initial analysis and modeling

November 10, 2021

0.1 Importing libraries

[2]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb
from sklearn.linear_model import LinearRegression
import warnings
warnings.filterwarnings('ignore')
```

[1]:

```
#pip install -U seaborn
```

```
Collecting seaborn
  Using cached seaborn-0.11.2-py3-none-any.whl (292 kB)
Requirement already satisfied, skipping upgrade: pandas>=0.23 in
/opt/conda/lib/python3.7/site-packages (from seaborn) (1.0.3)
Requirement already satisfied, skipping upgrade: matplotlib>=2.2 in
/opt/conda/lib/python3.7/site-packages (from seaborn) (3.2.1)
Requirement already satisfied, skipping upgrade: scipy>=1.0 in
/opt/conda/lib/python3.7/site-packages (from seaborn) (1.4.1)
Requirement already satisfied, skipping upgrade: numpy>=1.15 in
/opt/conda/lib/python3.7/site-packages (from seaborn) (1.18.4)
Requirement already satisfied, skipping upgrade: pytz>=2017.2 in
/opt/conda/lib/python3.7/site-packages (from pandas>=0.23->seaborn) (2020.1)
Requirement already satisfied, skipping upgrade: python-dateutil>=2.6.1 in
/opt/conda/lib/python3.7/site-packages (from pandas>=0.23->seaborn) (2.8.1)
Requirement already satisfied, skipping upgrade: cycler>=0.10 in
/opt/conda/lib/python3.7/site-packages (from matplotlib>=2.2->seaborn) (0.10.0)
Requirement already satisfied, skipping upgrade:
pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /opt/conda/lib/python3.7/site-
packages (from matplotlib>=2.2->seaborn) (2.4.7)
Requirement already satisfied, skipping upgrade: kiwisolver>=1.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib>=2.2->seaborn) (1.2.0)
Requirement already satisfied, skipping upgrade: six>=1.5 in
/opt/conda/lib/python3.7/site-packages (from python-
dateutil>=2.6.1->pandas>=0.23->seaborn) (1.14.0)
Installing collected packages: seaborn
  Attempting uninstall: seaborn
```

```
    Found existing installation: seaborn 0.10.1
    Uninstalling seaborn-0.10.1:
      Successfully uninstalled seaborn-0.10.1
Successfully installed seaborn-0.11.2
Note: you may need to restart the kernel to use updated packages.
```

[2]:

```
#from IPython.core.interactiveshell import InteractiveShell
#InteractiveShell.ast_node_interactivity="all"
```

[3]:

```
df =pd.read_csv("hotaldataClean1.csv")
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 87230 entries, 0 to 87229
Data columns (total 31 columns):
 #   Column                       Non-Null Count  Dtype
---  ------                       --------------  -----
 0   IsCanceled                   87230 non-null  int64
 1   LeadTime                     87230 non-null  int64
 2   ArrivalDateYear              87230 non-null  int64
 3   ArrivalDateMonth             87230 non-null  object
 4   ArrivalDateWeekNumber        87230 non-null  int64
 5   ArrivalDateDayOfMonth        87230 non-null  int64
 6   StaysInWeekendNights         87230 non-null  int64
 7   StaysInWeekNights            87230 non-null  int64
 8   Adults                       87230 non-null  int64
 9   Children                     87230 non-null  float64
 10  Babies                       87230 non-null  int64
 11  Meal                         87230 non-null  object
 12  Country                      87230 non-null  object
 13  MarketSegment                87230 non-null  object
 14  DistributionChannel          87230 non-null  object
 15  IsRepeatedGuest              87230 non-null  int64
 16  PreviousCancellations        87230 non-null  int64
 17  PreviousBookingsNotCanceled  87230 non-null  int64
 18  ReservedRoomType             87230 non-null  object
 19  AssignedRoomType             87230 non-null  object
 20  BookingChanges               87230 non-null  int64
 21  DepositType                  87230 non-null  object
 22  Agent                        87230 non-null  float64
 23  DaysInWaitingList            87230 non-null  int64
 24  CustomerType                 87230 non-null  object
 25  ADR                          87230 non-null  float64
 26  RequiredCarParkingSpaces     87230 non-null  int64
 27  TotalOfSpecialRequests       87230 non-null  int64
 28  ReservationStatus            87230 non-null  object
 29  ReservationStatusDate        87230 non-null  object
 30  Hotal                        87230 non-null  object
```

```
dtypes: float64(3), int64(16), object(12)
memory usage: 20.6+ MB
```

0.2 Modifying to relavant attribute types in the dataframe

[3]:

```
df['ReservationStatusDate']= pd.to_datetime(df['ReservationStatusDate'])
df["IsCanceled"] = df["IsCanceled"].astype("category")
df["ArrivalDateYear"] = df["ArrivalDateYear"].astype("category")
df["ArrivalDateMonth"] = df["ArrivalDateMonth"].astype("category")
df["Meal"] = df["Meal"].astype("category")
df["Country"] = df["Country"].astype("category")
df["MarketSegment"] = df["MarketSegment"].astype("category")
df["DistributionChannel"] = df["DistributionChannel"].astype("category")
df["IsRepeatedGuest"] = df["IsRepeatedGuest"].astype("category")
df["ReservedRoomType"] = df["ReservedRoomType"].astype("category")
df["AssignedRoomType"] = df["AssignedRoomType"].astype("category")
df["DepositType"] = df["DepositType"].astype("category")
df["Agent"] = df["Agent"].astype("category")
df["CustomerType"] = df["CustomerType"].astype("category")
df["ReservationStatus"] = df["ReservationStatus"].astype("category")
df["Hotal"] = df["Hotal"].astype("category")
```

1 Displaying Dataframe Structure

[4]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 87230 entries, 0 to 87229
Data columns (total 31 columns):
 #   Column                       Non-Null Count  Dtype
---  ------                       --------------  -----
 0   IsCanceled                   87230 non-null  category
 1   LeadTime                     87230 non-null  int64
 2   ArrivalDateYear              87230 non-null  category
 3   ArrivalDateMonth             87230 non-null  category
 4   ArrivalDateWeekNumber        87230 non-null  int64
 5   ArrivalDateDayOfMonth        87230 non-null  int64
 6   StaysInWeekendNights         87230 non-null  int64
 7   StaysInWeekNights            87230 non-null  int64
 8   Adults                       87230 non-null  int64
 9   Children                     87230 non-null  float64
 10  Babies                       87230 non-null  int64
 11  Meal                         87230 non-null  category
 12  Country                      87230 non-null  category
 13  MarketSegment                87230 non-null  category
 14  DistributionChannel          87230 non-null  category
 15  IsRepeatedGuest              87230 non-null  category
 16  PreviousCancellations        87230 non-null  int64
 17  PreviousBookingsNotCanceled  87230 non-null  int64
 18  ReservedRoomType             87230 non-null  category
 19  AssignedRoomType             87230 non-null  category
 20  BookingChanges               87230 non-null  int64
 21  DepositType                  87230 non-null  category
 22  Agent                        87230 non-null  category
 23  DaysInWaitingList            87230 non-null  int64
 24  CustomerType                 87230 non-null  category
 25  ADR                          87230 non-null  float64
 26  RequiredCarParkingSpaces     87230 non-null  int64
 27  TotalOfSpecialRequests       87230 non-null  int64
 28  ReservationStatus            87230 non-null  category
 29  ReservationStatusDate        87230 non-null  datetime64[ns]
 30  Hotal                        87230 non-null  category
dtypes: category(15), datetime64[ns](1), float64(2), int64(13)
memory usage: 12.1 MB
```

2 decsribing the stats for numerical attributes

[5]:
```
df.describe()
```

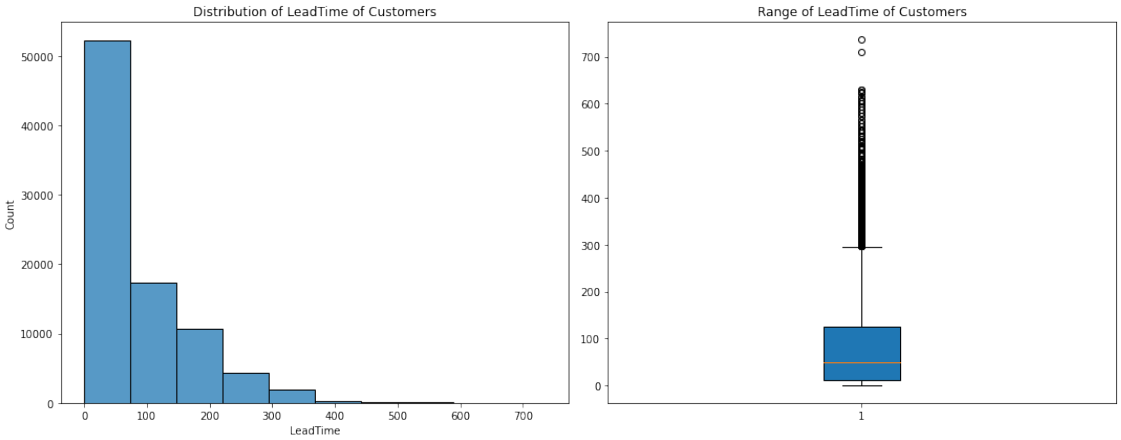
[5]:
```
           LeadTime  ArrivalDateWeekNumber  ArrivalDateDayOfMonth  \
count  87230.000000           87230.000000           87230.000000
mean      79.971019              26.835091              15.815832
std       86.058683              13.669216               8.835545
min        0.000000               1.000000               1.000000
25%       11.000000              16.000000               8.000000
50%       49.000000              27.000000              16.000000
75%      125.000000              37.000000              23.000000
max      737.000000              53.000000              31.000000

       StaysInWeekendNights  StaysInWeekNights        Adults      Children  \
count          87230.000000       87230.000000  87230.000000  87230.000000
mean               1.004609           2.623925      1.879365      0.138897
std                1.027408           2.039830      0.621724      0.456265
min                0.000000           0.000000      0.000000      0.000000
25%                0.000000           1.000000      2.000000      0.000000
50%                1.000000           2.000000      2.000000      0.000000
75%                2.000000           4.000000      2.000000      0.000000
max               19.000000          50.000000     55.000000     10.000000

             Babies  PreviousCancellations  PreviousBookingsNotCanceled  \
count  87230.000000           87230.000000                 87230.000000
```

```
mean       0.010845               0.030402                     0.184054
std        0.113704               0.369344                     1.733033
min        0.000000               0.000000                     0.000000
25%        0.000000               0.000000                     0.000000
50%        0.000000               0.000000                     0.000000
75%        0.000000               0.000000                     0.000000
max       10.000000              26.000000                    72.000000

       BookingChanges  DaysInWaitingList           ADR  \
count    87230.000000       87230.000000  87230.000000
mean         0.268497           0.746291    106.518031
std          0.710633          10.001001     54.891227
min          0.000000           0.000000     -6.380000
25%          0.000000           0.000000     72.250000
50%          0.000000           0.000000     98.200000
75%          0.000000           0.000000    134.100000
max         18.000000         391.000000   5400.000000

       RequiredCarParkingSpaces  TotalOfSpecialRequests
count              87230.000000            87230.000000
mean                   0.084306                0.698934
std                    0.281659                0.832051
min                    0.000000                0.000000
25%                    0.000000                0.000000
50%                    0.000000                0.000000
75%                    0.000000                1.000000
max                    8.000000                5.000000
```

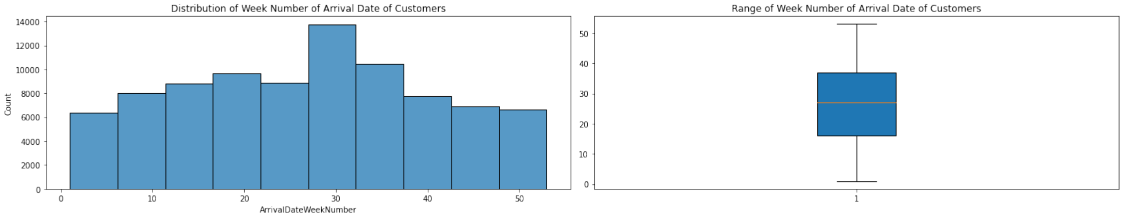
[7]:
```
df.shape
```

[7]:
```
(87230, 31)
```

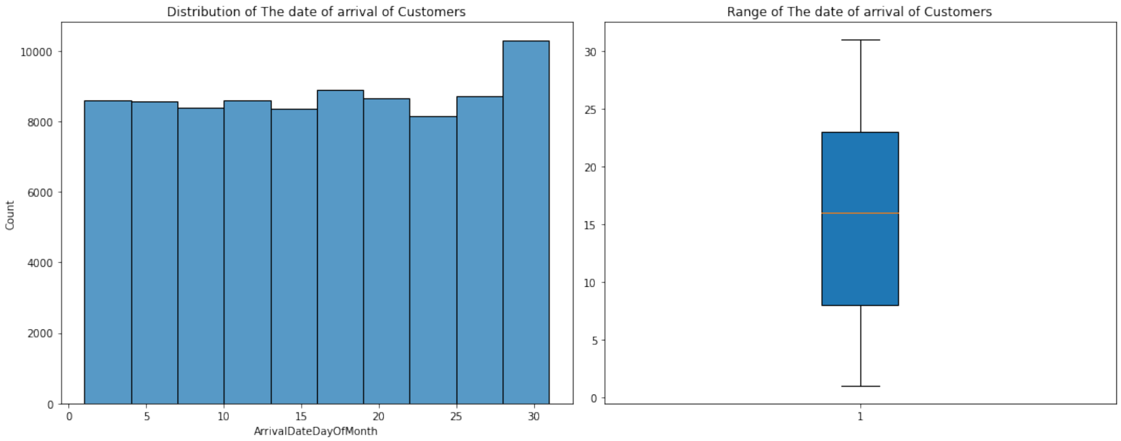
[6]:
```
fig, axes = plt.subplots(1,2,figsize=(15,6))
sb.histplot(df['LeadTime'],bins=10,ax=axes[0])
plt.boxplot(df['LeadTime'],patch_artist = True)
axes[0].set_title('Distribution of LeadTime of Customers')
axes[1].set_title('Range of LeadTime of Customers')
plt.tight_layout()
plt.show()
```



