Logistic Regression

Linda

Load the libraries

```
library(tidyverse)
library(ggplot2)
library(openxlsx)
library(caret)
library(fastDummies)
```

Load the dataset

```
data<-read.xlsx(file.choose())
```

Exploratory Data Analysis

Explore the dataset

```
head(data) # 6 first rows
```

```
##     id                                              name host_id   host_nam
e
## 1 2539               Clean & quiet apt home by the park    2787        Joh
n
## 2 2595                           Skylit Midtown Castle    2845    Jennife
r
## 3 3647             THE VILLAGE OF HARLEM....NEW YORK !    4632   Elisabet
h
## 4 3831                  Cozy Entire Floor of Brownstone    4869 LisaRoxann
e
## 5 5022 Entire Apt: Spacious Studio/Loft by central park    7192       Laur
a
## 6 5099        Large Cozy 1 BR Apartment In Midtown East    7322       Chri
s
##   neighbourhood_group neighbourhood latitude longitude       room_type pri
ce
## 1            Brooklyn    Kensington 40.64749 -73.97237    Private room   1
49
## 2           Manhattan       Midtown 40.75362 -73.98377 Entire home/apt   2
25
## 3           Manhattan        Harlem 40.80902 -73.94190    Private room   1
50
## 4            Brooklyn  Clinton Hill 40.68514 -73.95976 Entire home/apt
89
## 5           Manhattan   East Harlem 40.79851 -73.94399 Entire home/apt
80
```

```
## 6           Manhattan   Murray Hill 40.74767 -73.97500 Entire home/apt   2
00
##   minimum_nights number_of_reviews last_review reviews_per_month
## 1              1                 9       43392              0.21
## 2              1                45       43606              0.38
## 3              3                 0          NA                NA
## 4              1               270       43651              4.64
## 5             10                 9       43423              0.10
## 6              3                74       43638              0.59
##   calculated_host_listings_count availability_365
## 1                              6              365
## 2                              2              355
## 3                              1              365
## 4                              1              194
## 5                              1                0
## 6                              1              129
```

```
summary(data) #Descriptive statistics
```

```
##        id                 name              host_id           host_name
##  Min.   :    2539   Length:48895       Min.   :     2438   Length:48895
##  1st Qu.: 9471945   Class :character   1st Qu.:  7822033   Class :characte
r
##  Median :19677284   Mode  :character   Median : 30793816   Mode  :characte
r
##  Mean   :19017143                      Mean   : 67620011
##  3rd Qu.:29152178                      3rd Qu.:107434423
##  Max.   :36487245                      Max.   :274321313
##
##  neighbourhood_group neighbourhood        latitude       longitude
##  Length:48895        Length:48895       Min.   :40.50   Min.   :-74.24
##  Class :character    Class :character   1st Qu.:40.69   1st Qu.:-73.98
##  Mode  :character    Mode  :character   Median :40.72   Median :-73.96
##                                         Mean   :40.73   Mean   :-73.95
##                                         3rd Qu.:40.76   3rd Qu.:-73.94
##                                         Max.   :40.91   Max.   :-73.71
##
##   room_type             price         minimum_nights    number_of_reviews
##  Length:48895       Min.   :    0.0   Min.   :   1.00   Min.   :  0.00
##  Class :character   1st Qu.:   69.0   1st Qu.:   1.00   1st Qu.:  1.00
##  Mode  :character   Median :  106.0   Median :   3.00   Median :  5.00
##                     Mean   :  152.7   Mean   :   7.03   Mean   : 23.27
##                     3rd Qu.:  175.0   3rd Qu.:   5.00   3rd Qu.: 24.00
##                     Max.   :10000.0   Max.   :1250.00   Max.   :629.00
##
##   last_review    reviews_per_month calculated_host_listings_count
##  Min.   :40630   Min.   : 0.010    Min.   :  1.000
##  1st Qu.:43289   1st Qu.: 0.190    1st Qu.:  1.000
##  Median :43604   Median : 0.720    Median :  1.000
##  Mean   :43377   Mean   : 1.373    Mean   :  7.144
```

```
##  3rd Qu.:43639   3rd Qu.: 2.020    3rd Qu.:  2.000
##  Max.   :43654   Max.   :58.500    Max.   :327.000
##  NA's   :10052   NA's   :10052
##  availability_365
##  Min.   :  0.0
##  1st Qu.:  0.0
##  Median : 45.0
##  Mean   :112.8
##  3rd Qu.:227.0
##  Max.   :365.0
##
```

