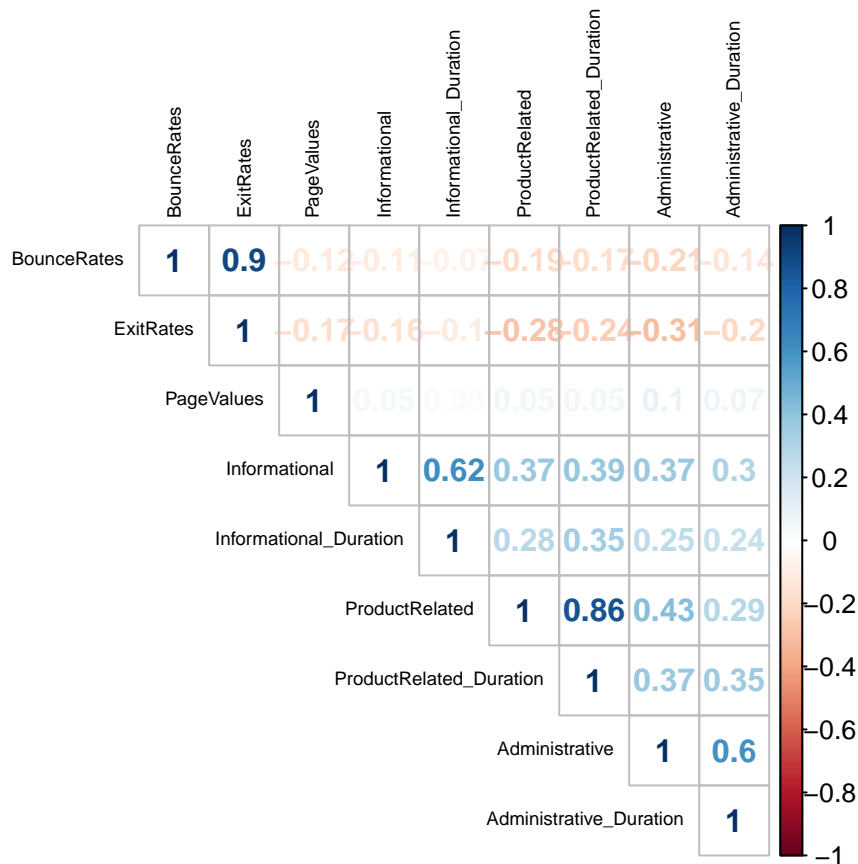



```
ggplot(traffic_page_stats, aes(x=TrafficType, y = ProductRelated))+  
  geom_bar(stat = "identity", fill="lightblue")
```



Observations - Traffic 5 on average experiences the highest number of administrative visits - Traffic 14 on average experiences the highest number of informational visits - Traffic 14 on average experiences the highest number of ProductRelated visits

```
# Correlational plot
corrplot(corr = cor(df[, c(1:9)]), method = "number", type = "upper", order = "hclust", tl.col = "black")
```