[7]:
```
fig, axes = plt.subplots(1,2, figsize=(20,4))

sb.histplot(df['ArrivalDateWeekNumber'],bins=10,ax=axes[0])
plt.boxplot(df['ArrivalDateWeekNumber'],patch_artist = True)

axes[0].set_title('Distribution of Week Number of Arrival Date of Customers')
axes[1].set_title('Range of Week Number of Arrival Date of Customers')
plt.tight_layout()
#plt.savefig("hist of ArrivalDateWeekNumber.png" )
plt.show()
```

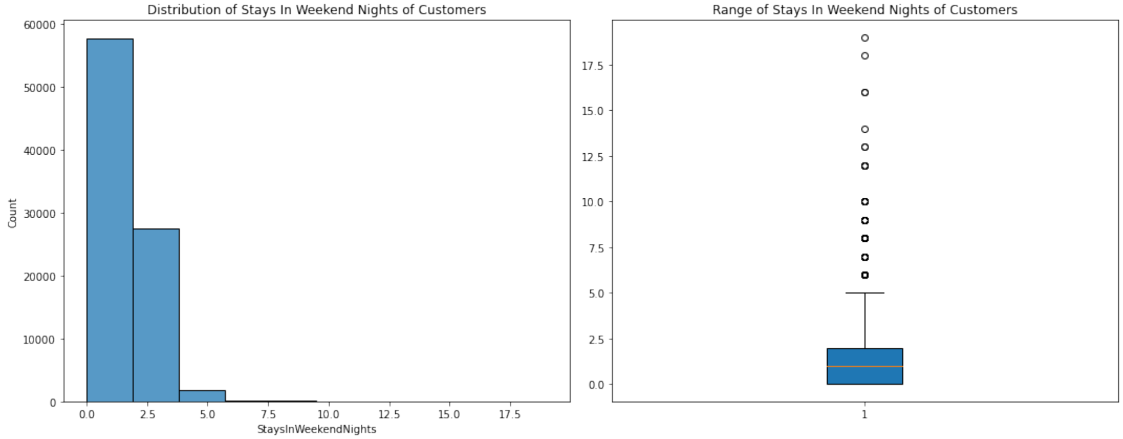


[8]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))
sb.histplot(df['ArrivalDateDayOfMonth'],bins=10,ax=axes[0])
plt.boxplot(df['ArrivalDateDayOfMonth'],patch_artist = True)

axes[0].set_title('Distribution of The date of arrival of Customers')
axes[1].set_title('Range of The date of arrival of Customers')
plt.tight_layout()
#plt.savefig("hist of ArrivalDateDayOfMonth.png" )
plt.show()
```



[9]:

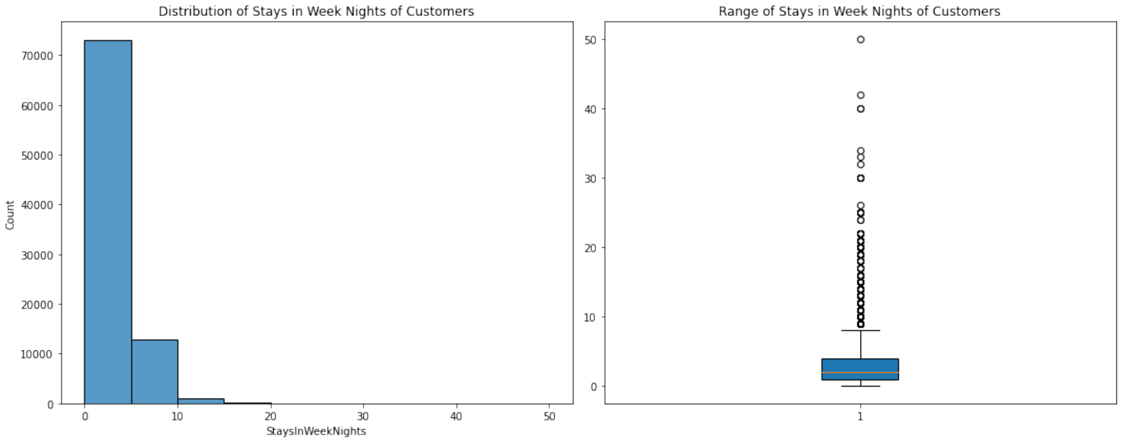
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['StaysInWeekendNights'],bins=10,ax=axes[0])
plt.boxplot(df['StaysInWeekendNights'],patch_artist=True)

axes[0].set_title('Distribution of Stays In Weekend Nights of Customers')
axes[1].set_title('Range of Stays In Weekend Nights of Customers')
plt.tight_layout()
#plt.savefig("hist of StaysInWeekendNights.png" )
plt.show()
```



[10]:

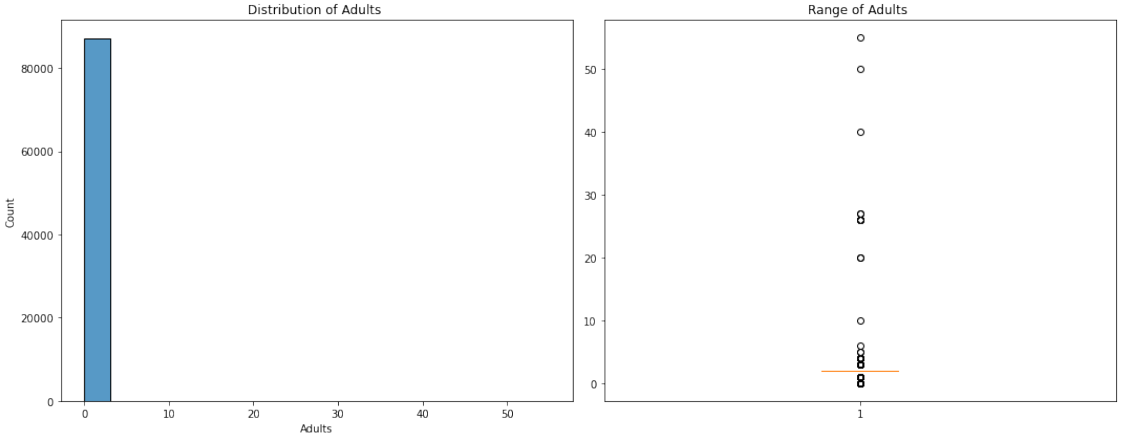
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['StaysInWeekNights'],bins= 10,ax=axes[0])
plt.boxplot(df['StaysInWeekNights'],patch_artist=True)
axes[0].set_title('Distribution of Stays in Week Nights of Customers')
```

```
axes[1].set_title('Range of Stays in Week Nights of Customers')
plt.tight_layout()
#plt.savefig("hist of StaysInWeekNights.png" )
plt.show()
```



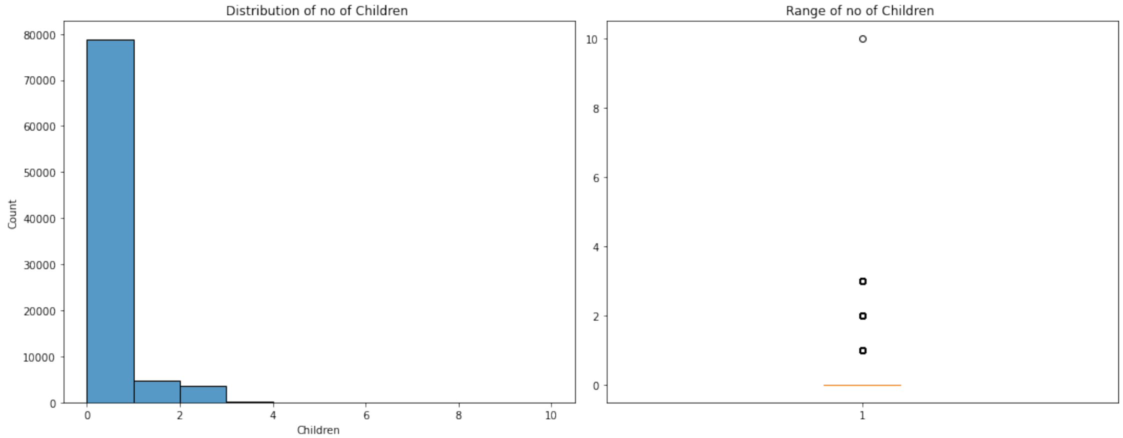
[11]:

```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['Adults'],ax=axes[0])


plt.boxplot(df['Adults'],patch_artist=True)
axes[0].set_title('Distribution of Adults ')
axes[1].set_title('Range of Adults ')
plt.tight_layout()
#plt.savefig("hist of Adults.png" )
plt.show()
```



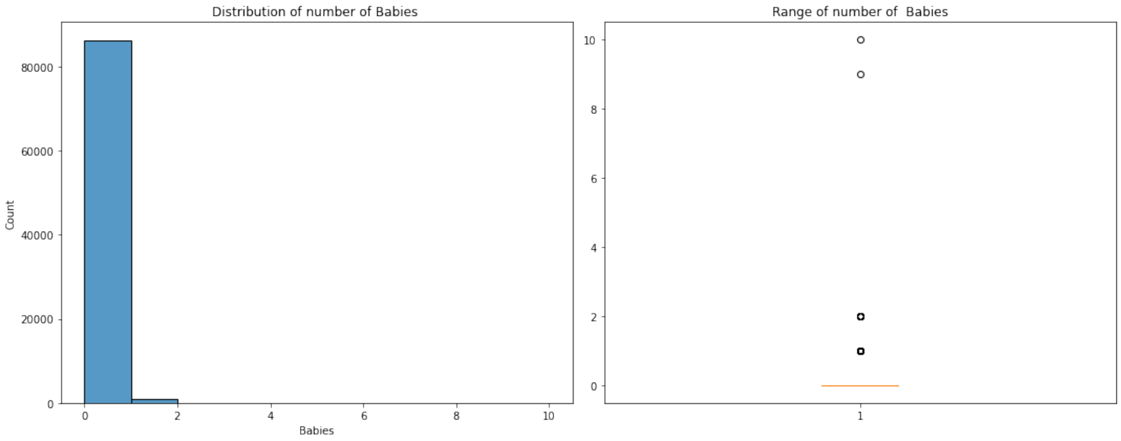
[12]:

```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['Children'],bins= 10,ax=axes[0])


plt.boxplot(df['Children'],patch_artist=True)
axes[0].set_title('Distribution of no of Children ')
axes[1].set_title('Range of no of Children ')
plt.tight_layout()
#plt.savefig("hist of Children.png" )
plt.show()
```

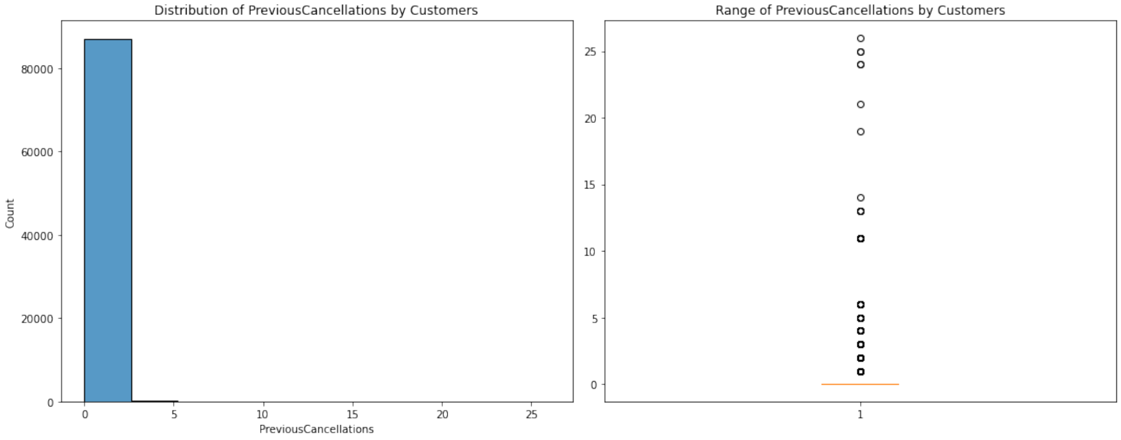


[13]:

```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['Babies'],bins= 10,ax=axes[0])


plt.boxplot(df['Babies'],patch_artist=True)## Whiskers in the Boxplot shows␣
 ↪that there are outliers
axes[0].set_title('Distribution of number of Babies ')
axes[1].set_title('Range of number of  Babies')
plt.tight_layout()
#plt.savefig("hist of Babies.png" )
plt.show()
```

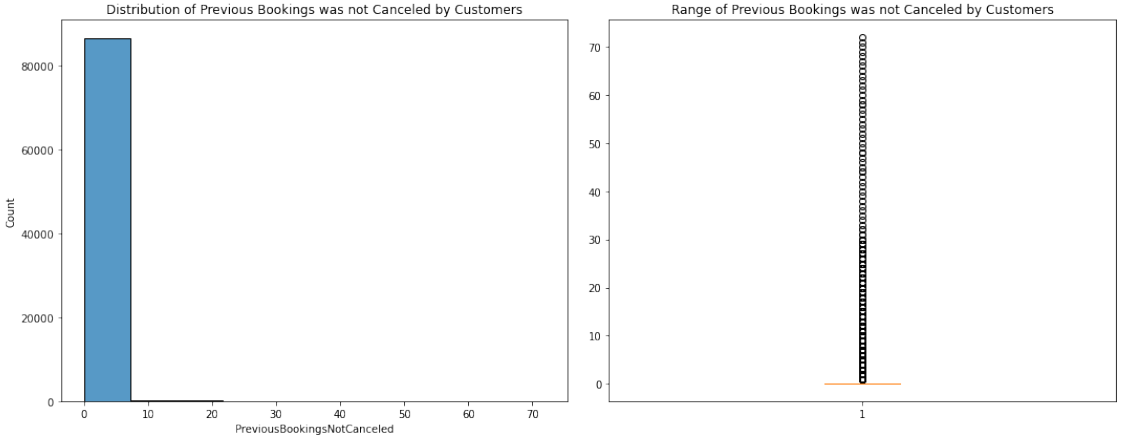


[14]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['PreviousCancellations'],bins= 10,ax=axes[0])


plt.boxplot(df['PreviousCancellations'],patch_artist=True)
axes[0].set_title('Distribution of PreviousCancellations by Customers')
axes[1].set_title('Range of PreviousCancellations by Customers')
plt.tight_layout()
#plt.savefig("hist of PreviousCancellations.png" )
plt.show()
```