Data cleaning

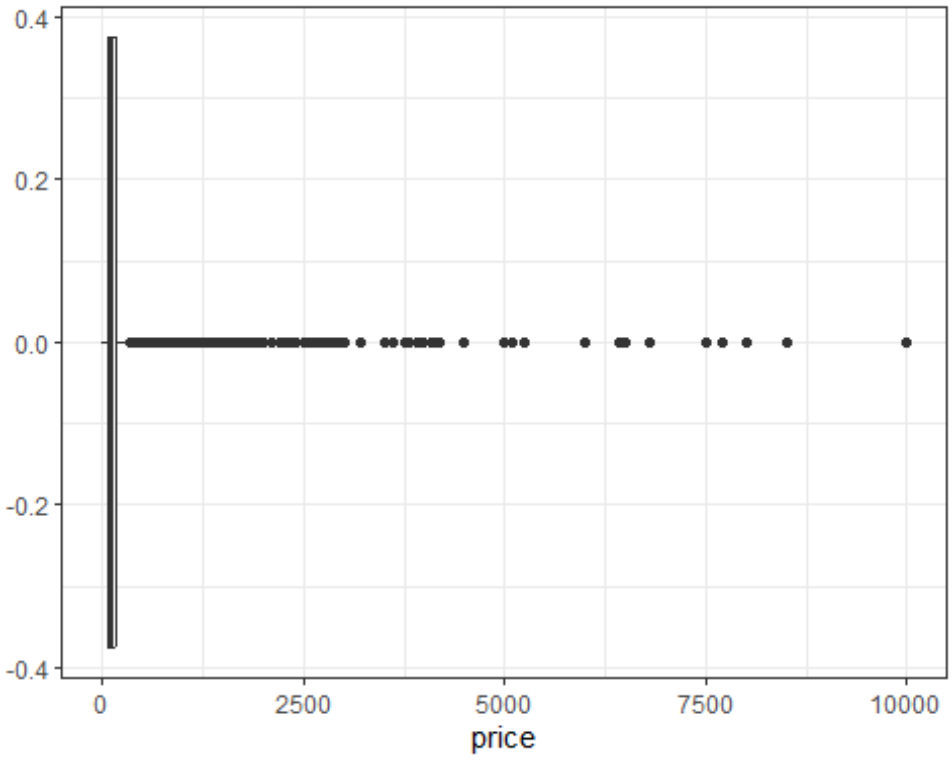
```
sum(is.na(data))
```

```
## [1] 20152
```

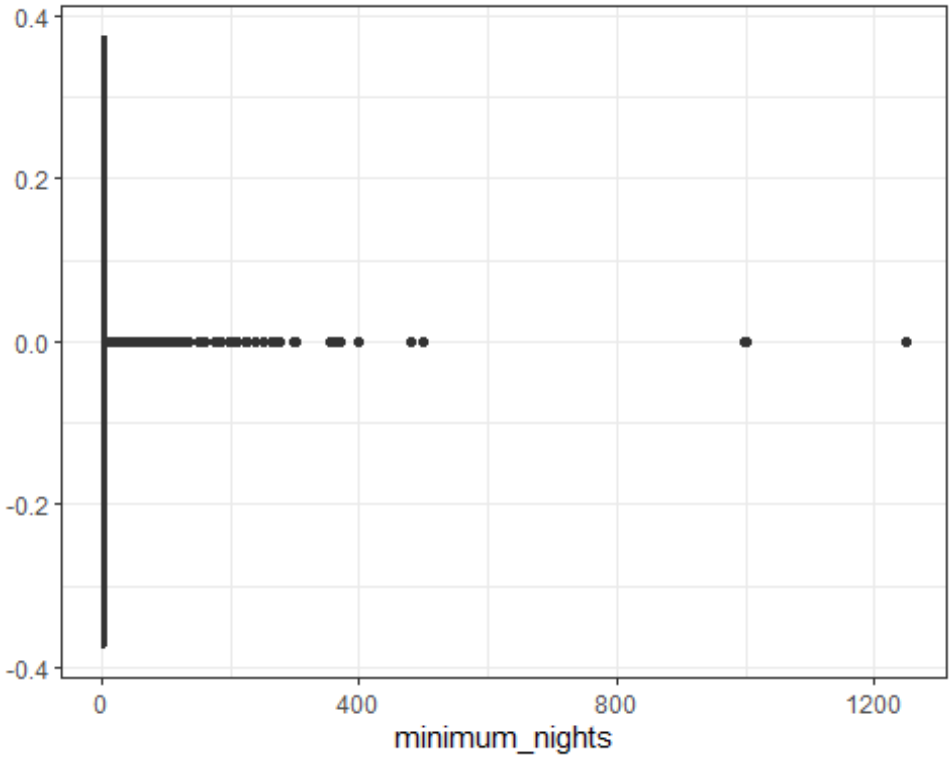
```
##Check missing values
data$last_review[is.na(data$last_review)]<-0
data$name[is.na(data$name)]<-'Unknown'
data$host_name[is.na(data$host_name)]<-'Unkown'
data$reviews_per_month[is.na(data$reviews_per_month)]<-mode(data$reviews_per_
month)[1]

## Check the absence of na values
colSums(is.na(data))
```

```
##                             id                           name
##                              0                              0
##                        host_id                      host_name
##                              0                              0
##           neighbourhood_group                  neighbourhood
##                              0                              0
##                       latitude                      longitude
##                              0                              0
##                      room_type                          price
##                              0                              0
##                minimum_nights              number_of_reviews
##                              0                              0
##                   last_review             reviews_per_month
##                              0                              0
## calculated_host_listings_count               availability_365
##                              0                              0
```