5. Solution Implementation

K-Means Clustering

```
# One hot encode categorical features
new_shoppers <- df[, 1:17]
# new_shoppers[, 10:16] <- as.character(new_shoppers[, 10:16])
dmy <- dummyVars("~ SpecialDay + Month + OperatingSystems + Browser + Region + TrafficType + VisitorType")
ohe <- data.frame(predict(dmy, newdata = new_shoppers))
model_data <- cbind(new_shoppers[, 1:9], ohe)
model_data$Weekend <- as.numeric(df$Weekend)
head(model_data)
```

```
##      Administrative Administrative_Duration Informational Informational_Duration
## 1              0                      0              0                      0
## 2              0                      0              0                      0
## 3              0                      0              0                      0
## 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  0.20000000  0.2000000  0
## 2              2              64.000000  0.00000000  0.1000000  0
```

```
## 3          2          2.666667 0.05000000 0.1400000          0
## 4         10         627.500000 0.02000000 0.0500000          0
## 5         19         154.216667 0.01578947 0.0245614          0
## 6          2          37.000000 0.00000000 0.1000000          0
##   SpecialDay MonthAug MonthDec MonthFeb MonthJul MonthJune MonthMar MonthMay
## 1          0.0          0          0          1          0          0          0          0
## 2          0.0          0          0          1          0          0          0          0
## 3          0.0          0          0          1          0          0          0          0
## 4          0.0          0          0          1          0          0          0          0
## 5          0.0          0          0          1          0          0          0          0
## 6          0.8          0          0          1          0          0          0          0
##   MonthNov MonthOct MonthSep OperatingSystems Browser Region TrafficType
## 1          0          0          0              1          1          1          1
## 2          0          0          0              2          2          1          2
## 3          0          0          0              3          2          2          4
## 4          0          0          0              3          3          1          4
## 5          0          0          0              2          2          1          3
## 6          0          0          0              2          2          2          3
##   VisitorTypeNew_Visitor VisitorTypeOther VisitorTypeReturning_Visitor Weekend
## 1                      0                      0                      1          0
## 2                      0                      0                      1          0
## 3                      0                      0                      1          0
## 4                      0                      0                      1          1
## 5                      0                      0                      1          0
## 6                      0                      0                      1          0
```

```
colnames(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"
```

```
# Normalizing the continuous features
```

```
model_data[, 1:9] <- normalize(model_data[, 1:9], method = "range")
```

```
# Performing k-mean clustering with 5 clusters
```

```
customer_groups <- kmeans(model_data, centers = 5, nstart = 25)
str(customer_groups)
```

```
## List of 9
```

```
## $ cluster      : Named int [1:12164] 4 4 4 4 4 4 2 4 4 4 ...
```

```
##   ..- attr(*, "names")= chr [1:12164] "1" "2" "3" "4" ...
```

```
## $ centers      : num [1:5, 1:28] 0.0871 0.0781 0.0793 0.0911 0.0747 ...
```

```
##   ..- attr(*, "dimnames")=List of 2
```

```
##     .. ..$ : chr [1:5] "1" "2" "3" "4" ...
```

```
##     .. ..$ : chr [1:28] "Administrative" "Administrative_Duration" "Informational" "Informational_Dura"
```

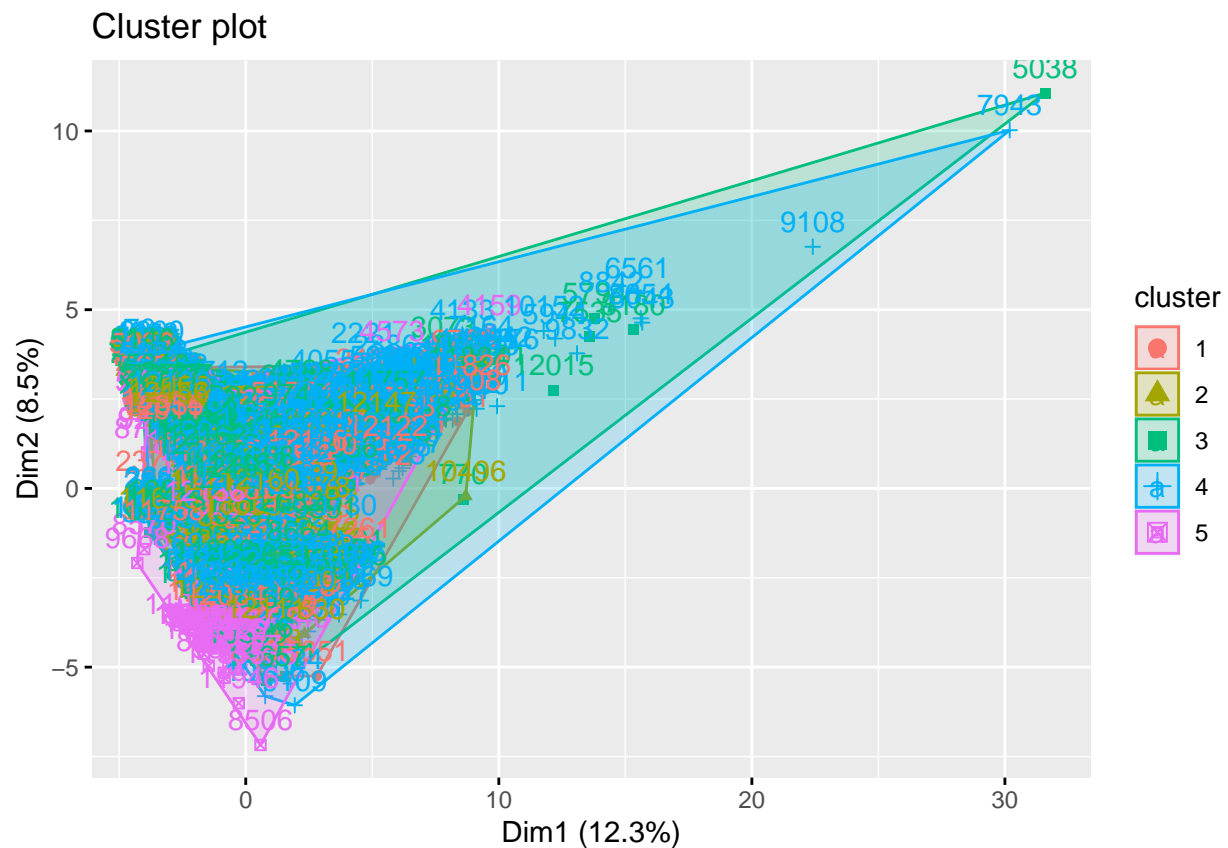
```
## $ totss      : num 329285
## $ withinss   : num [1:5] 15834 13026 23894 34071 9369
## $ tot.withinss: num 96194
## $ betweenss  : num 233091
## $ size       : int [1:5] 2253 1250 1855 6584 222
## $ iter       : int 4
## $ ifault     : int 0
## - attr(*, "class")= chr "kmeans"
```

```
# Cluster sizes
customer_groups$size
```

```
## [1] 2253 1250 1855 6584 222
```

