

# **A Data Driven Analysis on Barcelona Weekdays Airbnb**

<b>Contents</b>	<b>Page No.</b>
1. Introduction	03
2. Analysis	03
2.1. Preliminary Analysis	03
3. Analysis Methods	05
3.1. Subset Analysis	05
3.2. Generalized Linear Model	10 - 11
3.3 Random Forest Regression	12 - 13
4. Conclusion	14
5. References	15

# Introduction

The bulk of Airbnb datasets give information regarding the houses that are offered on the market as well as any related attributes. These features could be specifications like the kind of property (such an apartment or a house), the number of beds and bathrooms, the amenities provided, the location information, the price information, the host information, and reviews. In the Barcelona dataset, specific information about Airbnb listings in Barcelona is included, such as how much it costs to list a room during the week. Having access to the real data set is required in order to provide more in-depth information or perform any data analysis.

## Analysis

### Preliminary Analysis:

#### Summary of the dataset:

...	1	realSum	room_type	room_shared	room_private	person_capacity	host_is_superhost	multi
Min.	: 0.0	Min. : 69.59	Length:1555	Mode :logical	Mode :logical	Min. :2.000	Mode :logical	Min. :0.0000
1st Qu.:	388.5	1st Qu.: 161.99	Class :character	FALSE:1547	FALSE:370	1st Qu.:2.000	FALSE:1274	1st Qu.:0.0000
Median :	777.0	Median : 208.53	Mode :character	TRUE :8	TRUE :1185	Median :2.000	TRUE :281	Median :0.0000
Mean :	777.0	Mean : 288.39				Mean :2.756		Mean :0.3768
3rd Qu.:	1165.5	3rd Qu.: 335.37				3rd Qu.:3.000		3rd Qu.:1.0000
Max. :	1554.0	Max. :6943.70				Max. :6.000		Max. :1.0000
biz	cleanliness_rating	guest_satisfaction_overall	bedrooms	dist	metro_dist	attr_index		
Min. :	0.0000	Min. : 2.000	Min. : 20.00	Min. :0.000	Min. :0.1199	Min. :0.0130	Min. : 93.82	
1st Qu.:	0.0000	1st Qu.: 9.000	1st Qu.: 88.00	1st Qu.:1.000	1st Qu.:1.0906	1st Qu.:0.2521	1st Qu.: 282.77	
Median :	0.0000	Median :10.000	Median : 93.00	Median :1.000	Median :1.7518	Median :0.3705	Median : 389.20	
Mean :	0.3505	Mean : 9.286	Mean : 90.93	Mean :1.217	Mean :2.1173	Mean :0.4349	Mean : 464.37	
3rd Qu.:	1.0000	3rd Qu.:10.000	3rd Qu.: 97.00	3rd Qu.:1.000	3rd Qu.:2.9492	3rd Qu.:0.5542	3rd Qu.: 591.59	
Max. :	1.0000	Max. :10.000	Max. :100.00	Max. :6.000	Max. :8.4440	Max. :2.4028	Max. :2934.13	
attr_index_norm	rest_index	rest_index_norm	lng	lat				
Min. :	3.198	Min. : 159.8	Min. : 3.518	Min. :2.105	Min. :41.35			
1st Qu.:	9.637	1st Qu.: 494.4	1st Qu.:10.883	1st Qu.:2.156	1st Qu.:41.38			
Median :	13.265	Median : 801.8	Median :17.650	Median :2.171	Median :41.39			
Mean :	15.827	Mean : 877.7	Mean :19.320	Mean :2.169	Mean :41.39			
3rd Qu.:	20.162	3rd Qu.:1211.3	3rd Qu.:26.663	3rd Qu.:2.179	3rd Qu.:41.40			
Max. :	100.000	Max. :4542.8	Max. :100.000	Max. :2.226	Max. :41.46			

- The dataset contains 1,555 observations (listings), each of which provides information on a specific amenity of the lodgings. Significant information includes the following:
- Each listing has a unique numeric identity called Real Sum, which has a range of 0 to 1,554. There is one for each observation since it serves as an index or identifier.
- Room\_type is a category variable that describes the type of lodging, such as a shared room or a whole apartment, a private room, or both. The mode of this variable represents the most prevalent room type.
- person\_capacity variable specifies the maximum number of people the listing is capable of accommodating. The capacity for the average individual ranges from 2.76 to 6. This demonstrates that the bulk of ads, with person capacities ranging from 2.76 to 6, cater to small groups.

