Project_stat

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Libraries

```
library(ggplot2)
library(tidyverse)
library(leaps)
library(ggcorrplot)
library(regclass)
library(boot)
#library(caret)
library(MASS)
library(knitr)
library(corrplot)
library(glmnet)
library(plotly)
```

Hotel booking demand dataset

We decided to analyze the *Hotel booking demand dataset* that we load from Kaggle. This dataset contains information about two different kinds of hotel: City Hotel and Resort Hotel. Each observation represents an ho.tel booking. Both hotels are located in Portugal: the resort hotel at the resort region of Algarve and the city hotel at the city of Lisbon.

```
# Load the dataset

hotel_bookings <- read.csv("hotel_bookings.csv", na.strings="NULL")
View(hotel_bookings)
```

Dataset Pre-Processing

The dataset contains 32 variables describing 119390 observations.

```
# First look to the dataset

glimpse(hotel_bookings)
```

```
## Rows: 119,390
## Columns: 32
## $ hotel                          <chr> "Resort Hotel", "Resort Hotel", "Resort~
## $ is_canceled                    <int> 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, ~
## $ lead_time                      <int> 342, 737, 7, 13, 14, 14, 0, 9, 85, 75, ~
## $ arrival_date_year              <int> 2015, 2015, 2015, 2015, 2015, 2015, 201~
## $ arrival_date_month             <chr> "July", "July", "July", "July", "July",~
## $ arrival_date_week_number       <int> 27, 27, 27, 27, 27, 27, 27, 27, 27, 27,~
## $ arrival_date_day_of_month      <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ~
## $ stays_in_weekend_nights        <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ stays_in_week_nights           <int> 0, 0, 1, 1, 2, 2, 2, 2, 3, 3, 4, 4, 4, ~
## $ adults                         <int> 2, 2, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, ~
## $ children                       <chr> "0", "0", "0", "0", "0", "0", "0", "0",~
## $ babies                         <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ meal                           <chr> "BB", "BB", "BB", "BB", "BB", "BB", "BB~
## $ country                        <chr> "PRT", "PRT", "GBR", "GBR", "GBR", "GBR~
## $ market_segment                 <chr> "Direct", "Direct", "Direct", "Corporat~
## $ distribution_channel           <chr> "Direct", "Direct", "Direct", "Corporat~
## $ is_repeated_guest              <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ previous_cancellations         <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ previous_bookings_not_canceled <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ reserved_room_type             <chr> "C", "C", "A", "A", "A", "A", "C", "C",~
## $ assigned_room_type             <chr> "C", "C", "C", "A", "A", "A", "C", "C",~
## $ booking_changes                <int> 3, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ deposit_type                   <chr> "No Deposit", "No Deposit", "No Deposit~
## $ agent                          <int> NA, NA, NA, 304, 240, 240, NA, 303, 240~
## $ company                        <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA,~
## $ days_in_waiting_list           <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ customer_type                  <chr> "Transient", "Transient", "Transient", ~
## $ adr                            <dbl> 0.00, 0.00, 75.00, 75.00, 98.00, 98.00,~
## $ required_car_parking_spaces    <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ~
## $ total_of_special_requests      <int> 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 3, ~
## $ reservation_status             <chr> "Check-Out", "Check-Out", "Check-Out", ~
## $ reservation_status_date        <chr> "2015-07-01", "2015-07-01", "2015-07-02~
```

As we can see from the code above, there are many character variables that we converted into factors. Furthermore, we noticed that some categorical variables like *children* were numeric, so we converted them.

```r
# Convert character columns into factors

hotel_bookings_new <- as.data.frame(unclass(hotel_bookings),
                      stringsAsFactors = TRUE)

# Convert binary columns "is_canceled" and "is_repeated_guest" into factor

hotel_bookings_new$is_canceled <- as.factor(hotel_bookings_new$is_canceled)
levels(hotel_bookings_new$is_canceled) <- c(0, 1)

hotel_bookings_new$is_repeated_guest <- as.factor(hotel_bookings_new$is_repeated_guest)
levels(hotel_bookings_new$is_repeated_guest) <- c(0, 1)

# Convert column "arrival_date_year" into factor

hotel_bookings_new$arrival_date_year <- as.factor(hotel_bookings_new$arrival_date_year)
levels(hotel_bookings_new$arrival_date_year) <- c("2015", "2016", "2017")
```

```r
# Convert column "children" into numeric

hotel_bookings_new$children <- as.numeric(as.character(hotel_bookings_new$children))

# Convert column "reservation status date" into date

hotel_bookings_new$reservation_status_date <- as.Date(
  hotel_bookings_new$reservation_status_date, format = "%Y-%m-%d")
```