The first cluster has the most components

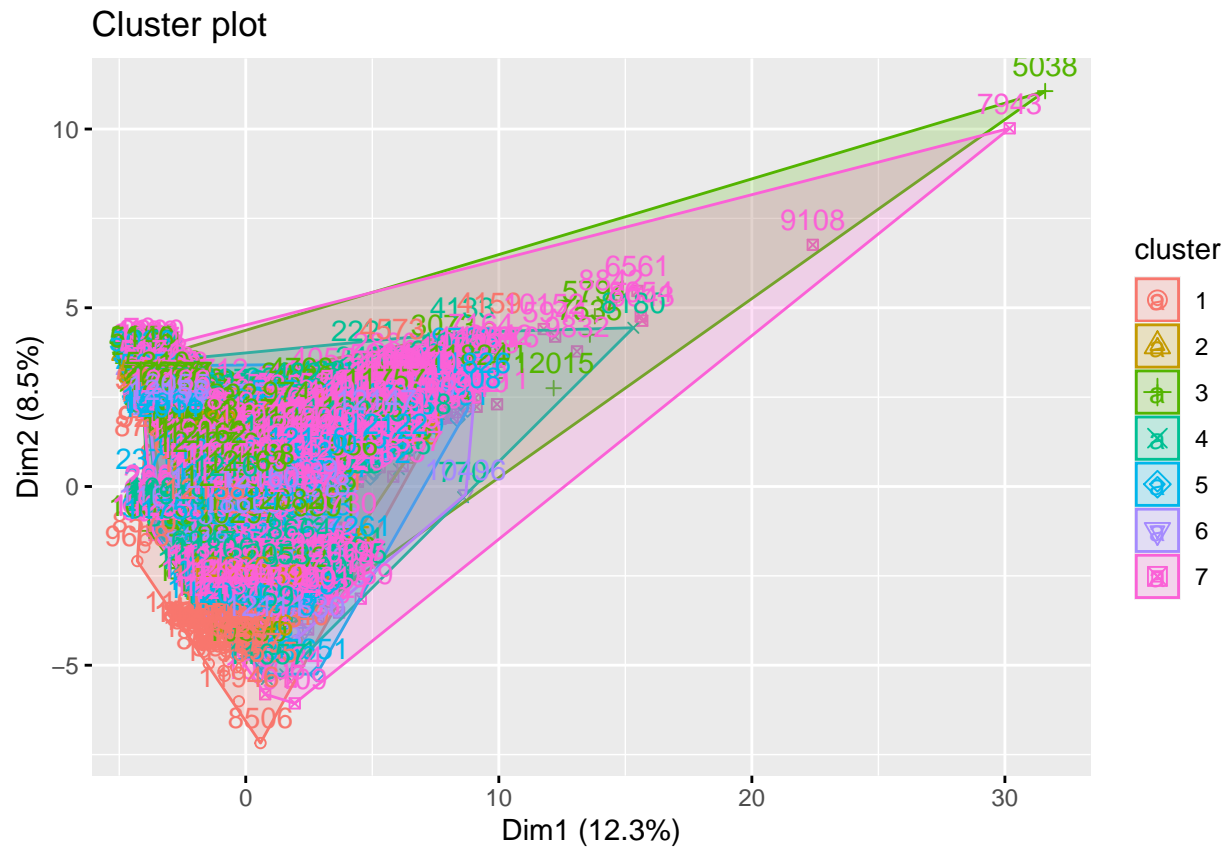
```
# Visualizing the clusters
fviz_cluster(customer_groups, data = model_data)
```



```
# 7 clusters
customer_groups <- kmeans(model_data, centers = 7, nstart = 25)
customer_groups$size
```

```
## [1] 221 410 1185 1569 2183 727 5869
```