- The binary variable `host_is_superhost` can be used to detect if a host is designated as a superhost. Superhosts are seasoned hosts with excellent ratings and reviews.
- The variables `cleanliness_rating` and `guest_satisfaction_overall`, respectively, describe the evaluations of cleanliness and overall guest satisfaction. Both variables range from 2 to 10, with higher values indicating better ratings.
- `bedrooms`: The number of bedrooms in the accommodation is indicated by this variable, which has a range of 0 to 6. The median number reveals that one-bedroom listings are most common.
- `dist` and `metro_dist`: These variables display how distant a lodging is from a certain location or metro stop. Their measuring methods and parameters vary.
- `lng` and `lat`, `rest_index`, `rest_index_norm`, `attr_index`, and `attr_index_norm`: These variables likely relate to latitude and longitude as well as the distances to nearby sites of interest or convenience. To analyse them precisely, further data from the dataset would be required.

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
...1	1	1555	777.00	449.03	777.00	777.00	576.73	0.00	1554.00	1554.00	0.00	-1.20	11.39
realSum	2	1555	288.39	321.18	208.53	243.05	102.48	69.59	6943.70	6874.11	13.28	253.78	8.14
room_type*	3	1555	1.77	0.43	2.00	1.83	0.00	1.00	3.00	2.00	-1.10	-0.22	0.01
room_shared	4	1555	NaN	NA	NA	NaN	NA	Inf	-Inf	-Inf	NA	NA	NA
room_private	5	1555	NaN	NA	NA	NaN	NA	Inf	-Inf	-Inf	NA	NA	NA
person_capacity	6	1555	2.76	1.28	2.00	2.47	0.00	2.00	6.00	4.00	1.51	0.96	0.03
host_is_superhost	7	1555	NaN	NA	NA	NaN	NA	Inf	-Inf	-Inf	NA	NA	NA
multi	8	1555	0.38	0.48	0.00	0.35	0.00	0.00	1.00	1.00	0.51	-1.74	0.01
biz	9	1555	0.35	0.48	0.00	0.31	0.00	0.00	1.00	1.00	0.63	-1.61	0.01
cleanliness_rating	10	1555	9.29	1.01	10.00	9.46	0.00	2.00	10.00	8.00	-2.54	11.12	0.03
guest_satisfaction_overall	11	1555	90.93	8.70	93.00	92.11	7.41	20.00	100.00	80.00	-2.36	10.66	0.22
bedrooms	12	1555	1.22	0.57	1.00	1.11	0.00	0.00	6.00	6.00	2.07	6.18	0.01
dist	13	1555	2.12	1.35	1.75	1.97	1.19	0.12	8.44	8.32	1.02	0.80	0.03
metro_dist	14	1555	0.43	0.28	0.37	0.40	0.21	0.01	2.40	2.39	1.63	4.27	0.01
attr_index	15	1555	464.37	268.32	389.20	431.76	214.34	93.82	2934.13	2840.31	2.21	9.98	6.80
attr_index_norm	16	1555	15.83	9.14	13.26	14.71	7.31	3.20	100.00	96.80	2.21	9.98	0.23
rest_index	17	1555	877.66	461.29	801.81	839.64	494.72	159.84	4542.75	4382.92	0.94	2.17	11.70
rest_index_norm	18	1555	19.32	10.15	17.65	18.48	10.89	3.52	100.00	96.48	0.94	2.17	0.26
lng	19	1555	2.17	0.02	2.17	2.17	0.02	2.11	2.23	0.12	0.06	0.14	0.00
lat	20	1555	41.39	0.02	41.39	41.39	0.02	41.35	41.46	0.11	0.71	0.58	0.00

The dataset's summary statistics lead to the following significant conclusions:

- Each listing corresponds to the index or identifier range of the variable "realSum", which is from 0 to 1,554. The standard deviation is around 321.18, while the mean value is almost 288.39.
- The variable "room\_type" indicates the kind of lodging, with a mean value of 1.77. Regarding the meaning of each category, further information would need to be given.