The dataset provides two different variables for the stay: *stays_in_weekend_nights* and *stays_in_week_nights*. We decided to add the sum of these two variables as a new variable *total_stays* for ease of analyses.

```r
# New column for total stays

hotel_bookings_new=hotel_bookings_new%>%
  mutate(total_stays=(stays_in_week_nights + stays_in_weekend_nights) )
```

Missing values

```r
colSums(is.na(hotel_bookings_new))[colSums(is.na(hotel_bookings_new))>0]
```

```
## children  country    agent  company
##        4      488    16340   112593
```

Since there are only 4 Nan values for the variable *children*, we decided to replace them with the value 0. The variables *agent* and *company* have too many Nan values, therefore we removed them. We left untouched the variable *country* because we did not use it in our models.

```r
# Replacing missing values in children column from the corresponding babies column

n_children <- length(hotel_bookings_new$children)
for (i in 1:n_children) {
  if (is.na(hotel_bookings_new$children[i]))
    hotel_bookings_new$children[i] <- 0
}

# Remove columns "agent" and "company"

index_agent <- which(colnames(hotel_bookings_new)=="agent")
index_company <- which(colnames(hotel_bookings_new)=="company")
hotel_bookings_new = hotel_bookings_new[-c(index_agent, index_company)]
```

At the end of the pre-processing, we obtained the following dataset:

```
##           hotel       is_canceled   lead_time   arrival_date_year
##  City Hotel  :79330   0:75166     Min.   :  0   2015:21996
##  Resort Hotel:40060   1:44224     1st Qu.: 18   2016:56707
##                                   Median : 69   2017:40687
##                                   Mean   :104
##                                   3rd Qu.:160
##                                   Max.   :737
##
##  arrival_date_month arrival_date_week_number arrival_date_day_of_month
##  August :13877      Min.   : 1.00            Min.   : 1.0
##  July   :12661      1st Qu.:16.00            1st Qu.: 8.0
##  May    :11791      Median :28.00            Median :16.0
##  October:11160      Mean   :27.17            Mean   :15.8
##  April  :11089      3rd Qu.:38.00            3rd Qu.:23.0
##  June   :10939      Max.   :53.00            Max.   :31.0
##  (Other):47873
##  stays_in_weekend_nights stays_in_week_nights     adults
##  Min.   : 0.0000         Min.   : 0.0         Min.   : 0.000
##  1st Qu.: 0.0000         1st Qu.: 1.0         1st Qu.: 2.000
##  Median : 1.0000         Median : 2.0         Median : 2.000
##  Mean   : 0.9276         Mean   : 2.5         Mean   : 1.856
##  3rd Qu.: 2.0000         3rd Qu.: 3.0         3rd Qu.: 2.000
##  Max.   :19.0000         Max.   :50.0         Max.   :55.000
##
##     children           babies                 meal          country
##  Min.   : 0.0000   Min.   : 0.000000   BB       :92310   PRT    :48590
##  1st Qu.: 0.0000   1st Qu.: 0.000000   FB       :  798   GBR    :12129
##  Median : 0.0000   Median : 0.000000   HB       :14463   FRA    :10415
##  Mean   : 0.1039   Mean   : 0.007949   SC       :10650   ESP    : 8568
##  3rd Qu.: 0.0000   3rd Qu.: 0.000000   Undefined: 1169   DEU    : 7287
##  Max.   :10.0000   Max.   :10.000000                     (Other):31913
##                                                          NA's   :  488
##       market_segment  distribution_channel is_repeated_guest
##  Online TA    :56477   Corporate: 6677      0:115580
##  Offline TA/TO:24219   Direct   :14645      1:  3810
##  Groups       :19811   GDS      :  193
##  Direct       :12606   TA/TO    :97870
##  Corporate    : 5295   Undefined:    5
##  Complementary:  743
##  (Other)      :  239
##  previous_cancellations previous_bookings_not_canceled reserved_room_type
##  Min.   : 0.00000       Min.   : 0.0000                A      :85994
##  1st Qu.: 0.00000       1st Qu.: 0.0000                D      :19201
##  Median : 0.00000       Median : 0.0000                E      : 6535
##  Mean   : 0.08712       Mean   : 0.1371                F      : 2897
##  3rd Qu.: 0.00000       3rd Qu.: 0.0000                G      : 2094
##  Max.   :26.00000       Max.   :72.0000                B      : 1118
##                                                        (Other): 1551
##  assigned_room_type booking_changes       deposit_type    days_in_waiting_list
##  A      :74053      Min.   : 0.0000   No Deposit:104641   Min.   :  0.000
##  D      :25322      1st Qu.: 0.0000   Non Refund: 14587   1st Qu.:  0.000
##  E      : 7806      Median : 0.0000   Refundable:   162   Median :  0.000
##  F      : 3751      Mean   : 0.2211                       Mean   :  2.321
##  G      : 2553      3rd Qu.: 0.0000                       3rd Qu.:  0.000
##  C      : 2375      Max.   :21.0000                       Max.   :391.000
##  (Other): 3530
##          customer_type        adr          required_car_parking_spaces
##  Contract       : 4076   Min.   :  -6.38   Min.   :0.00000
##  Group          :  577   1st Qu.:  69.29   1st Qu.:0.00000
##  Transient      :89613   Median :  94.58   Median :0.00000
##  Transient-Party:25124   Mean   : 101.83   Mean   :0.06252
##                          3rd Qu.: 126.00   3rd Qu.:0.00000
##                          Max.   :5400.00   Max.   :8.00000
##
##  total_of_special_requests reservation_status reservation_status_date
##  Min.   :0.0000           Canceled :43017    Min.   :2014-10-17
##  1st Qu.:0.0000           Check-Out:75166    1st Qu.:2016-02-01
##  Median :0.0000           No-Show  : 1207    Median :2016-08-07
##  Mean   :0.5714                              Mean   :2016-07-30
##  3rd Qu.:1.0000                              3rd Qu.:2017-02-08
##  Max.   :5.0000                              Max.   :2017-09-14
##
##   total_stays
##  Min.   : 0.000
##  1st Qu.: 2.000
##  Median : 3.000
##  Mean   : 3.428
##  3rd Qu.: 4.000
##  Max.   :69.000
##
```