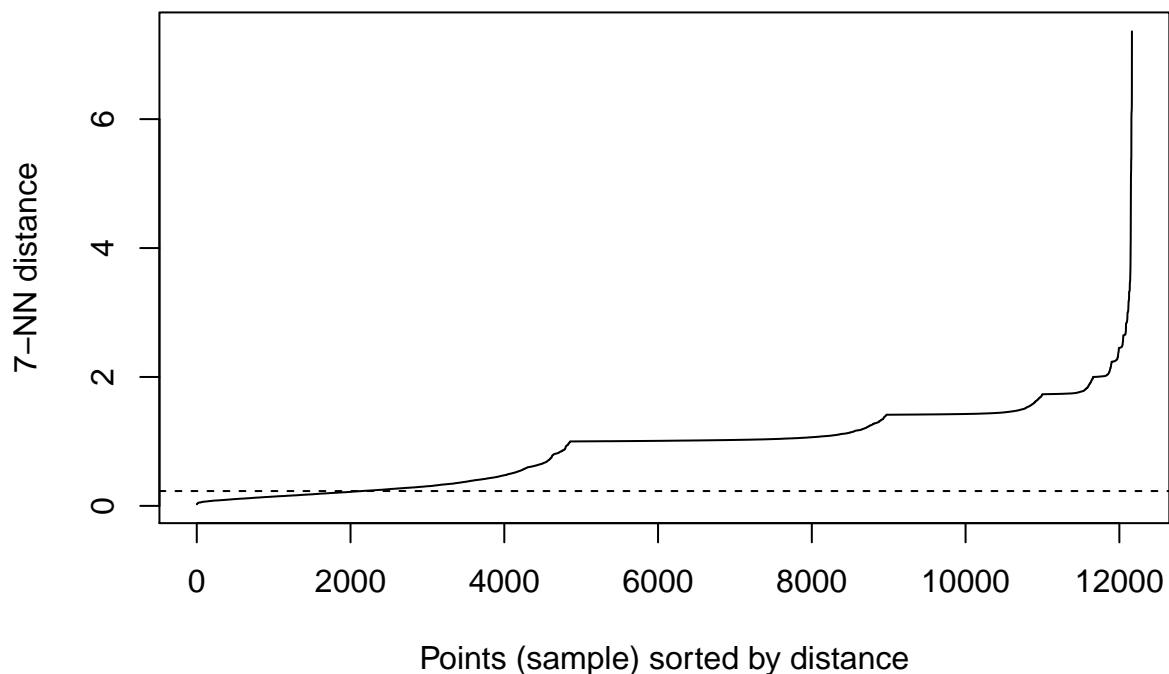
```
fviz_cluster(customer_groups, data = model_data)
```



After dimension reduction using PCA, the data has been separated into 7 distinct clusters.