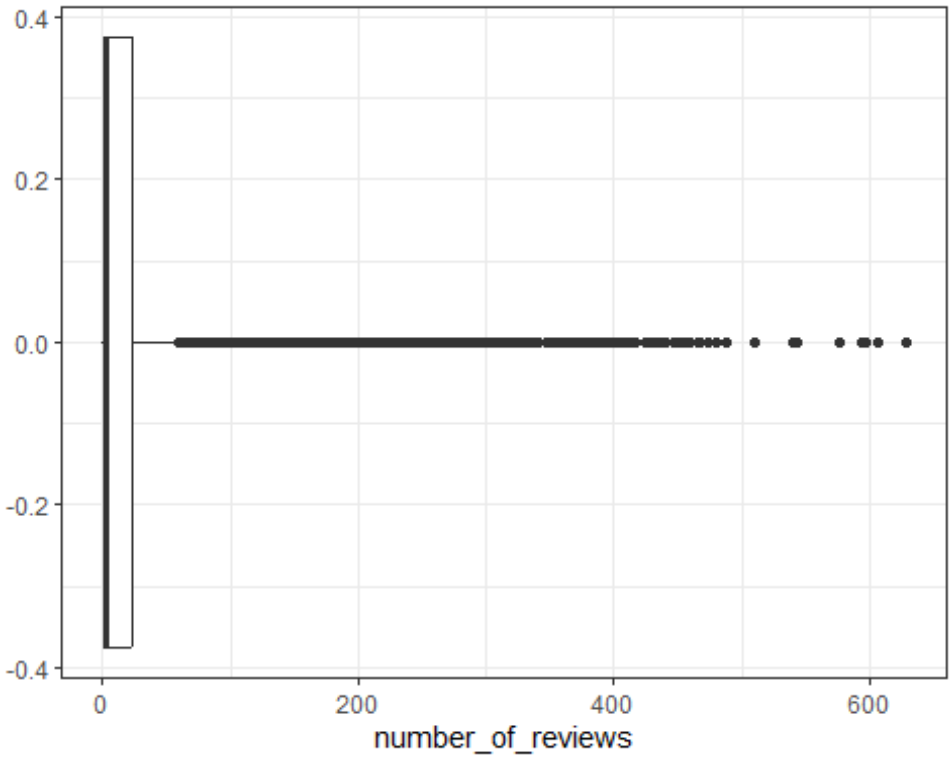
```
###Check for outliers in the numerical variables using boxplots
data|>ggplot(aes(price))+geom_boxplot()+theme_bw()
```



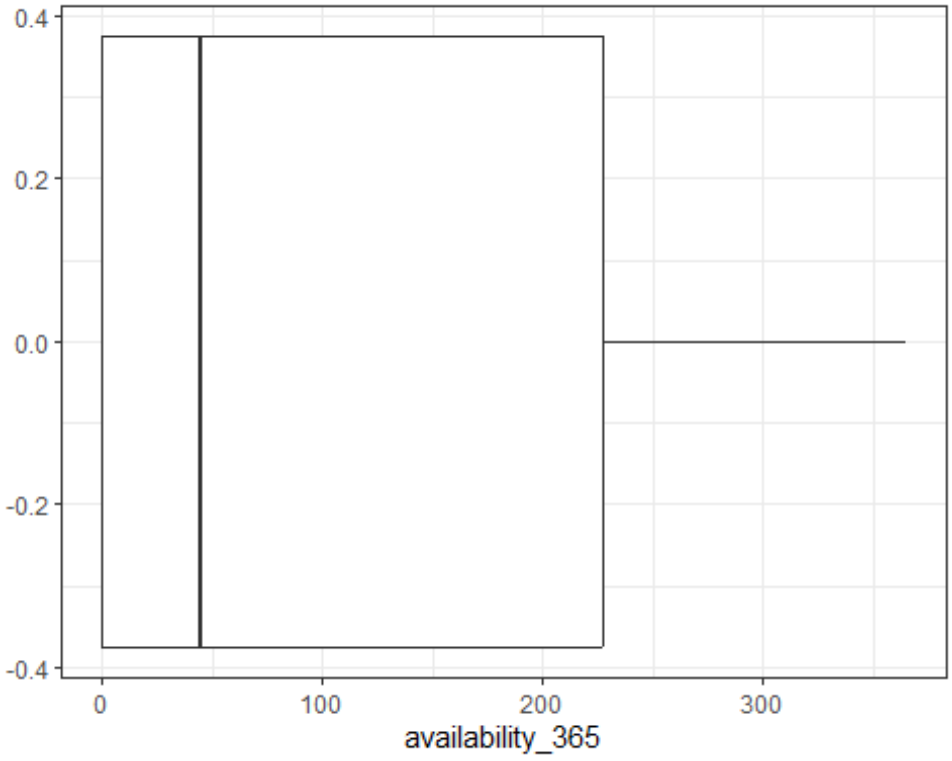

```
data|>ggplot(aes(minimum_nights))+geom_boxplot()+theme_bw()
```