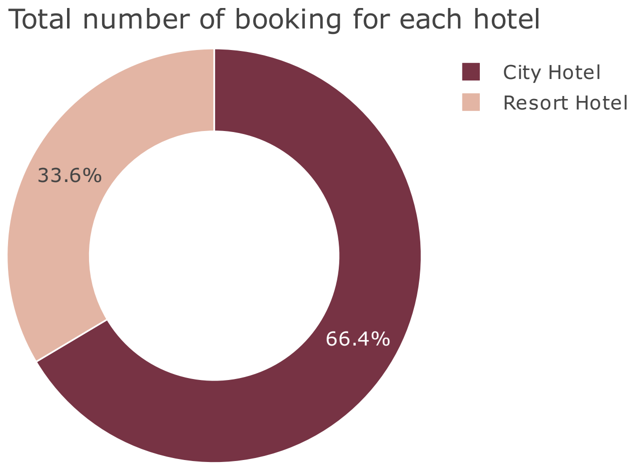
EDA

As stated above,the dataset contains information about two different kinds of hotel: City Hotel and Resort Hotel. There are 79330 observation for the former and 40060 for the latter.

```
# Hotel donut plot

df_hotel <- as.data.frame(hotel_bookings_new[, c("hotel")])
df_hotel <- as.data.frame(lapply(df_hotel, function(x) as.data.frame(table(x))))

colnames(df_hotel) <- c("hotel", "frequency")

df_hotel
```