Hierachical Clustering

```
# Determining the optimal value for epsilon
dbscan::kNNdistplot(model_data, k = 7)
abline(h = 0.23, lty = 2)
```



```
db_groups <- dbscan::dbscan(model_data, eps = 0.23, minPts = 7)
db_groups
```

```
## DBSCAN clustering for 12164 objects.
## Parameters: eps = 0.23, minPts = 7
## The clustering contains 206 cluster(s) and 8886 noise points.
##
##      0      1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
## 8886      9     29     83     15     43     19     57      9      9     24     25      7      8      7      7
##      16     17     18     19     20     21     22     23     24     25     26     27     28     29     30     31
##      17     14      8     14      9     16     14     25     26     16     11      9      8      7     11     11
##      32     33     34     35     36     37     38     39     40     41     42     43     44     45     46     47
##       8      8     11      7     12     21      7      9      8      7      7     15     10     19     16     29
##      48     49     50     51     52     53     54     55     56     57     58     59     60     61     62     63
##      20     73     13      9      7      7      7     32     27     15     12      9     73     21      8     11
##      64     65     66     67     68     69     70     71     72     73     74     75     76     77     78     79
##       9     14     33     13      9     13      8     11     10      9     13     17     10     10      8      8
##      80     81     82     83     84     85     86     87     88     89     90     91     92     93     94     95
##       8     10      7     12      8     11     11     11      8      7      7      7      7      7      9      7
##      96     97     98     99    100    101    102    103    104    105    106    107    108    109    110    111
##       7      7      7      7      7      7      7     20      8     13     23     13     16      7     11     28
##     112    113    114    115    116    117    118    119    120    121    122    123    124    125    126    127
##       8     19      8     10     12    168      8     51      9     15     42     69      9      7     20     55
##     128    129    130    131    132    133    134    135    136    137    138    139    140    141    142    143
##      13     10     41     16     20     27     33      7      7     18      8      7     14     38     69     20
```

```
## 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159
## 36 30 20 12 13 37 26 7 11 11 23 14 30 10 21 11
## 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175
## 11 8 11 10 23 16 18 26 8 7 13 7 9 17 8 20
## 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191
## 12 8 12 8 7 13 9 12 10 7 11 10 7 7 14 7
## 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206
## 8 10 7 7 8 7 8 7 7 7 9 11 7 7 7
##
## Available fields: cluster, eps, minPts
```

```
fviz_cluster(db_groups, model_data, geom="point")
```

```
## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '26'
```

```
## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '27'
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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```

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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

```

```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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```

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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

```

```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

```

```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '26'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '27'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '28'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '29'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '30'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '31'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8f

```

```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '26'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '26'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '27'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '27'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '28'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '28'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '29'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '29'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '30'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '30'

```

```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '31'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): unimplemented
## pch value '31'

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x7f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x81

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