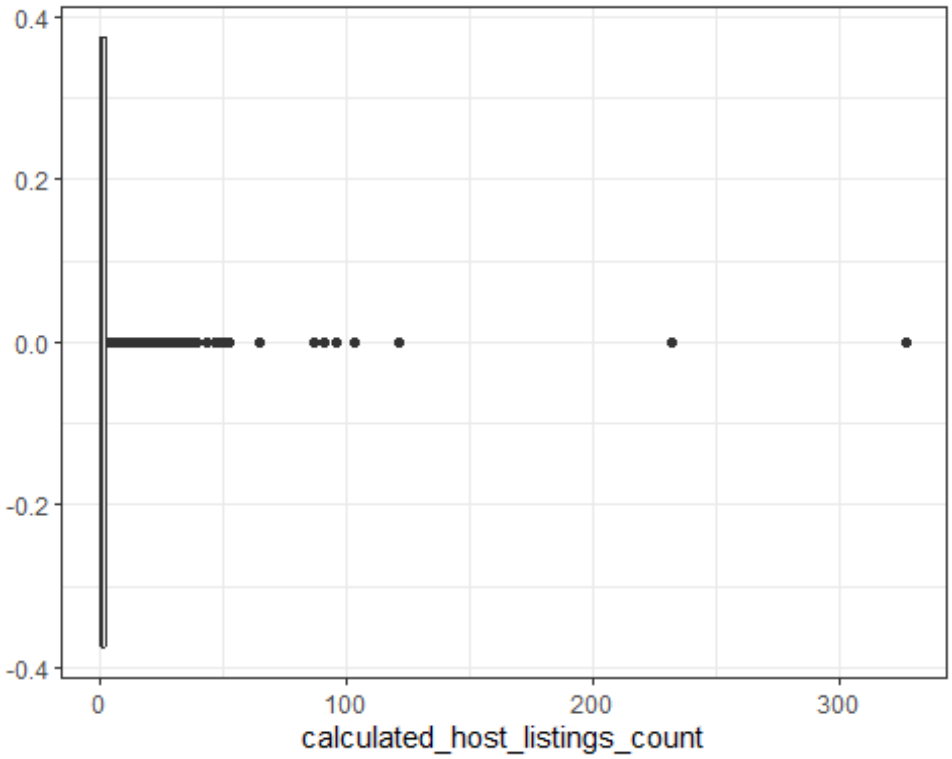

```
data|>ggplot(aes(number_of_reviews))+geom_boxplot()+theme_bw()
```




```
data|>ggplot(aes(availability_365))+geom_boxplot()+theme_bw()
```




```
data|>ggplot(aes(calculated_host_listings_count))+geom_boxplot()+theme_bw()
```




```
##Removing outliers
data<-data|>group_by(room_type)|>
  mutate(Q1=quantile(price,.25,na.rm=TRUE),
         Q3=quantile(price,.75,na.rm=TRUE),
         IQR=Q3-Q1,
         Lower_bound=Q1 -1.5*IQR,
         Upper_bound=Q3+ 1.5*IQR)|>
  filter(price>=Lower_bound & price <= Upper_bound)|>
  ungroup()|>
  select(-Q1,-Q3,-IQR)
summary(data$price)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.0    65.0   100.0   121.8   155.0   392.0

data<-data|>
  mutate(Q1=quantile(minimum_nights,0.25,na.rm=TRUE),
                     Q3=quantile(minimum_nights,0.75,na.rm=TRUE),
                     IQR=Q3-Q1,
                     Lower_bound=Q1-1.5*IQR,
                     Upper_bound=Q3+1.5*IQR)|>
  filter(minimum_nights>=Lower_bound & minimum_nights<=Upper_bound)|>
  select(-Q1,-Q3,-IQR)
summary(data$minimum_nights)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   1.000   2.000   2.715   3.000  11.000
```