- The variable "person\_capacity" indicates how many people the listings can accommodate in total. The average person capacity is around 2.76, with a standard variation of 1.28.
- "Cleanliness\_rating" and "guest\_satisfaction\_overall" are ratings for cleanliness and overall guest satisfaction, respectively. Average ratings for cleanliness are 9.29 and 90.93 respectively for guest satisfaction.
- The variable "Bedrooms" indicates the number of bedrooms that are available. The average number of bedrooms is around 1.22, with a standard deviation of 0.57.
- The variables "dist" and "metro\_dist" describe the distances from the accommodations to particular locations or metro stations. The average distances are 2.12 and 0.43 miles, respectively.

Other terms like "attr\_index", "attr\_index\_norm", "rest\_index", and "rest\_index\_norm" most likely refer to indices or normalized indices related to attractions or amenities. More understanding of these factors is needed to provide more in-depth insights. These summary statistics give a quick overview of the dataset, but a comprehensive study would need further research, data cleansing, and visualization to uncover more noteworthy patterns and connections.

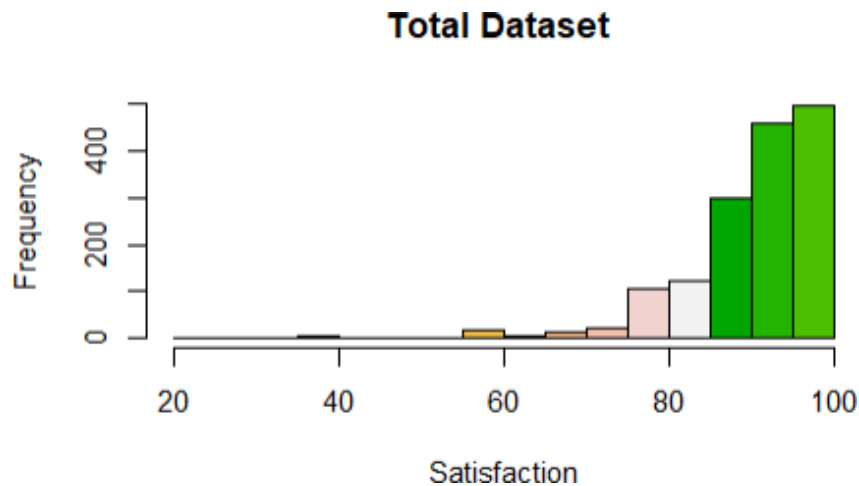
## Analysis Methods

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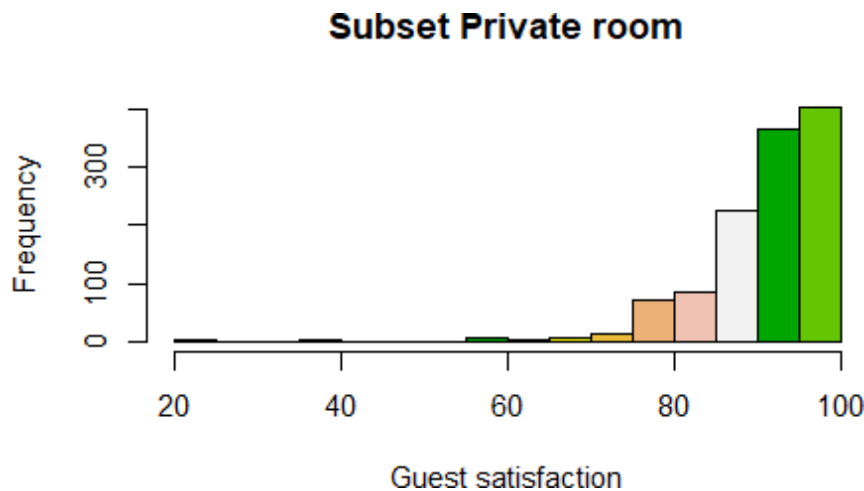
### Subset Analysis:

```
#subset analysis ----
subset_analysis<-subset(barcelona_weekdays,room_private ==
"TRUE")
subset_analysis_1 <-subset(barcelona_weekdays,room_private ==
"TRUE" & host_is_superhost == "TRUE")
subset_analysis_2 <-subset(barcelona_weekdays,room_private ==
"TRUE" & host_is_superhost == "FALSE" )
```