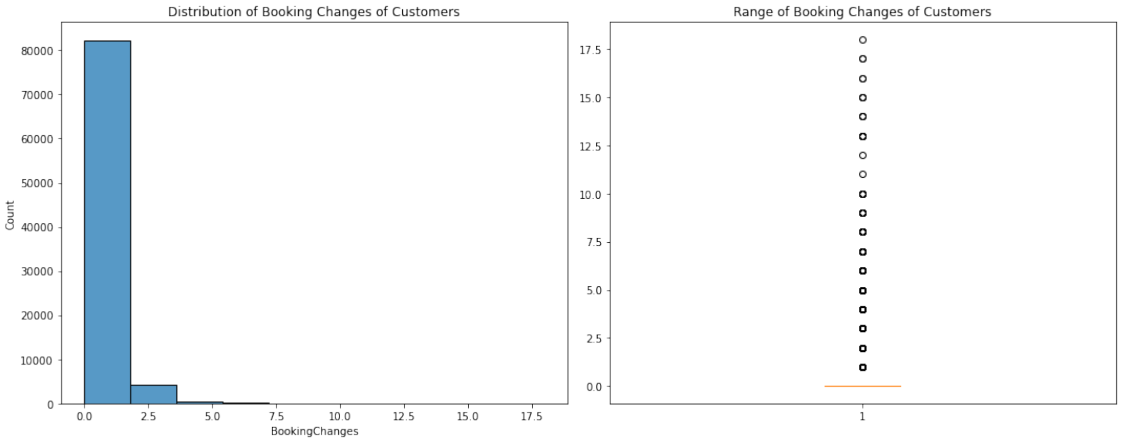


[15]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['PreviousBookingsNotCanceled'],bins= 10,ax=axes[0])
```

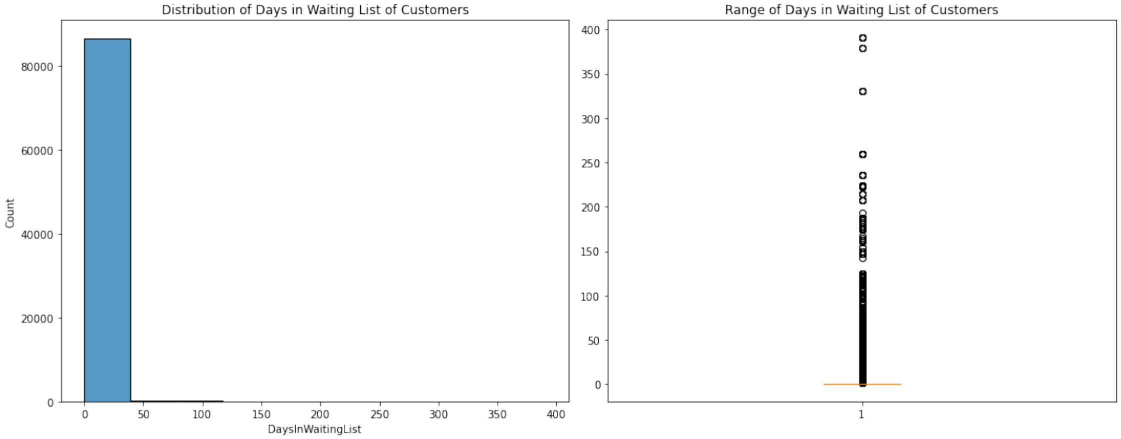
```
plt.boxplot(df['PreviousBookingsNotCanceled'],patch_artist=True)## Whiskers in␣
 ↪the Boxplot shows that there are outliers
axes[0].set_title('Distribution of Previous Bookings was not Canceled by␣
 ↪Customers')
axes[1].set_title('Range of Previous Bookings was not Canceled by Customers')
plt.tight_layout()
#plt.savefig("hist of PreviousBookingsNotCanceled.png" )
plt.show()
```



[16]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['BookingChanges'],bins= 10,ax=axes[0])


plt.boxplot(df['BookingChanges'],patch_artist=True)## Whiskers in the Boxplot␣
 ↪shows that there are outliers
axes[0].set_title('Distribution of Booking Changes of Customers')
axes[1].set_title('Range of Booking Changes of Customers')
plt.tight_layout()
#plt.savefig("hist of BookingChanges.png" )
plt.show()
```

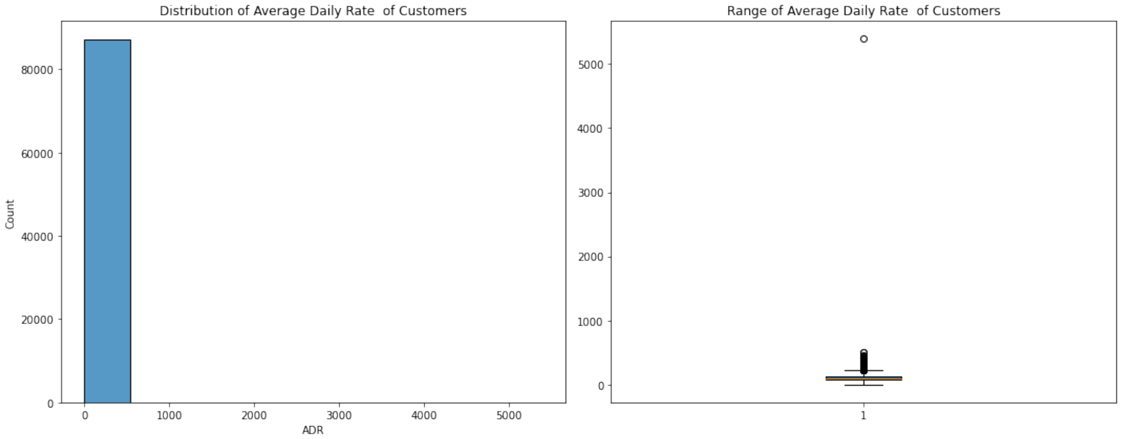


[17]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['DaysInWaitingList'],bins=10,ax=axes[0])


plt.boxplot(df['DaysInWaitingList'],patch_artist=True)## Whiskers in the Boxplot shows that there are outliers
axes[0].set_title('Distribution of Days in Waiting List of Customers')
axes[1].set_title('Range of Days in Waiting List of Customers')
plt.tight_layout()
#plt.savefig("hist of DaysInWaitingList.png" )
plt.show()
```

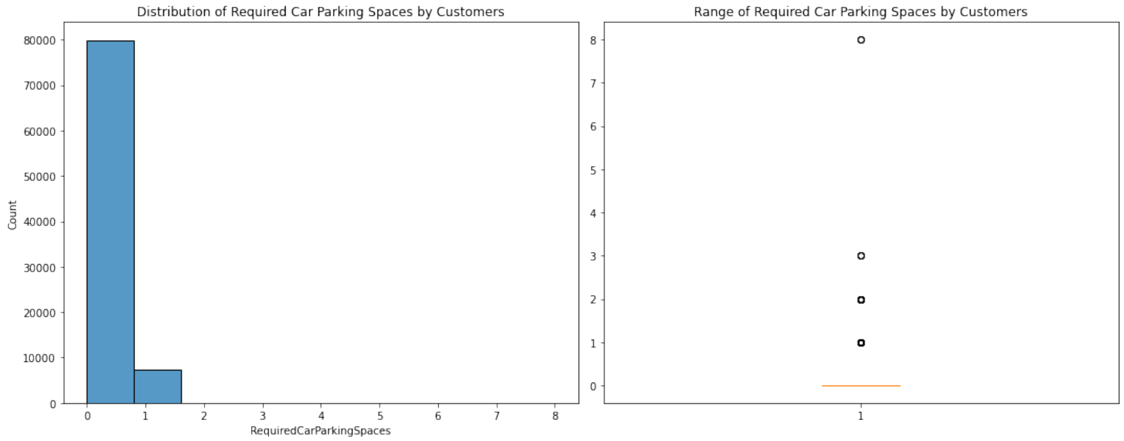


[18]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['ADR'],bins=10,ax=axes[0])
```

```


plt.boxplot(df['ADR'],patch_artist=True)
axes[0].set_title('Distribution of Average Daily Rate  of Customers')
axes[1].set_title('Range of Average Daily Rate  of Customers')
plt.tight_layout()
#plt.savefig("hist of ADR.png" )
plt.show()
```

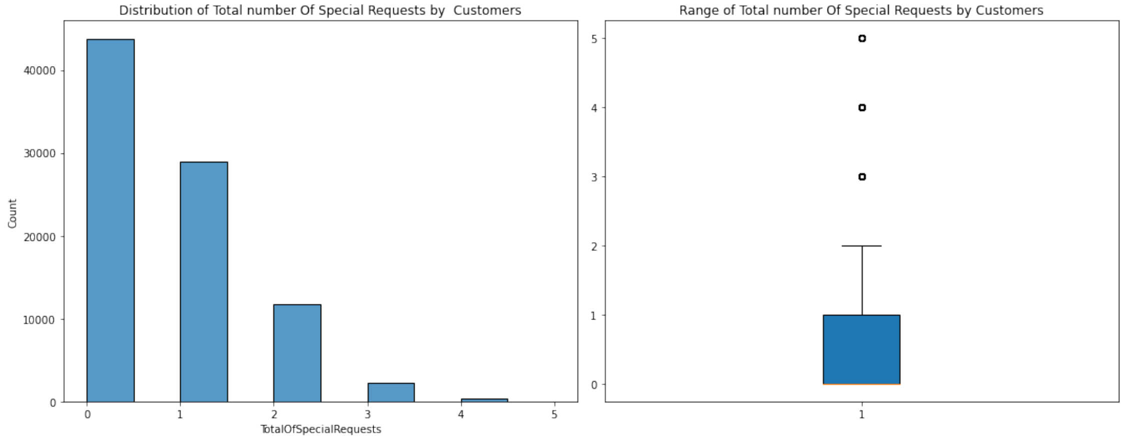


[19]:
```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['RequiredCarParkingSpaces'],bins= 10, ax=axes[0])


plt.boxplot(df['RequiredCarParkingSpaces'],patch_artist=True)## Whiskers in the␣
 ↪Boxplot shows that there are outliers
axes[0].set_title('Distribution of Required Car Parking Spaces by Customers')
axes[1].set_title('Range of Required Car Parking Spaces by Customers')
plt.tight_layout()
#plt.savefig("hist of RequiredCarParkingSpaces.png" )
plt.show()
```



[20]:

```
fig, axes = plt.subplots(1,2, figsize=(15,6))

sb.histplot(df['TotalOfSpecialRequests'],bins= 10,ax=axes[0])


plt.boxplot(df['TotalOfSpecialRequests'],patch_artist=True)## Whiskers in the␣
 ↪Boxplot shows that there are outliers
axes[0].set_title('Distribution of Total number Of Special Requests by ␣
 ↪Customers')
axes[1].set_title('Range of Total number Of Special Requests by Customers')
plt.tight_layout()
#plt.savefig("hist of TotalOfSpecialRequests.png" )
plt.show()
```



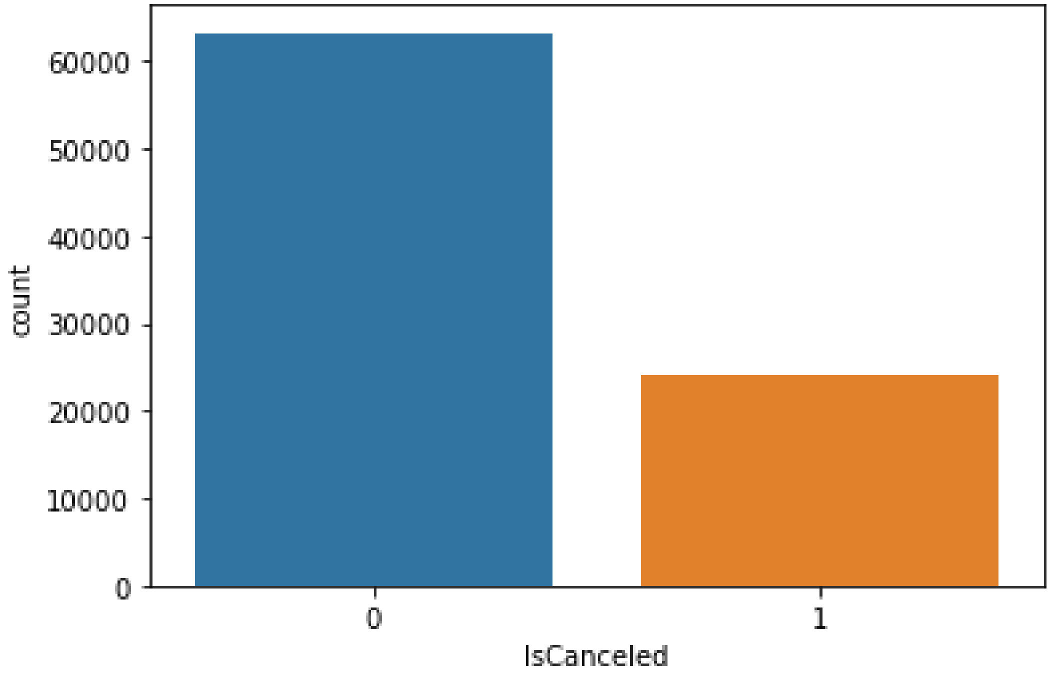
[21]:

```
numeric = []
category = []
```