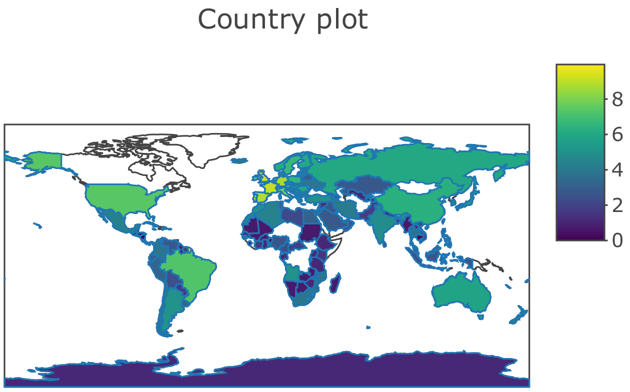
```
##          hotel frequency
## 1   City Hotel     79330
## 2 Resort Hotel     40060
```

```
colors_donut <- c('rgb((119,51,68))','rgb((227,181,164))')

fig_hotel <- df_hotel %>% plot_ly(labels = ~hotel, values = ~frequency,
                                  marker = list(colors = colors_donut,
                                  line = list(color = '#FFFFFF', width = 1)))
fig_hotel <- fig_hotel %>% add_pie(hole = 0.6)
fig_hotel <- fig_hotel %>% layout(title = "Total number of booking for each hotel",
                      showlegend = T,
                      xaxis = list(showgrid = FALSE, zeroline = FALSE, showticklabels = FALSE),
                      yaxis = list(showgrid = FALSE, zeroline = FALSE, showticklabels = FALSE))

fig_hotel
```



Both hotels are located in Portugal; this is the reason why most of the guests come from Portugal, as we can see from the map plot below:

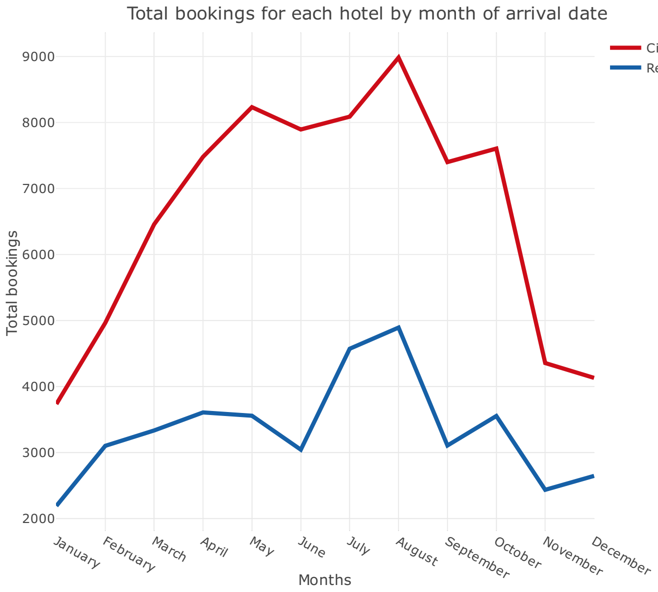
```r
# Country plot

df_country <- as.data.frame(hotel_bookings_new[hotel_bookings_new$is_canceled==0, c("country")])
df_country <- as.data.frame(lapply(df_country, function(x) as.data.frame(table(x))))
colnames(df_country) <- c('country', 'frequency')

# we used log-scale to see better the different number of guests for each country
fig_country <- plot_ly(df_country, type='choropleth', locations=df_country$country,
                       z=log(df_country$frequency+1), colorscale = 'Viridis' )
fig_country <- fig_country %>% layout(title = "Country plot")
fig_country
```



Total bookings considering both canceled and not canceled Total guests considering only is_canceled==0