The first subset subset\_analysis is created by subsetting the original dataset when the value of the room\_private variable is "TRUE". Only the rows in this subgroup have private rooms listed as their room type. The second subset, subset\_analysis\_1, is created when both the host\_is\_superhost and the room\_private variables are set to "TRUE". The only rows with a private room type and a superhost host are included in this subset. By subsetting the original dataset with the values "TRUE" for the room\_private variable and "FALSE" for the host\_is\_superhost variable, the third subset, "subset\_analysis\_2," is created. Only the rows with a private room type and a non-superhost host are contained in this subset.



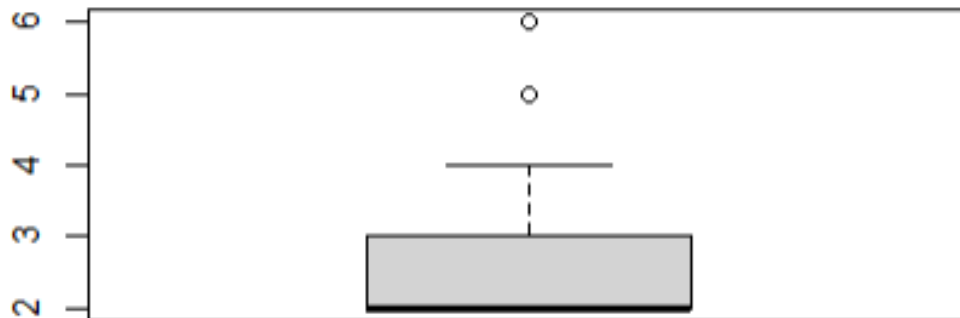
The first histogram displays the distribution of customer satisfaction scores throughout the full dataset. The x-axis displays the satisfaction rating, while the y-axis depicts the frequency or number of listings with that rating. The color scheme for the bars is `terrain.colors(13)`, which provides a variety of distinctive tones. The "Satisfaction" x-axis and the "Frequency" y-axis are both displayed. "Total Dataset" is the main heading of the histogram.



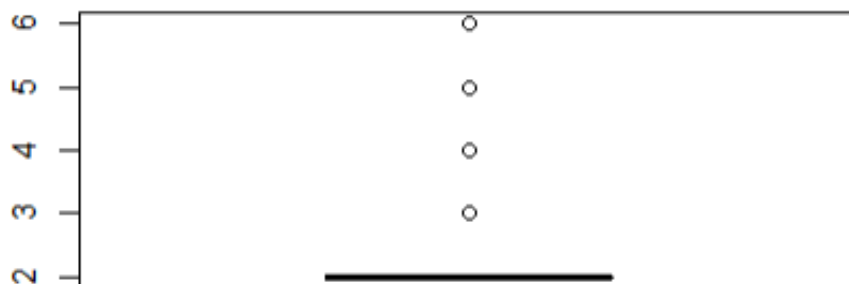
The distribution of reviews from guests for a sample of private room listings is shown in the second histogram. Both the y-axis and the x-axis display the frequency of listings with that rating and the level of visitor satisfaction, respectively. In contrast to the first histogram, this histogram's bars are colored using the more diverse `terrain.colors(7)` color scheme. The y-axis is labeled "Frequency," the x-axis is "Guest satisfaction," and the major title is "Subset Private room." Looking at the histograms will reveal further information about the distribution of the guest satisfaction ratings throughout the overall dataset as well as the subset of private room listings. The distributions of

the full dataset and the private room subset may be compared, along with any significant peaks or trends, and the concentration of ratings in different satisfaction bands can be displayed.