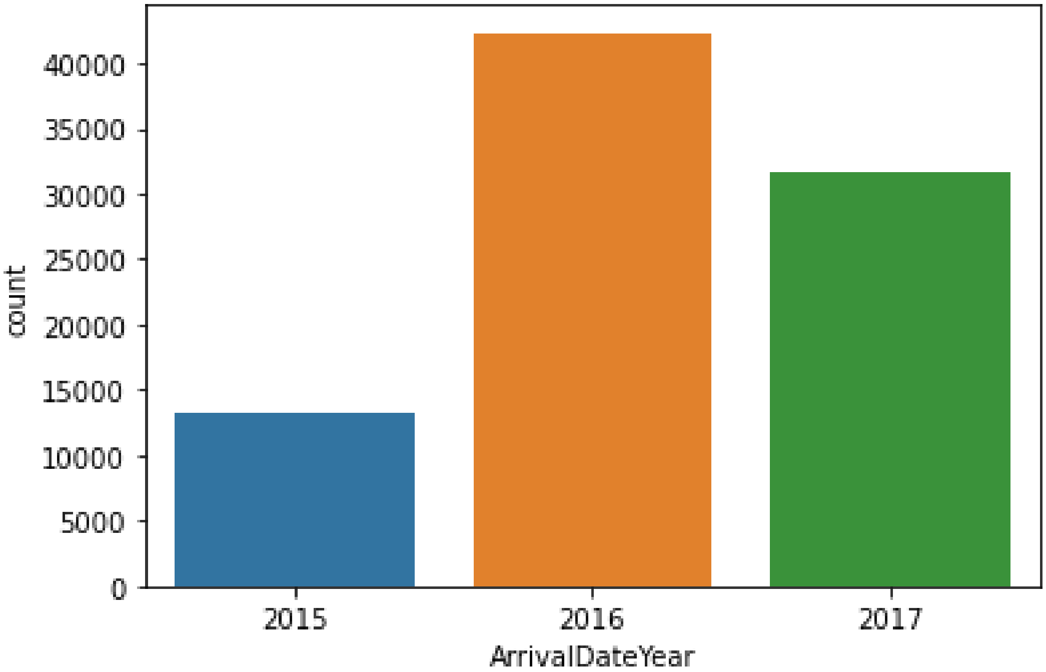
```
for col in df:
    if pd.api.types.is_numeric_dtype(df[col]):
        numeric.append(col)
    else:
         category.append(col)
print("category :",category)
```

```
category : ['IsCanceled', 'ArrivalDateYear', 'ArrivalDateMonth', 'Meal',
'Country', 'MarketSegment', 'DistributionChannel', 'IsRepeatedGuest',
'ReservedRoomType', 'AssignedRoomType', 'DepositType', 'Agent', 'CustomerType',
'ReservationStatus', 'ReservationStatusDate', 'Hotal']
```

[23]:
```
chart = sb.countplot(df["IsCanceled"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of IsCanceled.png" )
plt.show()
```

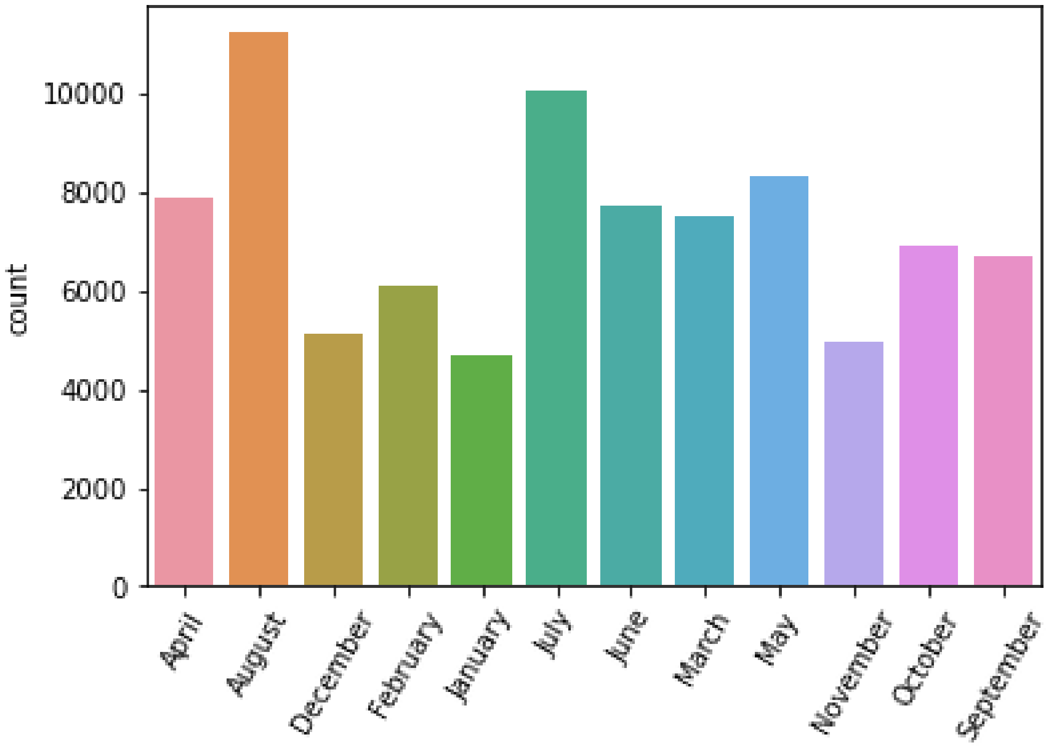


[24]:
```
chart = sb.countplot(df["ArrivalDateYear"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of ArrivalDateYear.png" )
plt.show()
```

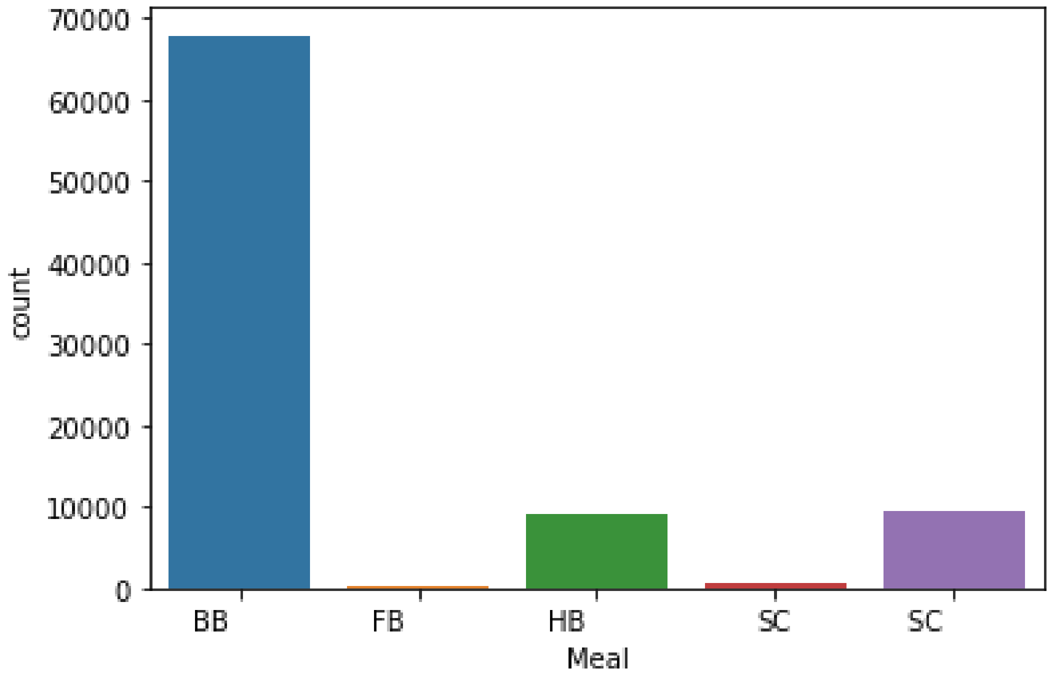


[25]:

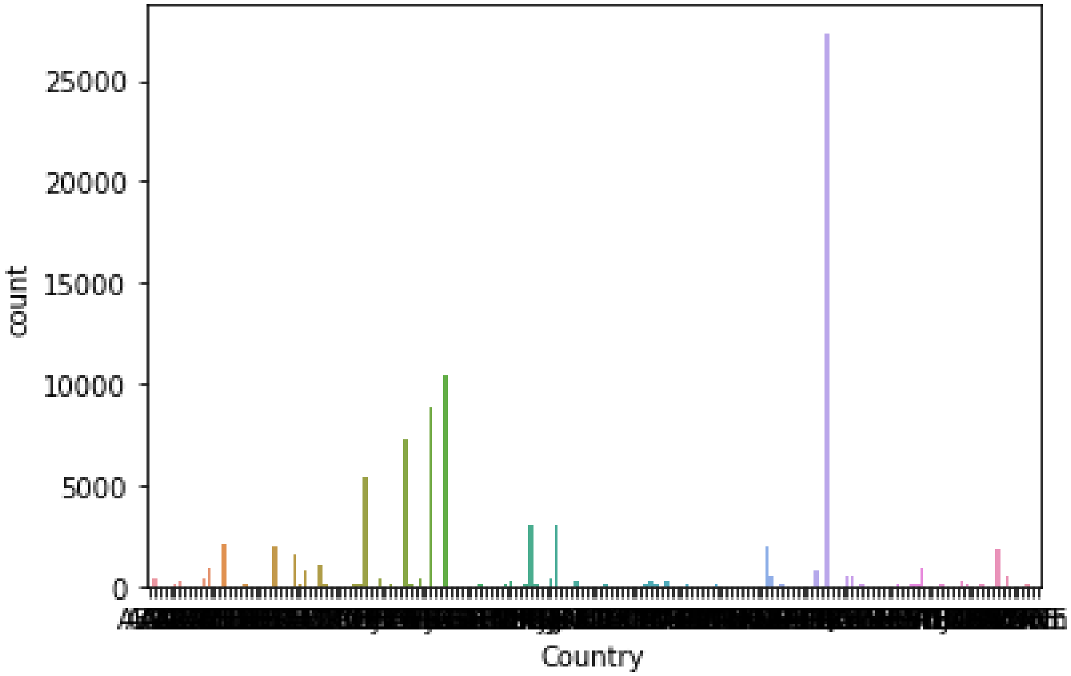
```
chart = sb.countplot(df["ArrivalDateMonth"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels(),rotation=60)
#plt.savefig("A.png",bbox_inches='tight' )
plt.show()
```



[26]:
```
chart = sb.countplot(df["Meal"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of Meal.png" )
plt.show()
```

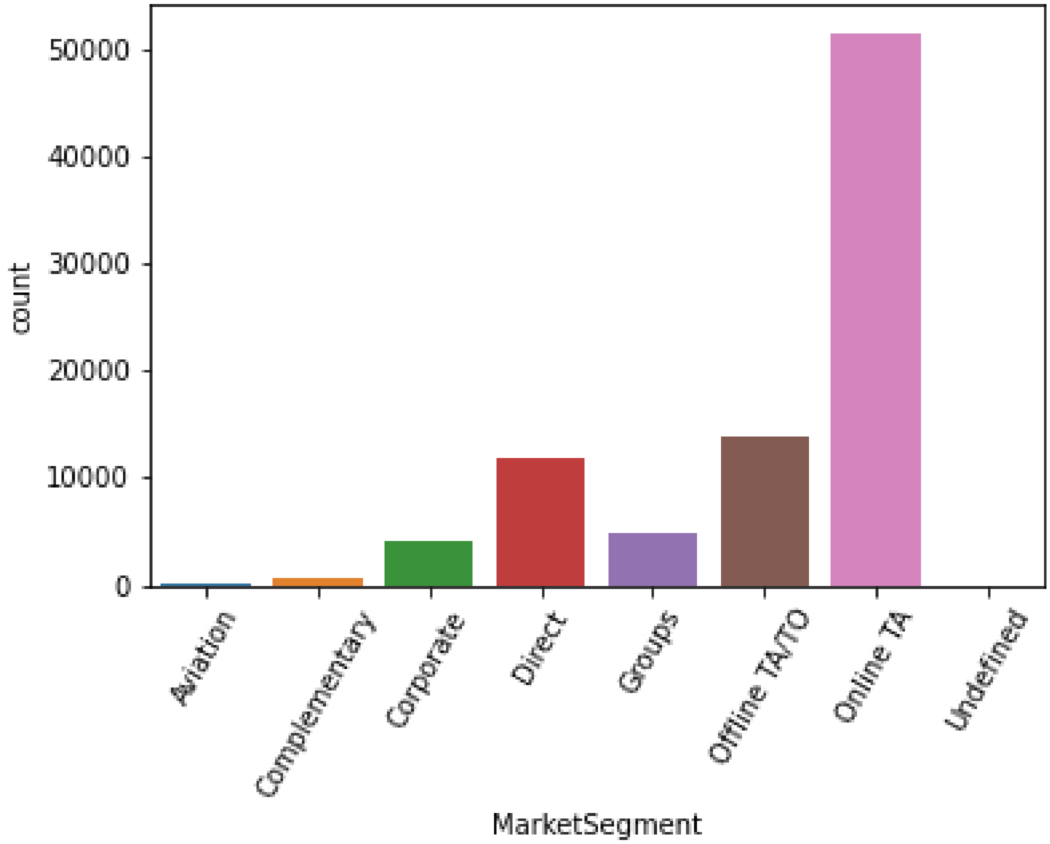


```
[27]: chart = sb.countplot(df["Country"]) # frequency distribution
      chart.set_xticklabels(chart.get_xticklabels())
      #plt.savefig("hist of Country.png" )
      plt.show()
```