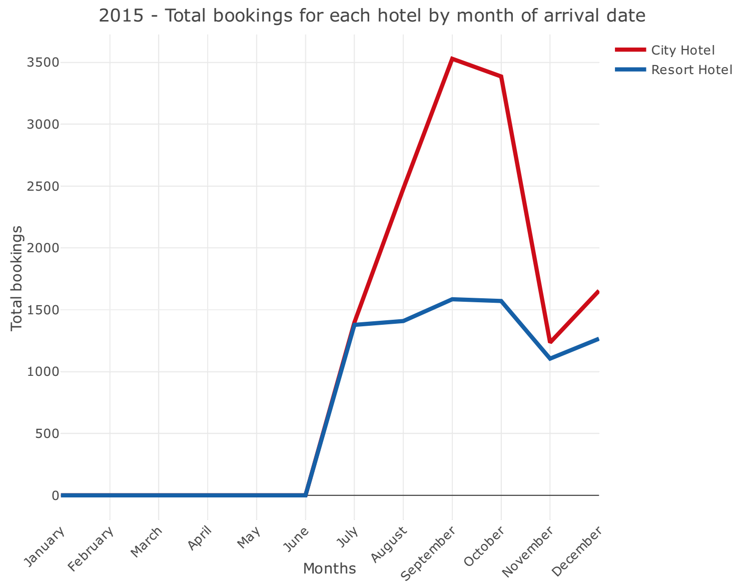
```
# Total bookings for each hotel by month of arrival date

df_months_City <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='City Hotel',
                                                   c( "arrival_date_month")])

df_months_Resort <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='Resort Hotel',
                                                     c( "arrival_date_month")])

df_months_City <- as.data.frame(lapply(df_months_City, function(x) as.data.frame(table(x))))

df_months_Resort <- as.data.frame(lapply(df_months_Resort, function(x) as.data.frame(table(x))))

colnames(df_months_City) <- c("arrival_date_month_City", "frequency_City" )

colnames(df_months_Resort) <- c("arrival_date_month_Resort", "frequency_Resort")

df_months_City$arrival_date_month_City <- factor(df_months_City$arrival_date_month_City,
          levels = c("January", "February", "March","April", "May", "June", "July",
                     "August", "September", "October", "November", "December"))

df_months_Resort$arrival_date_month_Resort <- factor(df_months_Resort$arrival_date_month_Resort,
          levels = c("January", "February", "March","April", "May", "June", "July",
                     "August", "September", "October", "November", "December"))
```

```r
fig_months <- plot_ly()

fig_months <- fig_months %>% add_lines(data=df_months_City,
                                       x = ~arrival_date_month_City, y = ~frequency_City,
                                       name = 'City Hotel', type = 'scatter', mode = 'lines',
                                       line = list(color = 'rgb(205, 12, 24)', width = 4))

fig_months <- fig_months %>% add_lines(data=df_months_Resort, x = ~arrival_date_month_Resort,
                                       y = ~frequency_Resort, name = 'Resort Hotel',
                                       type = 'scatter', mode = 'lines',
                                       line = list(color = 'rgb(22, 96, 167)', width = 4))

fig_months <- fig_months %>%
layout(title = "Total bookings for each hotel by month of arrival date",
         xaxis = list(title = "Months"),
         yaxis = list (title = "Total bookings"))

fig_months
```



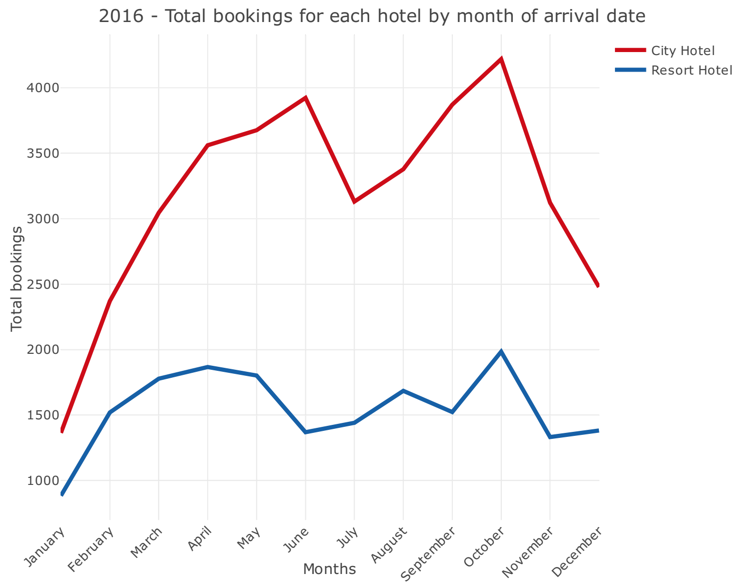
For each year

```r
# Total bookings for each hotel by month (year: 2015)

df_months_City_2015 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='City Hotel'
              & hotel_bookings_new$arrival_date_year==2015, c( "arrival_date_month")])

df_months_Resort_2015 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='Resort Hotel'
              & hotel_bookings_new$arrival_date_year==2015, c( "arrival_date_month")])

df_months_City_2015 <- as.data.frame(lapply(df_months_City_2015, function(x)
  as.data.frame(table(x))))

df_months_Resort_2015 <- as.data.frame(lapply(df_months_Resort_2015, function(x)
  as.data.frame(table(x))))

colnames(df_months_City_2015) <- c("arrival_date_month_City", "frequency_City" )

colnames(df_months_Resort_2015) <- c("arrival_date_month_Resort", "frequency_Resort")

df_months_City_2015$arrival_date_month_City <- factor(df_months_City_2015$arrival_date_month_City,
            levels = c("January", "February", "March","April", "May", "June", "July",
                       "August", "September", "October", "November", "December"))

df_months_Resort_2015$arrival_date_month_Resort <- factor(df_months_Resort_2015$arrival_date_month_Reso


fig_months_2015 <- plot_ly()

fig_months_2015 <- fig_months_2015 %>% add_lines(data=df_months_City_2015, x = ~arrival_date_month_City

fig_months_2015 <- fig_months_2015 %>% add_lines(data=df_months_Resort_2015, x = ~arrival_date_month_Res

fig_months_2015 <- fig_months_2015 %>% layout(title = "2015 - Total bookings for each hotel by month of
         xaxis = list(title = "Months",tickangle = -45),
         yaxis = list (title = "Total bookings"))
fig_months_2015
```