Detect and Remove the duplicated rows

```
sum(duplicated(data))
```

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

```
data<-data|> ###Removes the duplicated rows
  distinct()
```

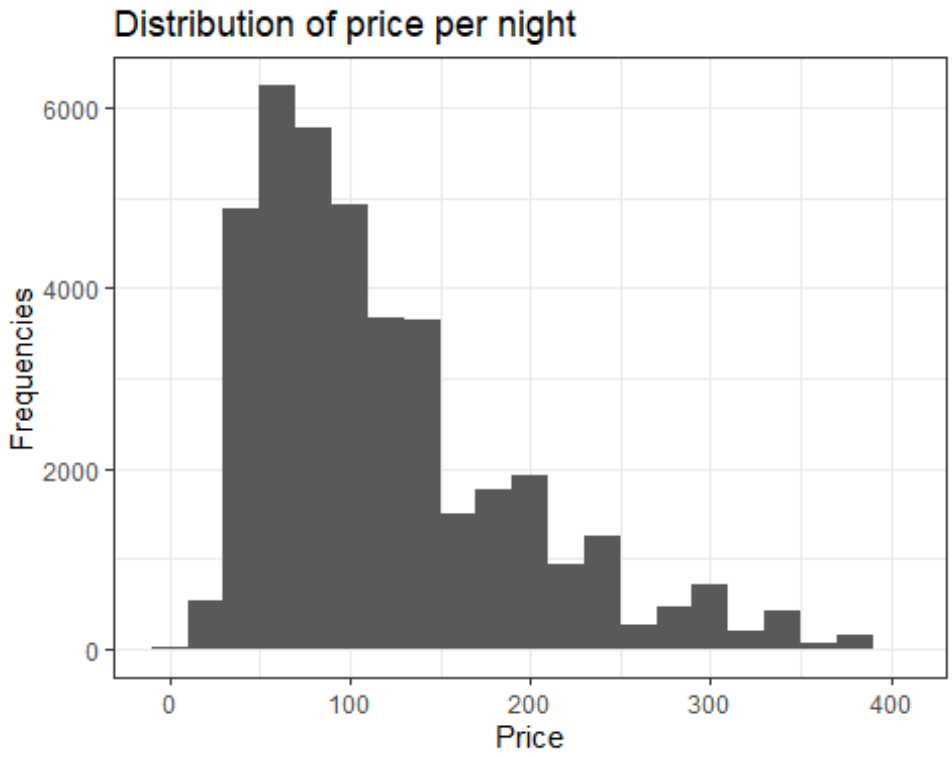
Select the columns to use to determine what happens when the price of a listing is higher than the mean price of the listings per night using the minimum nights requirement,availability of a listing during the year, the number of reviews and room type.

```
data<-data|>
  select('price','minimum_nights','number_of_reviews','availability_365','roo
m_type')
head(data) ## 6 first rows
```

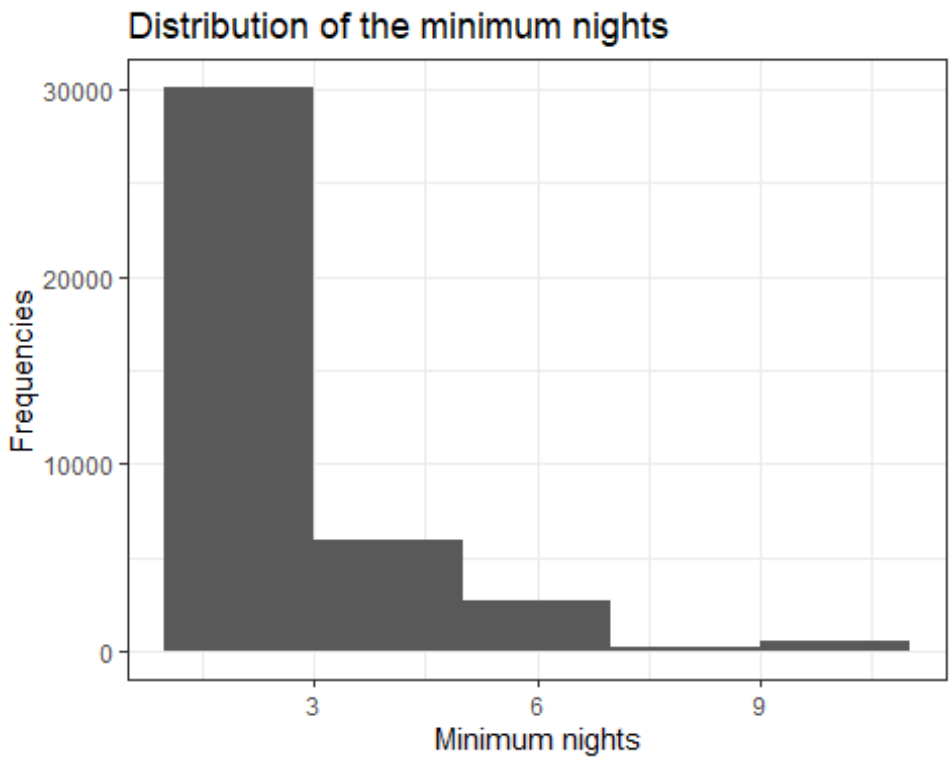
```
## # A tibble: 6 × 5
##   price minimum_nights number_of_reviews availability_365 room_type
##   <dbl>          <dbl>             <dbl>            <dbl> <chr>
## 1   149              1                 9              365 Private room
## 2   225              1                45              355 Entire home/apt
## 3   150              3                 0              365 Private room
## 4    89              1               270              194 Entire home/apt
## 5    80             10                 9                0 Entire home/apt
## 6   200              3                74              129 Entire home/apt
```