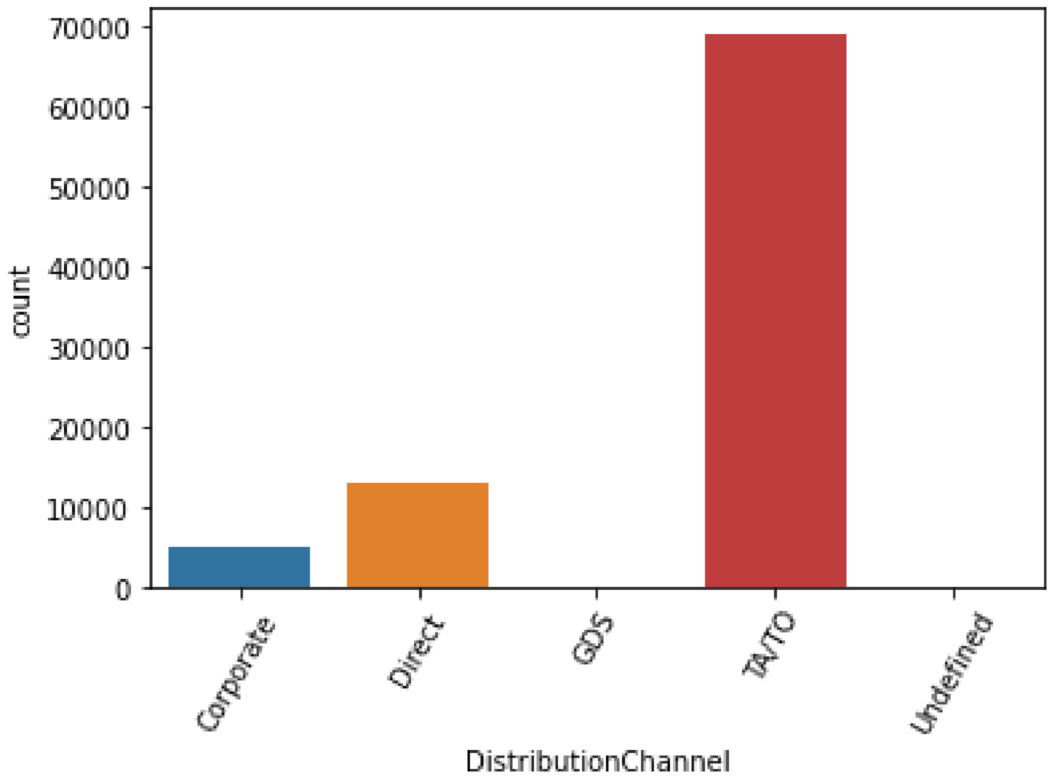
[299]:

```
chart = sb.countplot(df["MarketSegment"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels(),rotation=60)
#plt.savefig("hist of MarketSegment.png",bbox_inches='tight' )
plt.show()
```

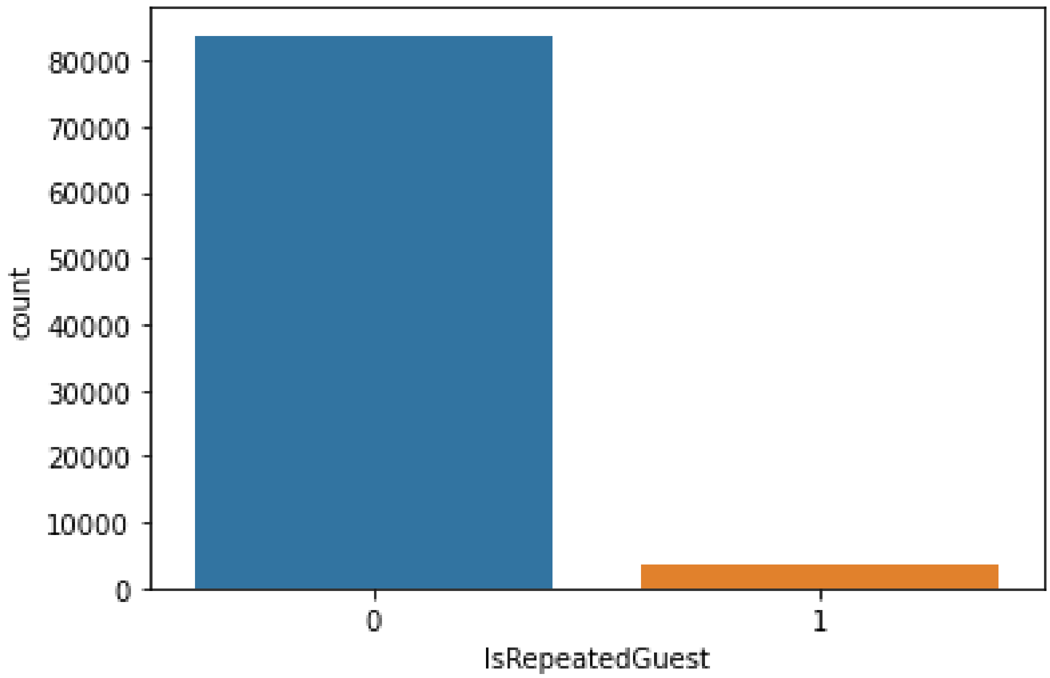


[28]:

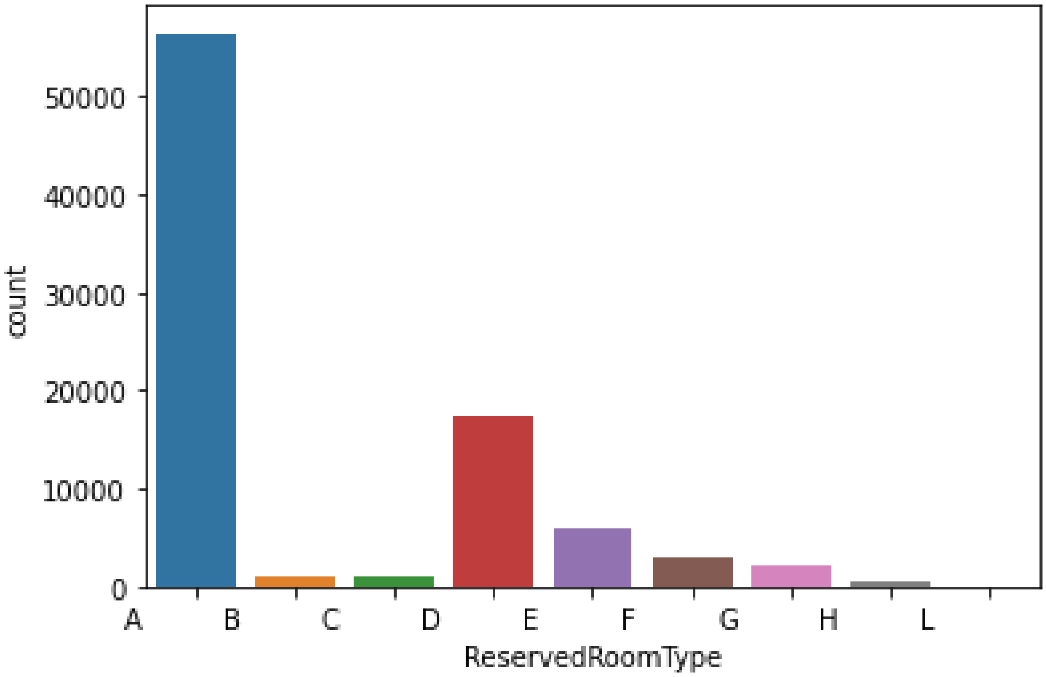
```
chart = sb.countplot(df["DistributionChannel"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels(),rotation=60)
plt.savefig("hist of DistributionChannel.png",bbox_inches='tight'  )
plt.show()
```



[29]:
```
chart = sb.countplot(df["IsRepeatedGuest"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of IsRepeatedGuest.png" )
plt.show()
```

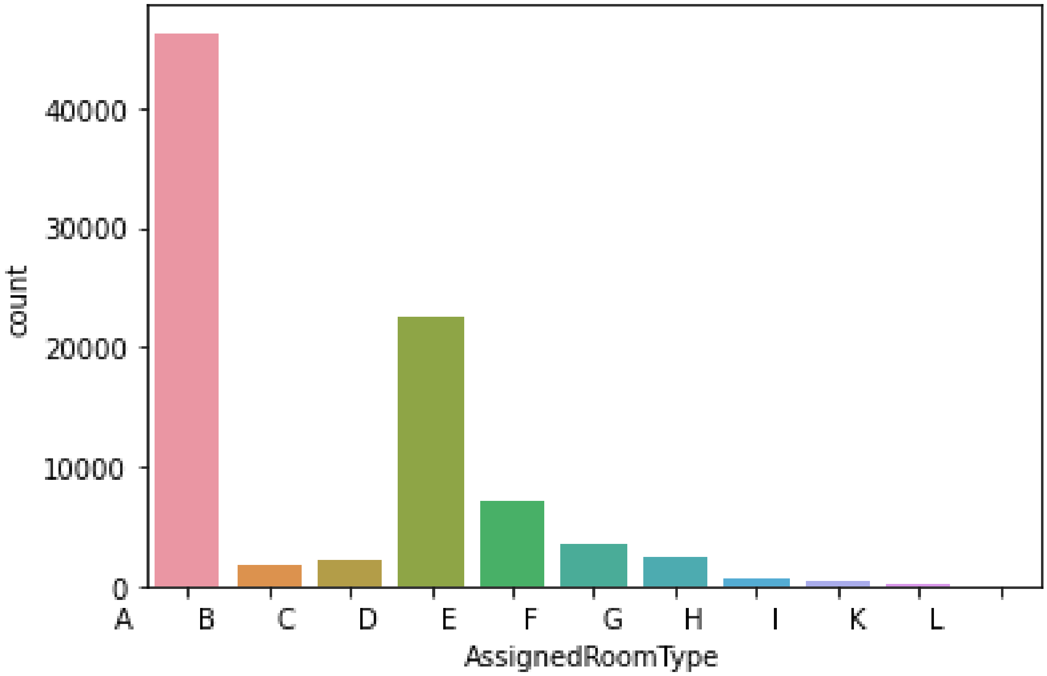


[30]:
```
chart = sb.countplot(df["ReservedRoomType"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of ReservedRoomType.png" )
plt.show()
```



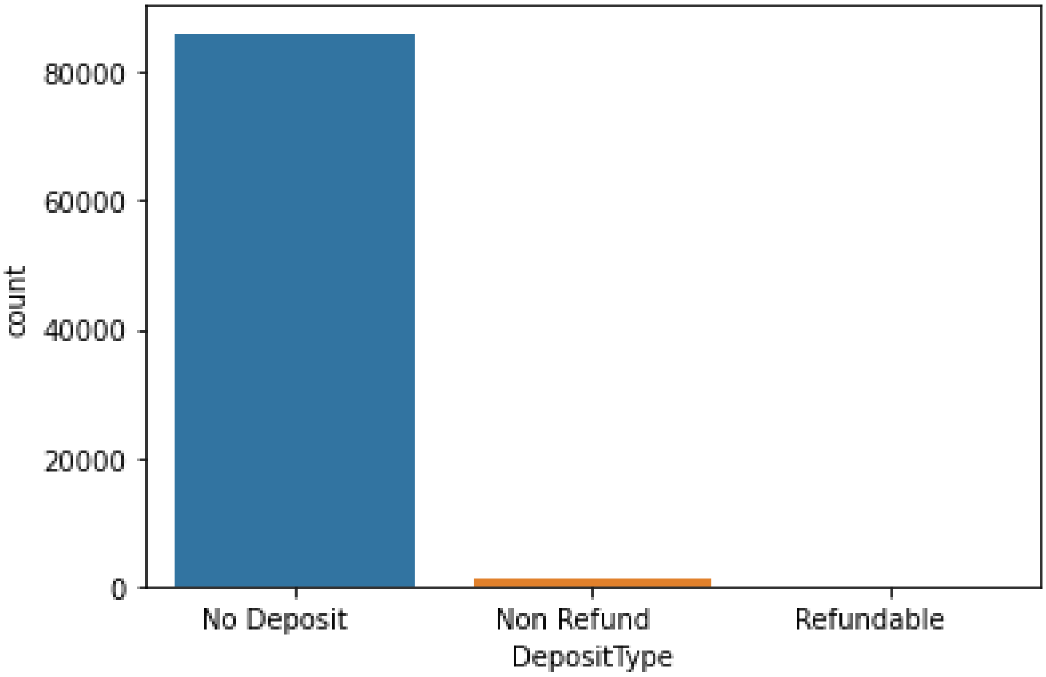
[31]:

```
chart = sb.countplot(df["AssignedRoomType"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of AssignedRoomType.png" )
plt.show()
```



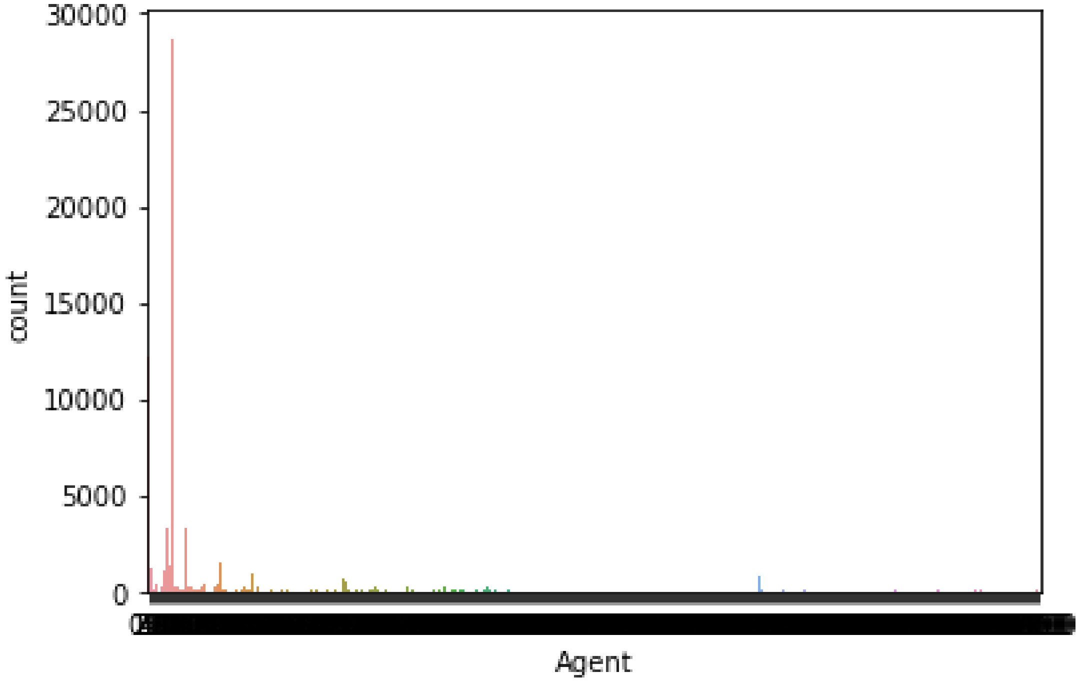
[32]:

```
chart = sb.countplot(df["DepositType"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of DepositType.png" )
plt.show()
```