**Boxplot for total capacity**



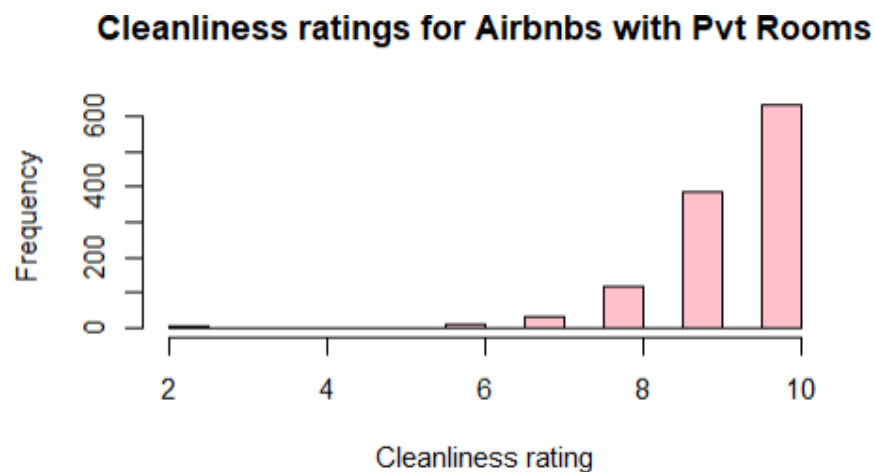
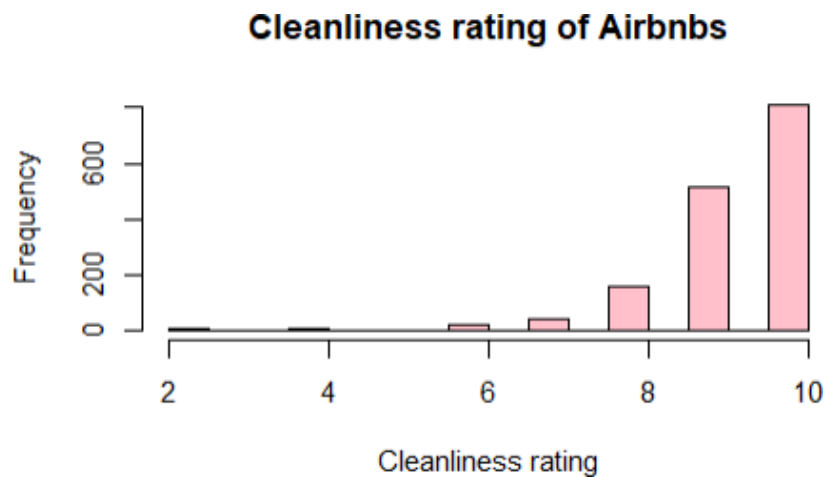
**Boxplot for total capacity with Private rooms**



The initial boxplot depicts the distribution of individuals over the whole dataset. The median value is displayed as a horizontal line inside the box that contains the interquartile range (IQR), which is represented as a box. The whiskers extend outward from the box to the values that are 1.5 times the IQR apart on the lowest and highest axis. Any data points outside of this range are flagged as outliers and shown individually. The main title of the boxplot is "Boxplot for total capacity."

The second boxplot shows the distribution of person capacity, particularly for the subgroup of private room listings. This box shows the interquartile range, the horizontal line inside it the median, and the whiskers the range within 1.5 times the interquartile range. Any outliers are shown as individual points. The headline for this boxplot reads, "Boxplot for total capacity with Private rooms."

These boxplots help explain how person capacity is distributed across the overall dataset and, more specifically, across the subset of private room listings. You may view the distribution of the data, the median value, and any potential outliers. Comparing the two boxplots will allow you to see if there are any differences in the distribution of person capacity between the total dataset and the subset of private rooms.