Histograms for numerical variables

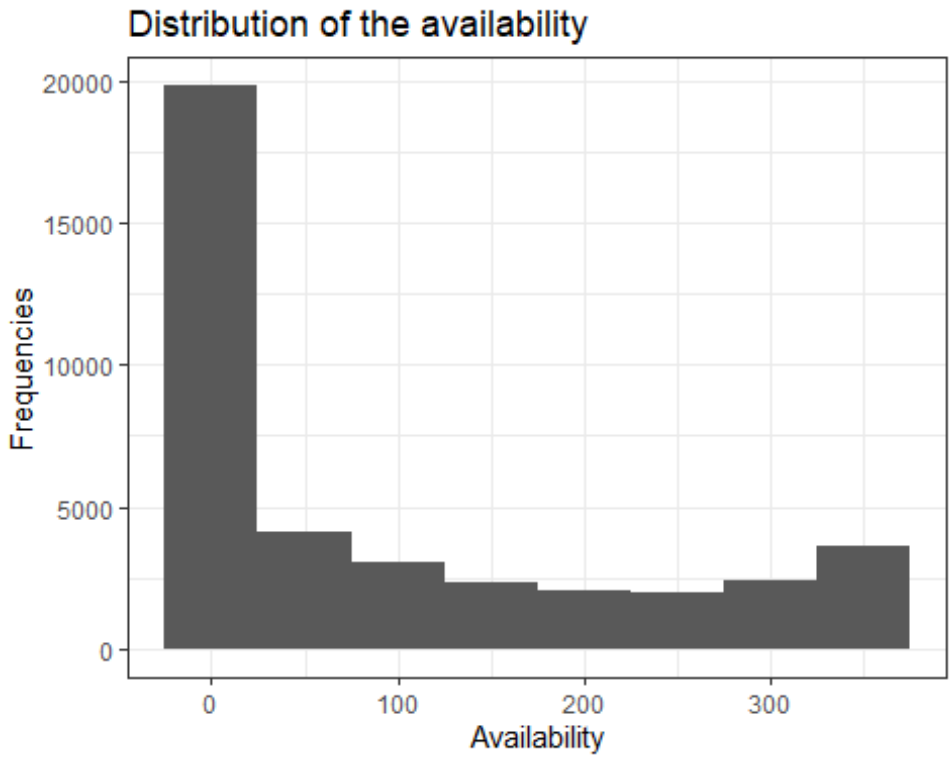
```
data|>ggplot(aes(price))+
  geom_histogram(binwidth = 20,position ='identity')+
  theme_bw()+
  labs(x='Price',y='Frequencies',title='Distribution of price per night')
```




```
data|>ggplot(aes(minimum_nights))+geom_histogram(binwidth = 2)+
  theme_bw()+
  labs(x='Minimum nights',y='Frequencies',title='Distribution of the minimum
nights')
```