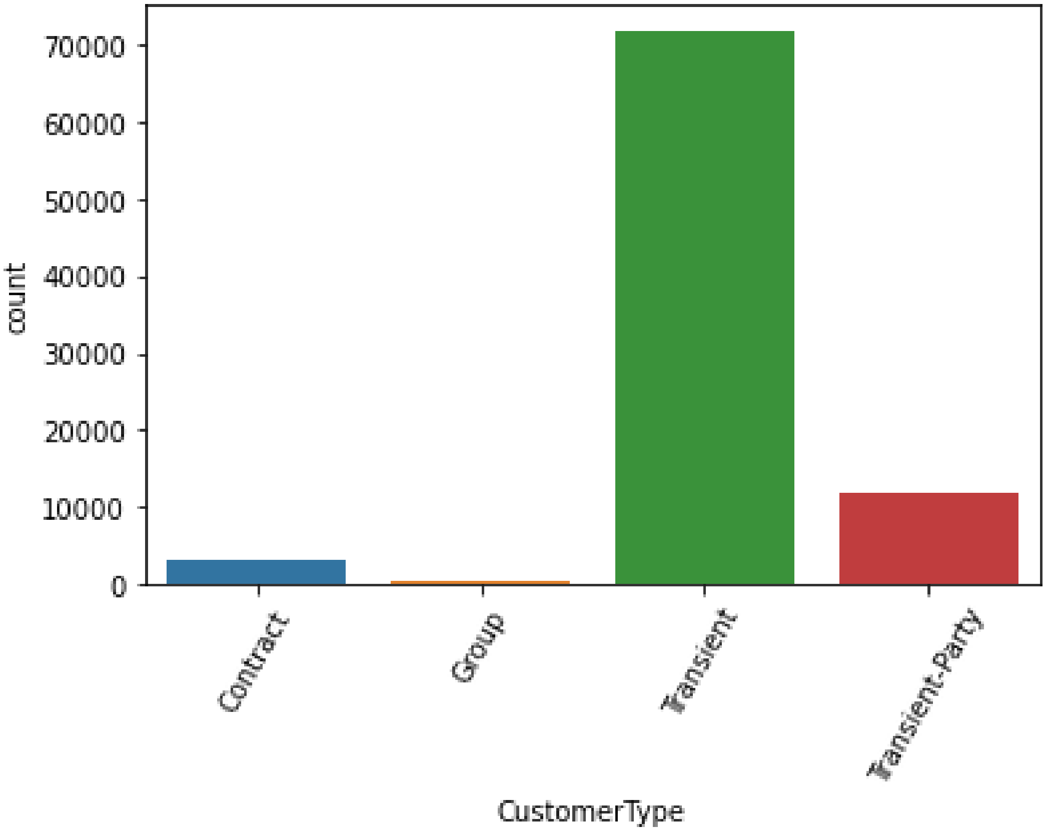


[33]:

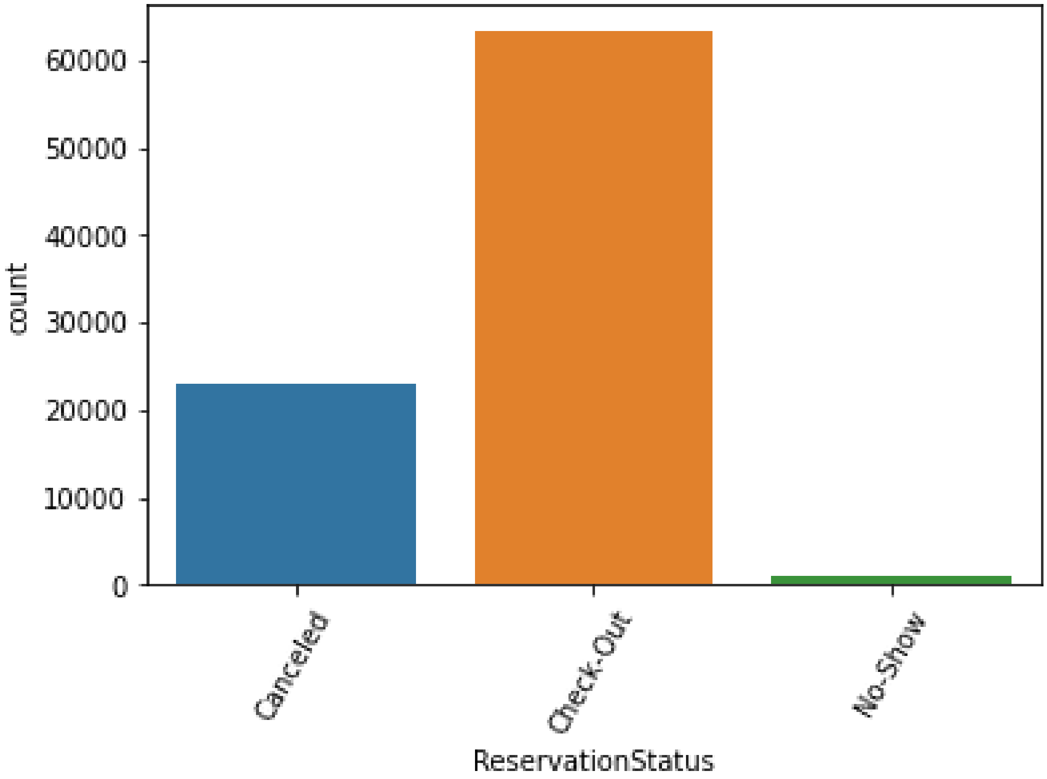
```
chart = sb.countplot(df["Agent"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of Agent.png" )
plt.show()
```



[34]:
```
chart = sb.countplot(df["CustomerType"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels(),rotation=60)
#plt.savefig("hist of CustomerType.png",bbox_inches='tight' )
plt.show()
```

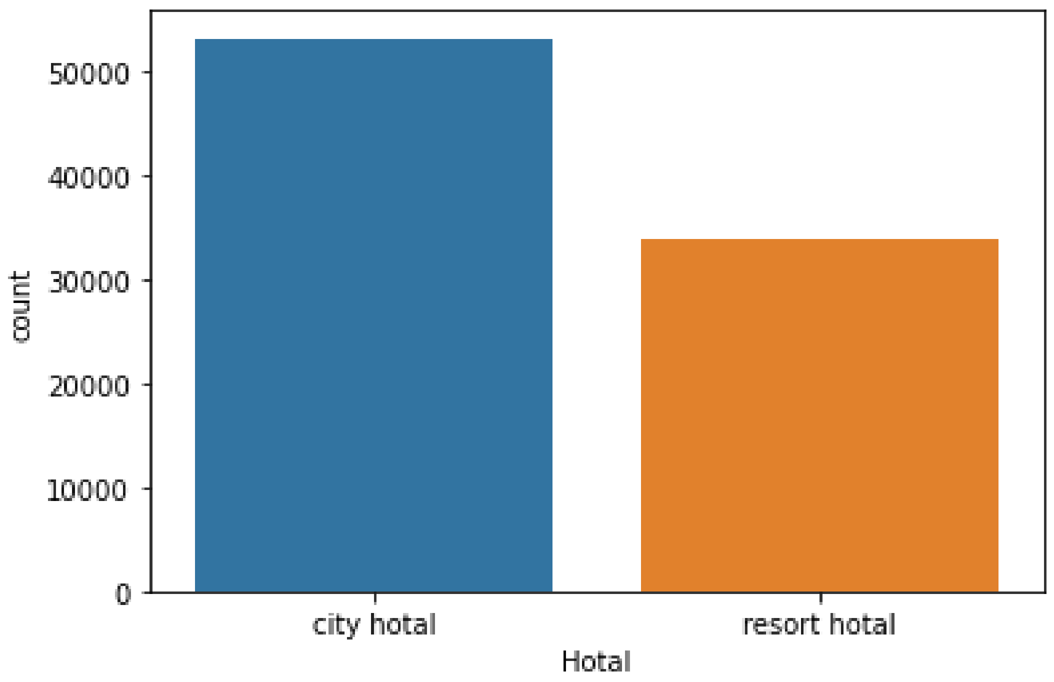


[35]:
```
chart = sb.countplot(df["ReservationStatus"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels(),rotation=60)
#plt.savefig("hist of ReservationStatus.png",bbox_inches='tight' )
plt.show()
```



[36]:

```
chart = sb.countplot(df["Hotal"]) # frequency distribution
chart.set_xticklabels(chart.get_xticklabels())
#plt.savefig("hist of Hotal.png" )
plt.show()
```



3 correlation

[109]:
```
corr =df.corr().round(2)
corr
#corr.to_csv("corr2.csv",index=True)
```

[109]:
```
                            LeadTime  ArrivalDateWeekNumber  \
LeadTime                        1.00                   0.10
ArrivalDateWeekNumber           0.10                   1.00
ArrivalDateDayOfMonth           0.01                   0.09
StaysInWeekendNights            0.24                   0.03
StaysInWeekNights               0.31                   0.03
Adults                          0.14                   0.03
Children                        0.03                   0.01
Babies                         -0.00                   0.01
PreviousCancellations           0.01                   0.01
PreviousBookingsNotCanceled    -0.08                  -0.02
BookingChanges                  0.08                   0.01
DaysInWaitingList               0.13                   0.01
ADR                             0.02                   0.10
RequiredCarParkingSpaces       -0.09                   0.01
TotalOfSpecialRequests          0.03                   0.05
```

```
                             ArrivalDateDayOfMonth  StaysInWeekendNights  \
LeadTime                                      0.01                  0.24
ArrivalDateWeekNumber                         0.09                  0.03
ArrivalDateDayOfMonth                         1.00                 -0.02
StaysInWeekendNights                         -0.02                  1.00
StaysInWeekNights                            -0.03                  0.55
Adults                                       -0.00                  0.09
Children                                      0.02                  0.03
Babies                                       -0.00                  0.01
PreviousCancellations                        -0.01                 -0.02
PreviousBookingsNotCanceled                   0.00                 -0.06
BookingChanges                                0.01                  0.03
DaysInWaitingList                             0.01                 -0.03
ADR                                           0.02                  0.04
RequiredCarParkingSpaces                      0.01                 -0.04
TotalOfSpecialRequests                       -0.00                  0.03

                             StaysInWeekNights  Adults  Children  Babies  \
LeadTime                                  0.31    0.14      0.03   -0.00
ArrivalDateWeekNumber                     0.03    0.03      0.01    0.01
ArrivalDateDayOfMonth                    -0.03   -0.00      0.02   -0.00
StaysInWeekendNights                      0.55    0.09      0.03    0.01
StaysInWeekNights                         1.00    0.10      0.03    0.02
Adults                                    0.10    1.00      0.02    0.02
Children                                  0.03    0.02      1.00    0.02
Babies                                    0.02    0.02      0.02    1.00
PreviousCancellations                    -0.02   -0.04     -0.02   -0.01
PreviousBookingsNotCanceled              -0.06   -0.12     -0.03   -0.01
BookingChanges                            0.07   -0.04      0.03    0.08
DaysInWaitingList                         0.00   -0.01     -0.02   -0.01
ADR                                       0.06    0.24      0.33    0.02
RequiredCarParkingSpaces                 -0.04    0.01      0.04    0.03
TotalOfSpecialRequests                    0.04    0.11      0.04    0.09

                             PreviousCancellations  \
LeadTime                                      0.01
ArrivalDateWeekNumber                         0.01
ArrivalDateDayOfMonth                        -0.01
StaysInWeekendNights                         -0.02
StaysInWeekNights                            -0.02
Adults                                       -0.04
Children                                     -0.02
Babies                                       -0.01
PreviousCancellations                         1.00
PreviousBookingsNotCanceled                   0.39
BookingChanges                               -0.01
DaysInWaitingList                             0.00
```