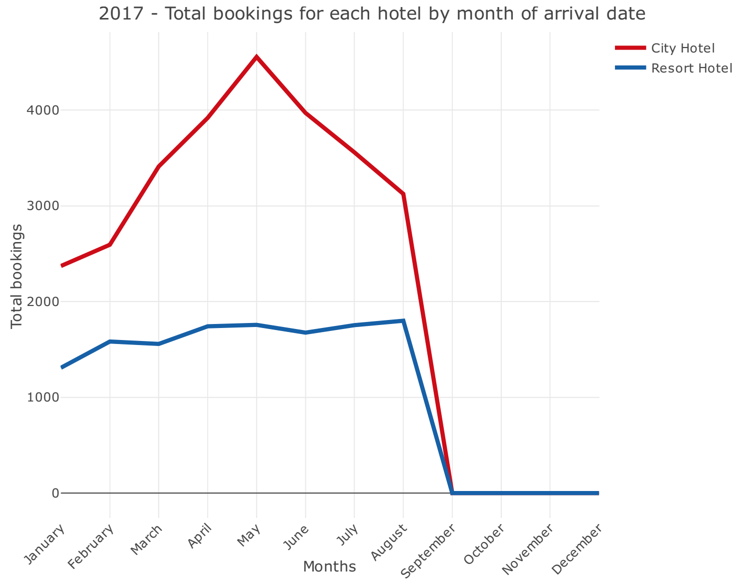


```
# Total bookings for each hotel by month (year: 2016)

df_months_City_2016 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='City Hotel' & hotel_

df_months_Resort_2016 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='Resort Hotel'& hote

df_months_City_2016 <- as.data.frame(lapply(df_months_City_2016, function(x) as.data.frame(table(x))))

df_months_Resort_2016 <- as.data.frame(lapply(df_months_Resort_2016, function(x) as.data.frame(table(x)

colnames(df_months_City_2016) <- c("arrival_date_month_City", "frequency_City" )

colnames(df_months_Resort_2016) <- c("arrival_date_month_Resort", "frequency_Resort")

df_months_City_2016$arrival_date_month_City <- factor(df_months_City_2016$arrival_date_month_City, level

df_months_Resort_2016$arrival_date_month_Resort <- factor(df_months_Resort_2016$arrival_date_month_Reso


fig_months_2016 <- plot_ly()
```

```
fig_months_2016 <- fig_months_2016 %>% add_lines(data=df_months_City_2016, x = ~arrival_date_month_City

fig_months_2016 <- fig_months_2016 %>% add_lines(data=df_months_Resort_2016, x = ~arrival_date_month_Res

fig_months_2016 <- fig_months_2016 %>% layout(title = "2016 - Total bookings for each hotel by month of
         xaxis = list(title = "Months",tickangle = -45),
         yaxis = list (title = "Total bookings"))

fig_months_2016
```