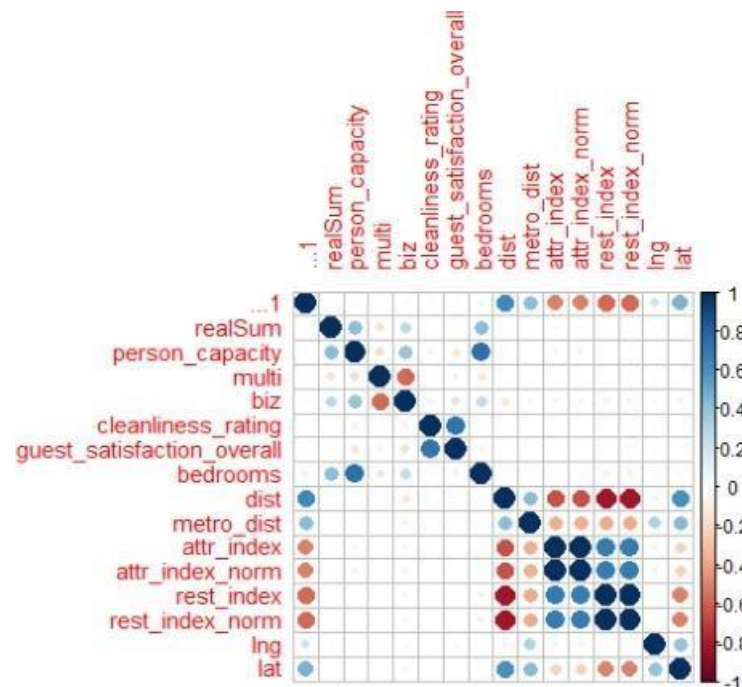
The distribution of cleanliness ratings for all Airbnbs in the dataset `barcelona_weekdays` is depicted in the first histogram. The number of Airbnbs with a particular cleanliness rating is indicated on the y-axis, and the frequency of those accommodations is shown on the x-axis. There are pink bars in the histogram. The histogram's subtitle is "Cleanliness rating of Airbnbs."



The distribution of cleanliness ratings for the subset of Airbnbs with private rooms is clearly shown in the second histogram (subset\_analysis). It focuses on the cleanliness ratings for Airbnbs that have been designated as private rooms. The frequency or number of Airbnbs with a particular cleanliness rating is displayed on the y-axis, and the cleanliness rating is represented on the x-axis. Like the last histogram, this one also has pink bars. This histogram's heading is "Cleanliness ratings for Airbnbs with Pvt Rooms."

These histograms show the distribution and frequency of cleanliness ratings for the entire dataset as well as specifically for the subset of Airbnbs with private rooms. One may view the range of cleanliness ratings, the most popular ratings, and the overall rating distribution. Comparing the two histograms will show you if there are any differences in the cleanliness ratings between the total dataset and the subset of private room listings.

### Correlation table:



A correlation plot is the name for this graphic representation of the correlation matrix. The correlation between two variables is depicted in each cell of a correlation plot. The intensity and color of the cell reflect the strength and direction of the relationship. Positive correlations are frequently represented by blue hues, while negative correlations are frequently illustrated by red hues. The size of the circles in the cells reveals how extensive the link is.