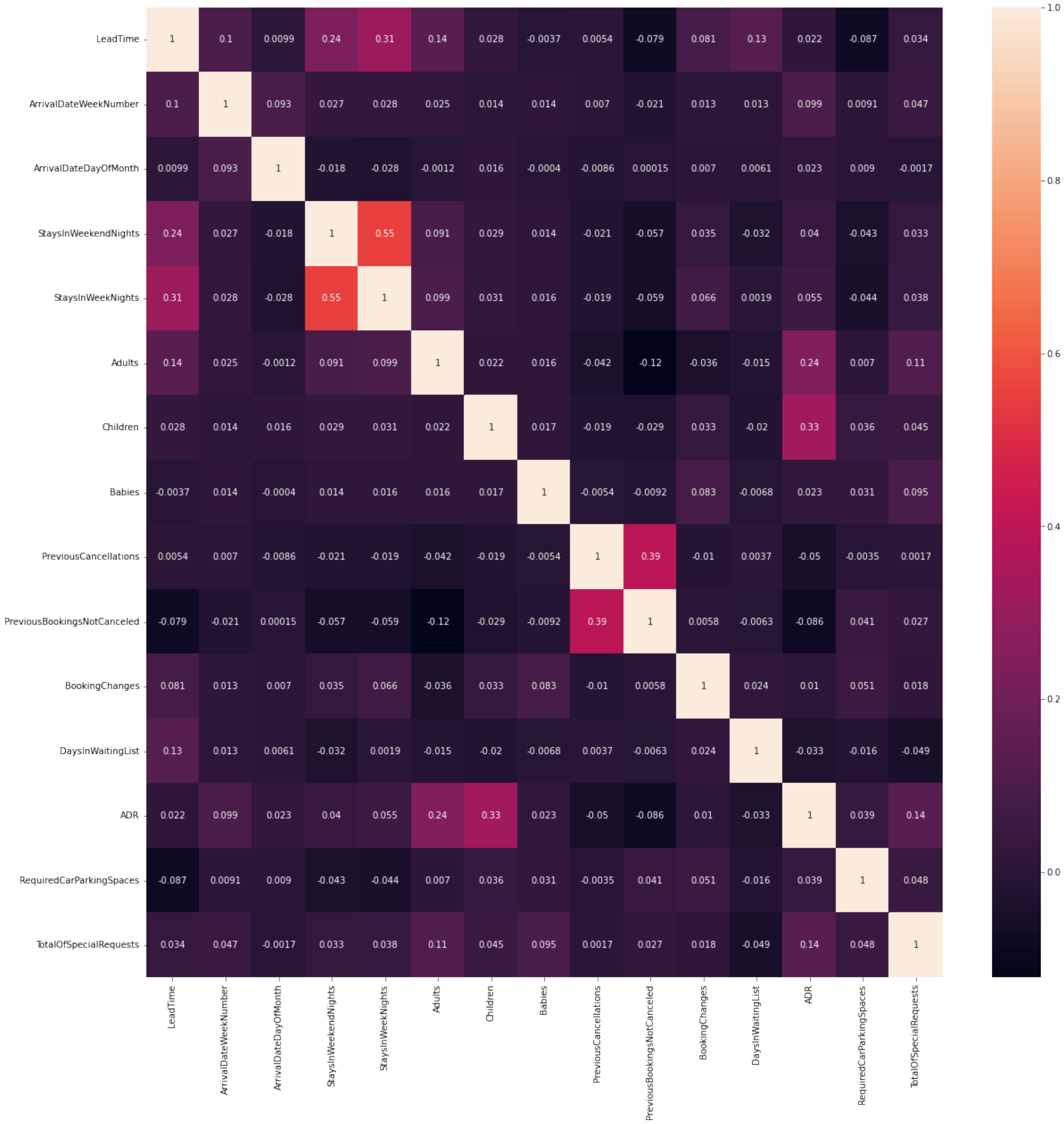
```
ADR                                          -0.05
RequiredCarParkingSpaces                     -0.00
TotalOfSpecialRequests                        0.00

                             PreviousBookingsNotCanceled  BookingChanges  \
LeadTime                                           -0.08            0.08
ArrivalDateWeekNumber                              -0.02            0.01
ArrivalDateDayOfMonth                               0.00            0.01
StaysInWeekendNights                               -0.06            0.03
StaysInWeekNights                                  -0.06            0.07
Adults                                             -0.12           -0.04
Children                                           -0.03            0.03
Babies                                             -0.01            0.08
PreviousCancellations                               0.39           -0.01
PreviousBookingsNotCanceled                         1.00            0.01
BookingChanges                                      0.01            1.00
DaysInWaitingList                                  -0.01            0.02
ADR                                                -0.09            0.01
RequiredCarParkingSpaces                            0.04            0.05
TotalOfSpecialRequests                              0.03            0.02

                             DaysInWaitingList   ADR  \
LeadTime                                  0.13  0.02
ArrivalDateWeekNumber                     0.01  0.10
ArrivalDateDayOfMonth                     0.01  0.02
StaysInWeekendNights                     -0.03  0.04
StaysInWeekNights                         0.00  0.06
Adults                                   -0.01  0.24
Children                                 -0.02  0.33
Babies                                   -0.01  0.02
PreviousCancellations                     0.00 -0.05
PreviousBookingsNotCanceled              -0.01 -0.09
BookingChanges                            0.02  0.01
DaysInWaitingList                         1.00 -0.03
ADR                                      -0.03  1.00
RequiredCarParkingSpaces                 -0.02  0.04
TotalOfSpecialRequests                   -0.05  0.14

                             RequiredCarParkingSpaces  TotalOfSpecialRequests
LeadTime                                        -0.09                    0.03
ArrivalDateWeekNumber                            0.01                    0.05
ArrivalDateDayOfMonth                            0.01                   -0.00
StaysInWeekendNights                            -0.04                    0.03
StaysInWeekNights                               -0.04                    0.04
Adults                                           0.01                    0.11
Children                                         0.04                    0.04
Babies                                           0.03                    0.09
```

```
PreviousCancellations                           -0.00                    0.00
PreviousBookingsNotCanceled                      0.04                    0.03
BookingChanges                                   0.05                    0.02
DaysInWaitingList                               -0.02                   -0.05
ADR                                              0.04                    0.14
RequiredCarParkingSpaces                         1.00                    0.05
TotalOfSpecialRequests                           0.05                    1.00
```

4 Correlation Heatmap

[39]:

```
plt.figure(figsize=(20,20))
sb.heatmap(df.corr(), annot=True)
#plt.savefig("corr.png",bbox_inches='tight' )
plt.show()
```



[41]:
```
dfX = df[df.columns[~df.columns.isin(category)]]
dfX
```

[41]:
```
       LeadTime  ArrivalDateWeekNumber  ArrivalDateDayOfMonth  \
0           342                     27                      1
1           737                     27                      1
2             7                     27                      1
3            13                     27                      1
4            14                     27                      1
...         ...                    ...                    ...
87225        23                     35                     30
```

```
87226       102                     35                     31
87227        34                     35                     31
87228       109                     35                     31
87229       205                     35                     29

       StaysInWeekendNights  StaysInWeekNights  Adults  Children  Babies  \
0                         0                  0       2       0.0       0
1                         0                  0       2       0.0       0
2                         0                  1       1       0.0       0
3                         0                  1       1       0.0       0
4                         0                  2       2       0.0       0
…                     …                …     …       …     …
87225                     2                  5       2       0.0       0
87226                     2                  5       3       0.0       0
87227                     2                  5       2       0.0       0
87228                     2                  5       2       0.0       0
87229                     2                  7       2       0.0       0

       PreviousCancellations  PreviousBookingsNotCanceled  BookingChanges  \
0                          0                            0               3
1                          0                            0               4
2                          0                            0               0
3                          0                            0               0
4                          0                            0               0
…                      …                          …             …
87225                      0                            0               0
87226                      0                            0               0
87227                      0                            0               0
87228                      0                            0               0
87229                      0                            0               0

       DaysInWaitingList     ADR  RequiredCarParkingSpaces  \
0                      0    0.00                         0
1                      0    0.00                         0
2                      0   75.00                         0
3                      0   75.00                         0
4                      0   98.00                         0
…                  …     …                       …
87225                  0   96.14                         0
87226                  0  225.43                         0
87227                  0  157.71                         0
87228                  0  104.40                         0
87229                  0  151.20                         0

       TotalOfSpecialRequests
0                           0
1                           0
```

```
2                            0
3                            0
4                            1
…                       …
87225                        0
87226                        2
87227                        4
87228                        0
87229                        2

[87230 rows x 15 columns]
```

5 Normalize the data set using Min-Max Scaling:

```
[42]: from sklearn import preprocessing
```

```
[43]: scaler = preprocessing.MinMaxScaler()
```

```
[44]: names = dfX.columns
```

```
[45]: d = scaler.fit_transform(dfX)
```

```
[46]: scaled_df = pd.DataFrame(d,columns=names)
```

```
[110]: scaled_df.head().T
```

```
[110]:                                    0         1         2         3         4
       LeadTime                    0.464043  1.000000  0.009498  0.017639  0.018996
       ArrivalDateWeekNumber       0.500000  0.500000  0.500000  0.500000  0.500000
       ArrivalDateDayOfMonth       0.000000  0.000000  0.000000  0.000000  0.000000
       StaysInWeekendNights        0.000000  0.000000  0.000000  0.000000  0.000000
       StaysInWeekNights           0.000000  0.000000  0.020000  0.020000  0.040000
       Adults                      0.036364  0.036364  0.018182  0.018182  0.036364
       Children                    0.000000  0.000000  0.000000  0.000000  0.000000
       Babies                      0.000000  0.000000  0.000000  0.000000  0.000000
       PreviousCancellations       0.000000  0.000000  0.000000  0.000000  0.000000
       PreviousBookingsNotCanceled 0.000000  0.000000  0.000000  0.000000  0.000000
       BookingChanges              0.166667  0.222222  0.000000  0.000000  0.000000
       DaysInWaitingList           0.000000  0.000000  0.000000  0.000000  0.000000
       ADR                         0.001180  0.001180  0.015053  0.015053  0.019307
       RequiredCarParkingSpaces    0.000000  0.000000  0.000000  0.000000  0.000000
       TotalOfSpecialRequests      0.000000  0.000000  0.000000  0.000000  0.200000
```

6 converting response variable to int so that KNN will treat this attribute as numeric attribute

[ ]:

```
dfY = df["IsCanceled"]
dfY = dfY.astype(int)
```

7 Divide the dataset to training and test sets.

[49]:

```
from sklearn.model_selection import train_test_split
```

[50]:

```
X_train, X_test, y_train, y_test = train_test_split(scaled_df,dfY, test_size=0.
 ↪2,random_state=40)
```

8 Modeling with KNN algorithm

[ ]:

```
# The K-NN algorithm can be used for both classification and regression,
#but it is more commonly employed for classification.
#The K-Nearest Neighbour algorithm is based on the Supervised Learning technique
# it is one of the simplest Machine Learning algorithms.
#The K-NN method thinks that the new case/data and existing cases are␣
 ↪comparable,
# and it places the new case in the category that is closest to the existing␣
 ↪categories.
```

[51]:

```
from sklearn.neighbors import KNeighborsClassifier
```

8.0.1 Choosing k-value

[52]:

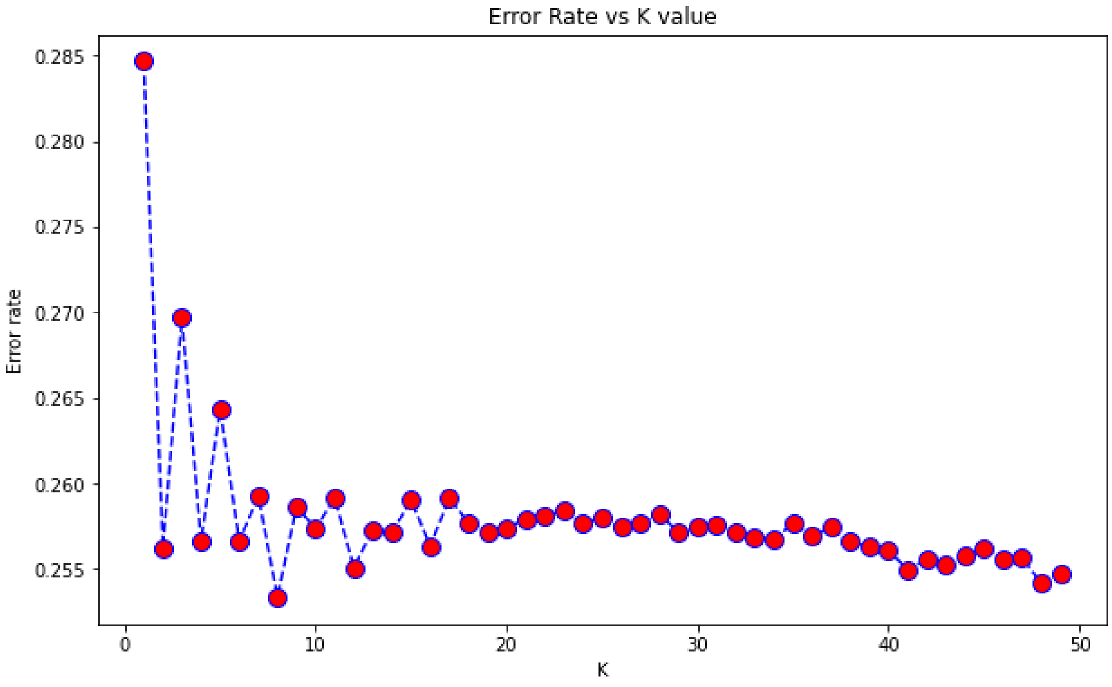
```
error_rate=[]
for i in range(1,50): # sqrt of rows is 47.3
    knn=KNeighborsClassifier(n_neighbors=i)
    knn.fit(X_train,y_train)
    pred=knn.predict(X_test)
    error_rate.append(np.mean(pred!=y_test))
```

[77]:

```
# error rate = (1 - (correct predictions / total predictions)) * 100
```

[78]:

```
plt.figure(figsize=(10,6))
plt.
 ↪plot(range(1,50),error_rate,color='blue',linestyle='dashed',marker='o',markerfacecolor='red
plt.title('Error Rate vs K value')
plt.xlabel('K')
plt.ylabel('Error rate')
## Display the visualization of the Confusion Matrix.
plt.savefig("Error Rate corresponding knn.png",bbox_inches='tight' )
plt.show()
```



8.0.2 checking with k=8

[54]:
```
knn=KNeighborsClassifier(n_neighbors=8)
knn.fit(X_train,y_train)
pred_k=knn.predict(X_test)
pred_k
```