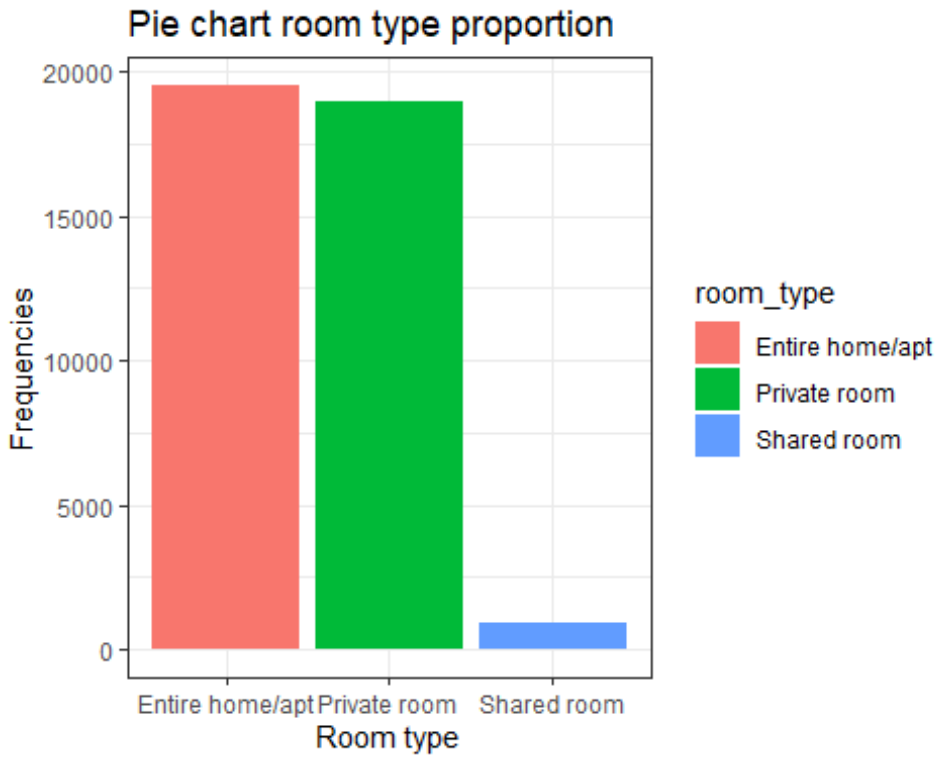



```
data|>ggplot(aes(availability_365))+geom_histogram(binwidth = 50 )+
  theme_bw()+
  labs(x='Availability',y='Frequencies',title='Distribution of the availabili
ty ')
```



Bar chart for the room type proportions

```
data|>ggplot(aes(room_type,fill=room_type))+geom_bar()+
  theme_bw()+labs(x='Room type',y='Frequencies',title='Pie chart room type pr
oportion')
```



Converting categorical variables to numerical variables

```
data$price_class<-ifelse(data$price>mean(data$price,na.rm=TRUE),1,0)  #Add co
lumn for converted price values
##data<-dummy_cols(data, select_columns ='room_type' )##Create room type dumm
y variables
head(data)
```

```
## # A tibble: 6 × 6
##   price minimum_nights number_of_reviews availability_365 room_type  price
_class
##   <dbl>          <dbl>             <dbl>            <dbl> <chr>
<dbl>
## 1   149              1                 9              365 Private r…
1
## 2   225              1                45              355 Entire ho…
1
## 3   150              3                 0              365 Private r…
1
## 4    89              1               270              194 Entire ho…
0
## 5    80             10                 9                0 Entire ho…
0
## 6   200              3                74              129 Entire ho…
1
```

Data partitioning

Splitting the dataset into train and test

```
set.seed(1124)#For reproducibility
library(caret)
index<-createDataPartition(data$price_class,
        p=.7,list=FALSE)
data_train<-data[index,]
data_test<-data[-index,]
head(data_train)
```

```
## # A tibble: 6 × 6
##   price minimum_nights number_of_reviews availability_365 room_type  price
_class
##   <dbl>          <dbl>             <dbl>            <dbl> <chr>
<dbl>
## 1   150              3                 0              365 Private r…
1
## 2   200              3                74              129 Entire ho…
1
## 3    79              2               430              220 Private r…
0
## 4    79              2               118                0 Private r…
0
## 5   150              1               160              188 Entire ho…
1
## 6   135              5                53                6 Entire ho…
1
```

Build the model

This involves training the model on the expected output

```
model<-glm(price_class~minimum_nights+number_of_reviews+availability_365+room
_type,family=binomial,data=data_train)
summary(model)
```

```
##
## Call:
## glm(formula = price_class ~ minimum_nights + number_of_reviews +
##     availability_365 + room_type, family = binomial, data = data_train)
##
## Coefficients:
##                          Estimate Std. Error z value Pr(>|z|)
## (Intercept)             0.8303727  0.0367923  22.569  < 2e-16 ***
## minimum_nights         -0.0153400  0.0089745  -1.709   0.0874 .
## number_of_reviews      -0.0029714  0.0003782  -7.856 3.95e-15 ***
## availability_365        0.0017946  0.0001449  12.386  < 2e-16 ***
## room_typePrivate room -3.4349783  0.0390144 -88.044  < 2e-16 ***
```

```
## room_typeShared room  -5.7188774  0.4112487 -13.906  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 36682  on 27561  degrees of freedom
## Residual deviance: 23580  on 27556  degrees of freedom
## AIC: 23592
##
## Number of Fisher Scoring iterations: 7
```