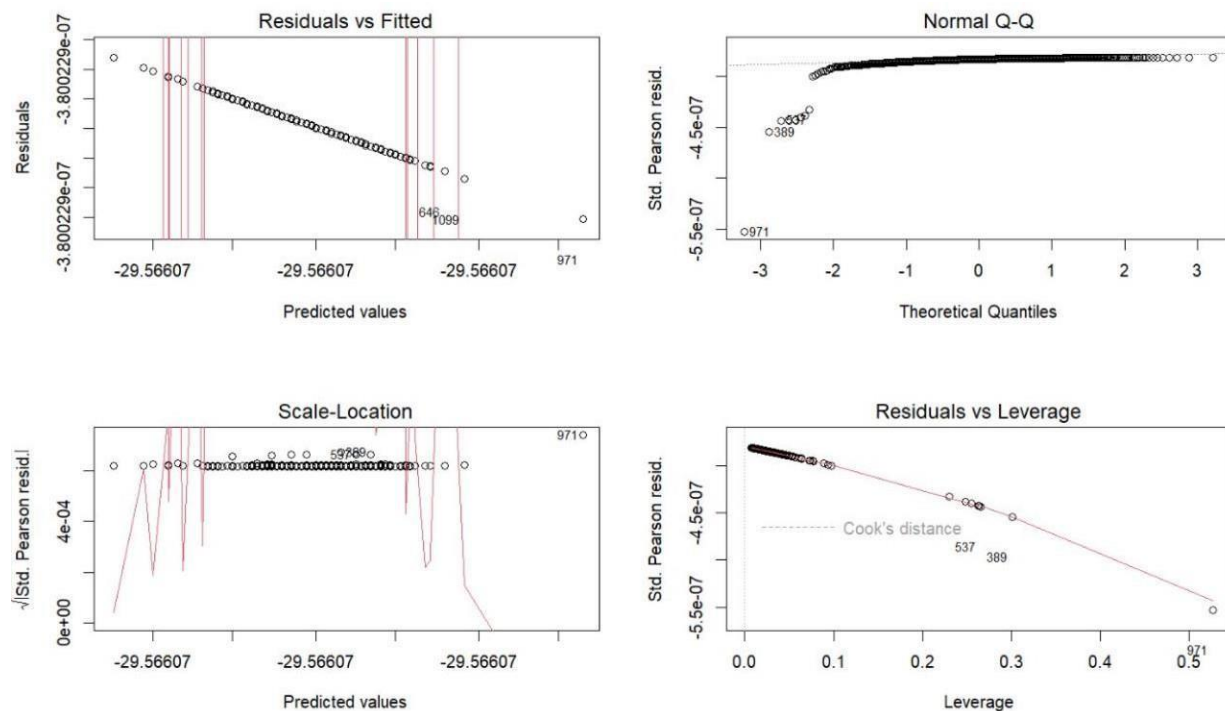
Looking at the correlation plot can help you understand the relationships between the different numerical variables in the dataset. Dark blue tones, which denote significant positive correlations, demonstrate a favourable association between the variables. Strong negative associations are indicated by the use of dark red colours. The correlation map, which identifies variables that are heavily related or have significant associations, can help with understanding the dataset and exploring potential patterns or links between variables.

### Generalised Linear Model:

In order to simulate the link between a group of predictor variables and a response variable, statisticians use generalized linear models (GLMs). The linear regression model provides a flexible framework for figuring out complex relationships and making predictions by extending its capabilities to encompass multiple response variables, such as binary, count, or categorical data.

	Estimate	Std. Error	t value
(Intercept)	411.79362	40.007717	10.292855
room_typePrivate room	-289.03513	25.107486	-11.511910
room_typeshared room	-395.66637	100.739904	-3.927603
person_capacity	35.88005	8.307799	4.318840
	Pr(> t )		
(Intercept)	4.427294e-24		
room_typePrivate room	1.744494e-29		
room_typeshared room	8.956163e-05		
person_capacity	1.668004e-05		

The result shows the coefficients, standard errors, t-values, and p-values for a multiple linear regression model with three predictor variables: room type (with Private room as the reference category), room capacity, and shared room. The intercept term denotes the predicted value of the response variable (price) when all predictor variables are equal to zero. The coefficients for each predictor variable show the projected change in the response variable (price) associated with a one-unit increase in each predictor variable, holding all other predictors constant. The p-value of each predictor variable indicates how relevant it is, with lower p-values denoting more significance. Each predictor variable's significant influence on the response variable is shown by the model. Private rooms, when compared to the reference group, have a negative impact on the price, whereas shared rooms have a large negative impact. However, the number of guests has a favourable effect on the price.



The resulting plot serves as a diagnostic plot for the logistic regression model (GLM). It aids in measuring the model's effectiveness and identifying any potential problems or model assumption breaches. A number of panels make up the plot:

- **Residuals vs. Fitted:** This panel displays the correlation between the model's predicted probability and the related residuals. It aids in finding patterns or nonlinearity in the data.
- **Normal Q-Q:** This panel evaluates the residuals' supposed normalcy. A relatively straight line denotes a reasonable adherence to the assumption.
- **Scale-Location:** This panel looks at the spread (variance) of the residuals in comparison to the values that were fitted. The ideal distribution of points along a horizontal line should show constant variance.
- **Residuals vs. Leverage:** This panel aids in locating noteworthy observations or outliers that could have a major effect on the model's coefficients.

We can assess the effectiveness of the logistic regression model and spot any potential problems, such as heteroscedasticity, nonlinearity, or significant observations, by examining these panels.