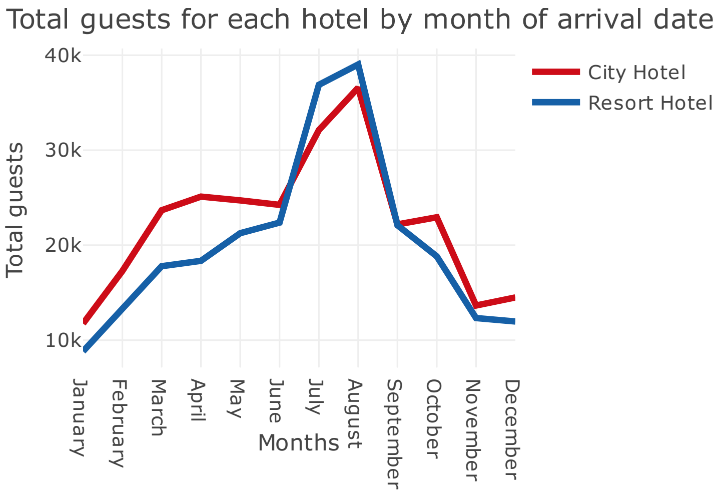


```
# Total bookings for each hotel by month (year: 2017)

df_months_City_2017 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='City Hotel' & hotel_

df_months_Resort_2017 <- as.data.frame(hotel_bookings_new[hotel_bookings_new$hotel=='Resort Hotel'& hote

df_months_City_2017 <- as.data.frame(lapply(df_months_City_2017, function(x) as.data.frame(table(x))))

df_months_Resort_2017 <- as.data.frame(lapply(df_months_Resort_2017, function(x) as.data.frame(table(x)

colnames(df_months_City_2017) <- c("arrival_date_month_City", "frequency_City" )
colnames(df_months_Resort_2017) <- c("arrival_date_month_Resort", "frequency_Resort")

df_months_City_2017$arrival_date_month_City <- factor(df_months_City_2017$arrival_date_month_City, level

df_months_Resort_2017$arrival_date_month_Resort <- factor(df_months_Resort_2017$arrival_date_month_Reso


fig_months_2017 <- plot_ly()

fig_months_2017 <- fig_months_2017 %>% add_lines(data=df_months_City_2017, x = ~arrival_date_month_City

fig_months_2017 <- fig_months_2017 %>% add_lines(data=df_months_Resort_2017, x = ~arrival_date_month_Re

fig_months_2017 <- fig_months_2017 %>% layout(title = "2017 - Total bookings for each hotel by month of
         xaxis = list(title = "Months",tickangle = -45),
         yaxis = list (title = "Total bookings"))

fig_months_2017
```



Total guests

```
# Total guests for each hotel by month

df_City <- as.data.frame(hotel_bookings_new[hotel_bookings_new$is_canceled==0 & hotel_bookings_new$hotel

df_guests_City <- df_City %>%
  group_by(arrival_date_month) %>%
  summarise(guests = sum(total_stays*(adults+children+babies))) %>%
  ungroup()

df_Resort <- as.data.frame(hotel_bookings_new[hotel_bookings_new$is_canceled==0 & hotel_bookings_new$hot

df_guests_Resort <- df_Resort %>%
  group_by(arrival_date_month) %>%
  summarise(guests = sum(total_stays*(adults+children+babies))) %>%
  ungroup()


df_guests_City$arrival_date_month <- factor(df_guests_City$arrival_date_month, levels = c("January", "Fe

df_guests_Resort$arrival_date_month <- factor(df_guests_Resort$arrival_date_month, levels = c("January"


fig_guests <- plot_ly()

fig_guests <- fig_guests %>% add_lines(data=df_guests_City, x = ~arrival_date_month, y = ~guests, name =

fig_guests <- fig_guests %>% add_lines(data=df_guests_Resort, x = ~arrival_date_month, y = ~guests, name

fig_guests <- fig_guests %>% layout(title = "Total guests for each hotel by month of arrival date",
         xaxis = list(title = "Months"),
         yaxis = list (title = "Total guests"))

fig_guests
```


Total guests for each hotel by month of arrival date
40k
30k
20k
10k
Total guests
January
February
March
April
May
June
July
August
September
October
November
December
Months
City Hotel
Resort Hotel