```



```

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x8f

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
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## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x90

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4

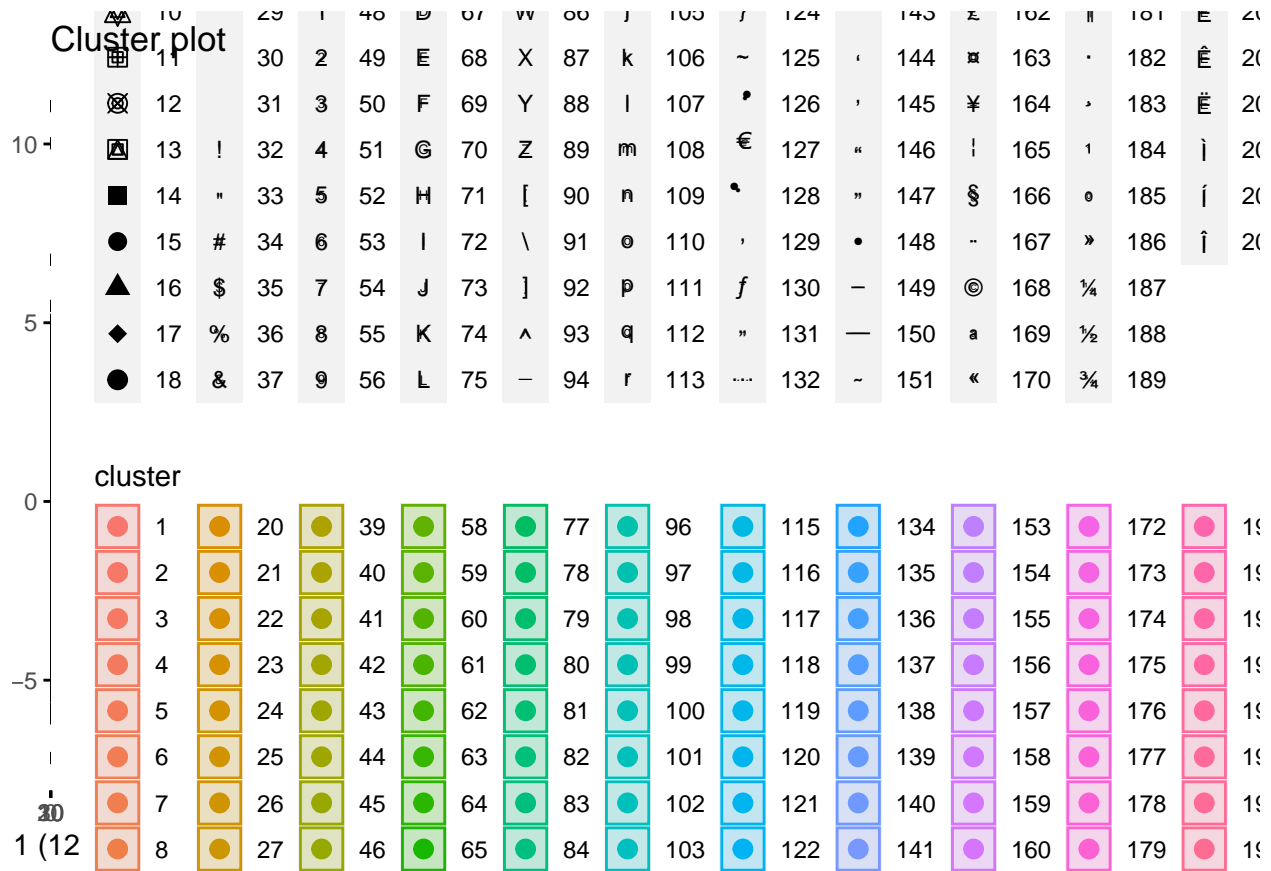
## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d

## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x9d

```

```
## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font width
## unknown for character 0x4
```

```
## Warning in grid.Call.graphics(C_points, x$x, x$y, x$pch, x$size): font metrics
## unknown for character 0x9d
```



The clusters in our data are spherical

Cluster Analysis

```
df <- df %>% mutate(group = customer_groups$cluster)
head(df)
```

```
## # A tibble: 6 x 19
##   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             0             0             0             2
## 4             0             0             0             0            10
## 5             0             0             0             0            19
## 6             0             0             0             0             2
## # ... with 14 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>, group <int>
```

```
# Summary Statistics
```

```
summary_stats <- df %>% group_by(group)%>% select(Administrative:PageValues, group)%>% summarise_all(me
summary_stats
```

```
## # A tibble: 7 x 10
```

```
##   group Administrative Administrative_Durati~ Informational Informational_Durat~
##   <int>          <dbl>          <dbl>          <dbl>          <dbl>
## 1     1           2.02           78.3           0.312           30.8
## 2     2           1.99           75.0           0.405           19.7
## 3     3           2.00           73.0           0.449           28.5
## 4     4           2.56           85.0           0.516           32.7
## 5     5           2.33           78.7           0.469           30.2
## 6     6           2.18           74.3           0.398           31.3
## 7     7           2.42           85.7           0.565           40.3
```

```
## # ... with 5 more variables: ProductRelated <dbl>,
## #   ProductRelated_Duration <dbl>, BounceRates <dbl>, ExitRates <dbl>,
## #   PageValues <dbl>
```