## Random Forest Regression:

A strong prediction model is created by integrating different decision trees with the use of the machine learning technique known as random forest regression. Support is provided for both continuous and categorical answer variables. The response variable in this code, `room_private`, is predicted using additional dataset variables. The `randomForest()` function builds an ensemble of decision trees by training each tree on a unique random subset of the training data. This ensemble strategy reduces overfitting and improves the model's ability to generalize. The `ntree` parameter displays the number of trees in the forest. After the model has been trained, predictions on the testing dataset are generated using the `predict()` method. These forecasts can then be evaluated or given further scrutiny.

Call:

```
randomForest(formula = as.factor(room_private) ~ ., data = training,  
ntree = 500)
```

          Type of random forest: classification

                  Number of trees: 500

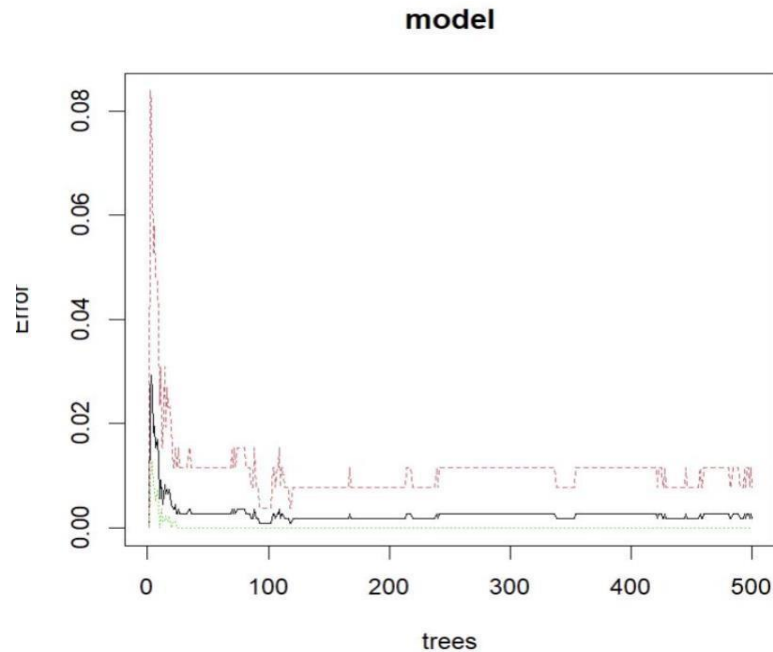
No. of variables tried at each split: 4

          OOB estimate of error rate: 0.09%

Confusion matrix:

	FALSE	TRUE	class.error
FALSE	258	1	0.003861004
TRUE	0	830	0.000000000

> |



The estimated error rate according to the out-of-bag (OOB) method is 0.09%, which is quite accurate. A class error rate of 0.0039% was achieved with 258 of the 259 occurrences labelled as FALSE being correctly identified, according to the confusion matrix. In a similar vein, all 830 occurrences marked as TRUE were correctly categorised, yielding a class error rate of 0.

# Conclusion:

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Random forest regression, subset analysis, and generalized linear models (GLM) are statistical modelling techniques used to predict outcomes or understand correlations in data.

Random forest regression, an ensemble learning technique, blends many decision trees to produce predictions. It is a strong, flexible algorithm that can handle complex links and interactions in data. The relative significance of each feature can be determined using random forest regression on high-dimensional datasets.

Subset analysis, also known as variable selection or feature selection, involves selecting relevant variables from a larger pool of potential predictors. This approach aims to improve model performance by reducing the number of dimensions in the data and focusing on the most informative characteristics. Subset analysis can be performed using a number of methods, such as stepwise regression, backward elimination, and forward selection.

The generalized linear model (GLM) is a framework that extends the traditional linear regression model to allow different response variables, including binary, count, or categorical outcomes. When modelling the relationship between predictors and the projected response value using a link function, it makes an explicit assumption about the probability distribution of the response variable. Non-linear relationships can be incorporated into GLM as well as other data distributions.

Finally, whereas random forest regression is a flexible ensemble method that aids in the selection of relevant predictors, GLM extends linear regression for a variety of response types. Any technique may be utilized since it has benefits depending on the analysis's requirements and the characteristics of the dataset.

# References

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