Test the model

```
data_test$predicted_probabilities<-predict(model,newdata=data_test,type='response')
##Convert the predicted probabilities to binary of 1's and 0's with a threshold of .5
data_test$predicted_class<-ifelse(data_test$predicted_probabilities>.5,1,0)

head(data_test)
```

```
## # A tibble: 6 × 8
##   price minimum_nights number_of_reviews availability_365 room_type  price_class
##   <dbl>          <dbl>             <dbl>            <dbl> <chr>           <dbl>
## 1   149              1                 9              365 Private r…          1
## 2   225              1                45              355 Entire ho…          1
## 3    89              1               270              194 Entire ho…          0
## 4    80             10                 9                0 Entire ho…          0
## 5    85              2               113              333 Private r…          0
## 6   140              2               148               46 Entire ho…          1
## # ℹ 2 more variables: predicted_probabilities <dbl>, predicted_class <dbl>
```

Validate the model

```
table(prediction=data_test$predicted_class, Actual=data_test$price_class)
```

```
##           Actual
## prediction    0    1
##          0 5480  439
##          1 1715 4178
```

Confusion matrix

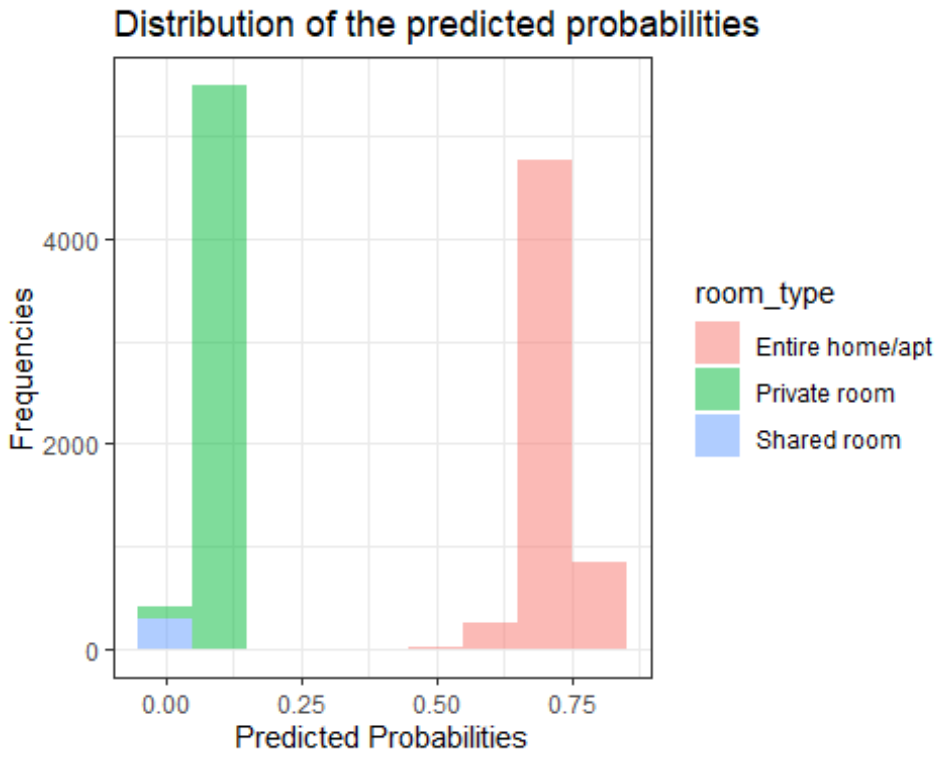
To validate the model accuracy and precision

```
confusion_Matrix<-confusionMatrix(table(prediction=data_test$predicted_class,
Actual=data_test$price_class))
###Get the confusion matrix
confusion_Matrix
```

```
## Confusion Matrix and Statistics
##
##           Actual
## prediction    0    1
##          0 5480  439
##          1 1715 4178
##
##                Accuracy : 0.8176
##                  95% CI : (0.8106, 0.8246)
##     No Information Rate : 0.6091
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.6351
##
##  Mcnemar's Test P-Value : < 2.2e-16
##
##             Sensitivity : 0.7616
##             Specificity : 0.9049
##          Pos Pred Value : 0.9258
##          Neg Pred Value : 0.7090
##              Prevalence : 0.6091
##          Detection Rate : 0.4639
##    Detection Prevalence : 0.5011
##       Balanced Accuracy : 0.8333
##
##        'Positive' Class : 0
##
```

##Histogram To visualize the predicted probanilities

```
data_test|>ggplot(aes(predicted_probabilities,fill=room_type))+geom_histogram
(binwidth = .1,alpha=.5)+theme_bw()+
  labs(x='Predicted Probabilities',y='Frequencies',title='Distribution of the
predicted probabilities')
```


Distribution of the predicted probabilities
Frequencies
4000
2000
0
0.00
0.25
0.50
0.75
Predicted Probabilities
room_type
Entire home/apt
Private room
Shared room