[54]:
```
array([0, 0, 0, …, 0, 0, 0])
```

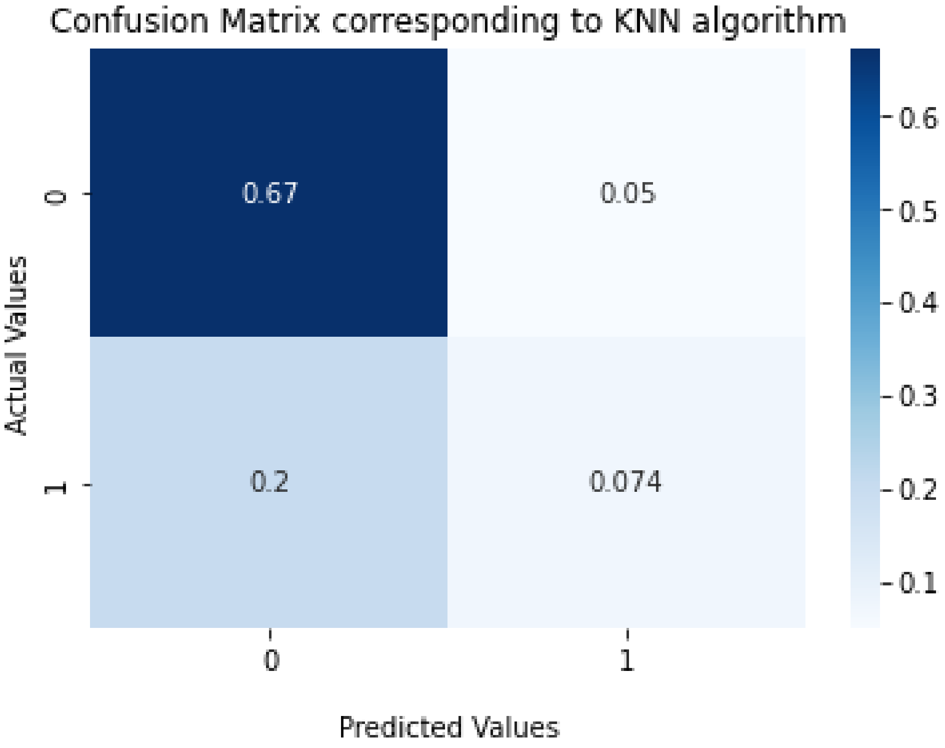
[66]:
```
from sklearn.metrics import␣
 ↪classification_report,confusion_matrix,accuracy_score
cf_matrix = confusion_matrix(y_test,pred_k)
print(cf_matrix)
print(classification_report(y_test,pred_k))
print(accuracy_score(y_test,pred_k)*100)
```

```
[[11741   872]
 [ 3548  1285]]
```

```
              precision    recall  f1-score   support

           0       0.77      0.93      0.84     12613
           1       0.60      0.27      0.37      4833

    accuracy                           0.75     17446
   macro avg       0.68      0.60      0.60     17446
weighted avg       0.72      0.75      0.71     17446

74.66467958271237
```

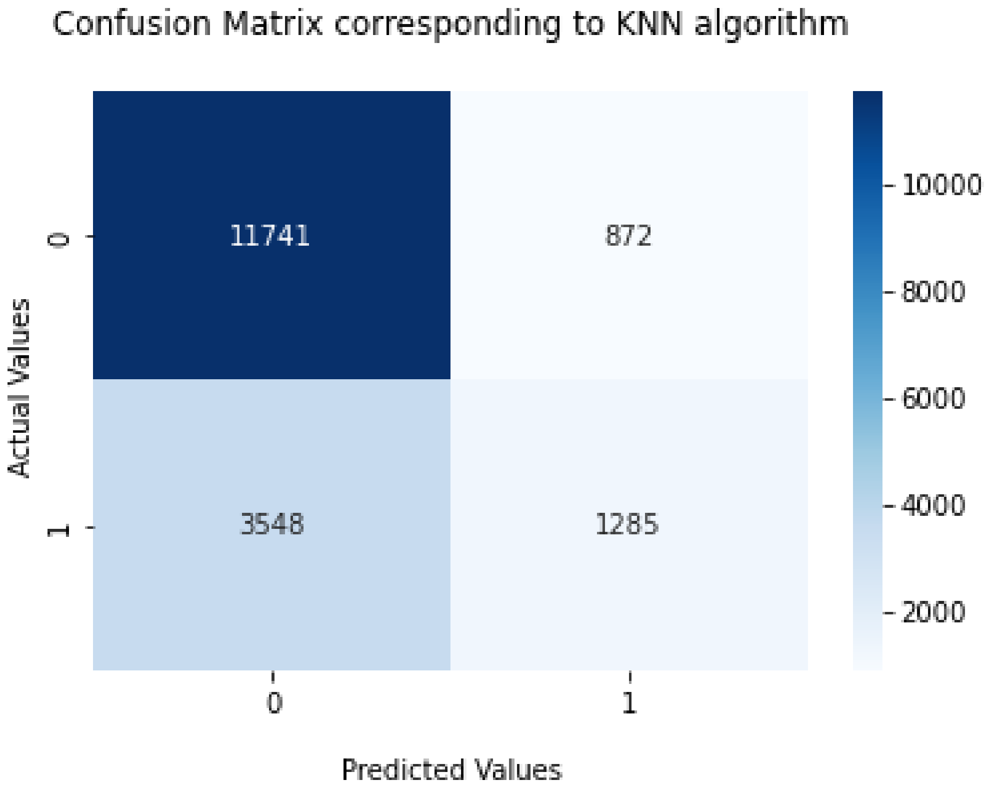
[99]:

```
ax = sb.heatmap(cf_matrix/np.sum(cf_matrix), annot=True, cmap='Blues')

ax.set_title('Confusion Matrix corresponding to KNN algorithm');
ax.set_xlabel('\nPredicted Values')
ax.set_ylabel('Actual Values ');

## Ticket labels - List must be in alphabetical order
ax.xaxis.set_ticklabels(['0','1'])
ax.yaxis.set_ticklabels(['0','1'])

## Display the visualization of the Confusion Matrix.
# plt.savefig("cf_matrix1.png",bbox_inches='tight' )
plt.show()
```



[97]:

```
ax = sb.heatmap(cf_matrix, annot=True, fmt="d", cmap='Blues')

ax.set_title(' Confusion Matrix corresponding to KNN algorithm \n');
ax.set_xlabel('\nPredicted Values')
ax.set_ylabel('Actual Values ');

## Ticket labels - List must be in alphabetical order
ax.xaxis.set_ticklabels(['0','1'])
ax.yaxis.set_ticklabels(['0','1'])

## Display the visualization of the Confusion Matrix.
plt.savefig("cf_matrix_KNN.png",bbox_inches='tight' )
plt.show()
```



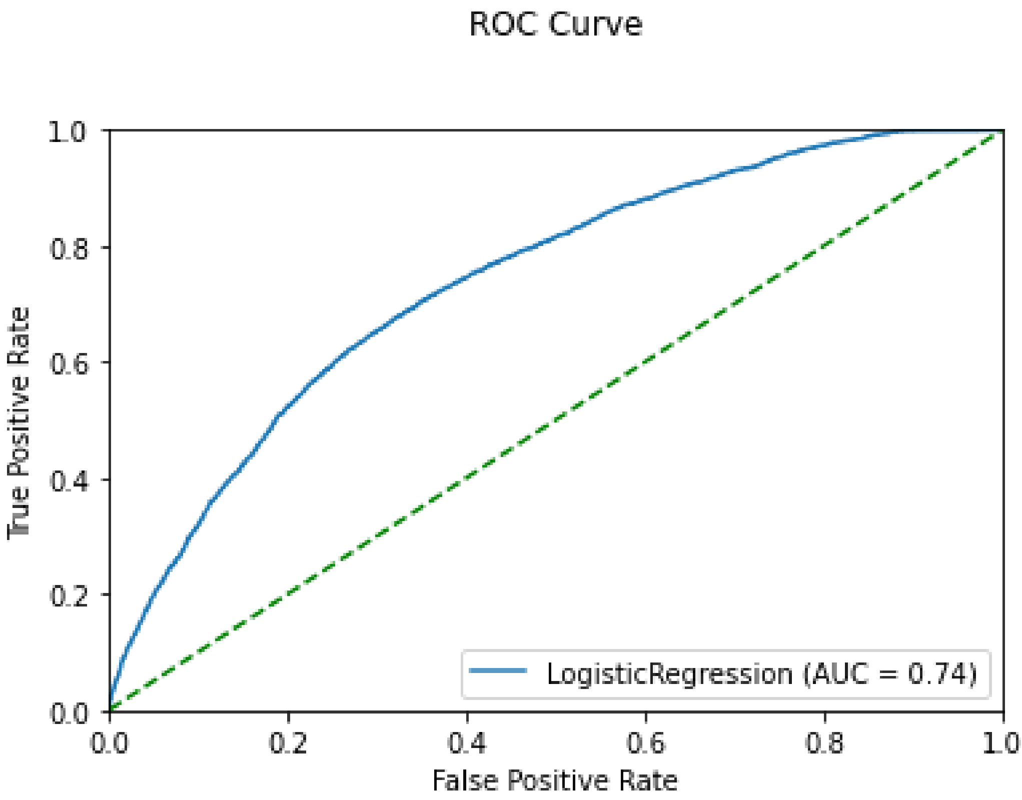
8.0.3 Logistic Regression

[83]:

```
# import sklearn.cross_validation from train_test_split
```

[87]:

```
from sklearn.linear_model import LogisticRegression
model=LogisticRegression()
model.fit(X_train,y_train)
metrics.plot_roc_curve(model, X_test, y_test)
plt.plot([0, 1], [0, 1],'g--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve\n\n')
#plt.savefig("ROC Curve.png",bbox_inches='tight' )
plt.show()
```



[89]:

```
predict_logistic=model.predict(X_test)
```

[94]:

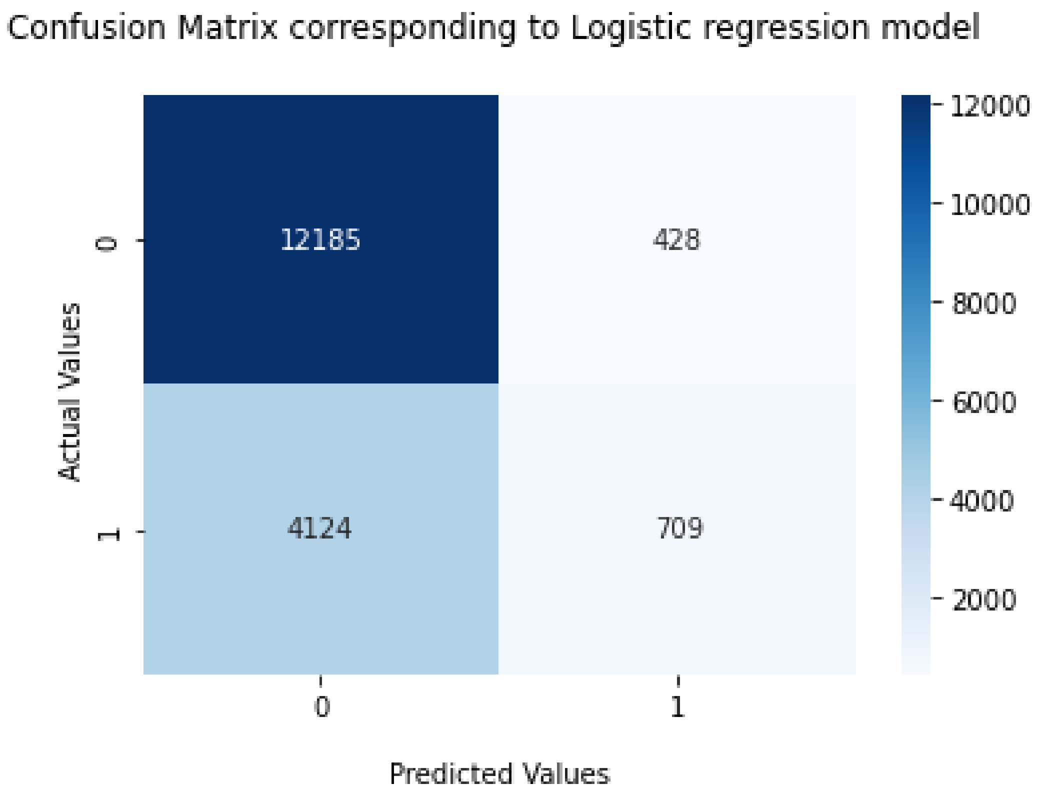
```
from sklearn import metrics
from sklearn.metrics import␣
 ↪confusion_matrix,classification_report,accuracy_score
cf_matrix_logistic = confusion_matrix(y_test,predict_logistic)
print(confusion_matrix(y_test,predict_logistic))
classification_report_logistic = classification_report(y_test,predict_logistic)
```

```
print(classification_report_logistic)
print(accuracy_score(y_test,predict_logistic)*100)
```

```
[[12185   428]
 [ 4124   709]]
              precision    recall  f1-score   support

           0       0.75      0.97      0.84     12613
           1       0.62      0.15      0.24      4833

    accuracy                           0.74     17446
   macro avg       0.69      0.56      0.54     17446
weighted avg       0.71      0.74      0.67     17446

73.90805915396079
```

[100]:

```
ax = sb.heatmap(cf_matrix_logistic, annot=True, fmt="d", cmap='Blues')

ax.set_title('Confusion Matrix corresponding to Logistic regression model \n');
ax.set_xlabel('\nPredicted Values')
ax.set_ylabel('Actual Values ');

## Ticket labels - List must be in alphabetical order
ax.xaxis.set_ticklabels(['0','1'])
ax.yaxis.set_ticklabels(['0','1'])

## Display the visualization of the Confusion Matrix.
# plt.savefig("Confusion Matrix corresponding to Logistic regression model.
 ↪png",bbox_inches='tight' )
plt.show()
```



```
[101]: from sklearn.ensemble  import RandomForestClassifier
```

```
[102]: model=RandomForestClassifier(n_estimators=20)
```

```
[103]: model.fit(X_train,y_train)
```

```
[103]: RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                              criterion='gini', max_depth=None, max_features='auto',
                              max_leaf_nodes=None, max_samples=None,
                              min_impurity_decrease=0.0, min_impurity_split=None,
                              min_samples_leaf=1, min_samples_split=2,
                              min_weight_fraction_leaf=0.0, n_estimators=20,
                              n_jobs=None, oob_score=False, random_state=None,
                              verbose=0, warm_start=False)
```

9 predicted value

```
[105]: model_predicted=model.predict(X_test)
       model_predicted
```

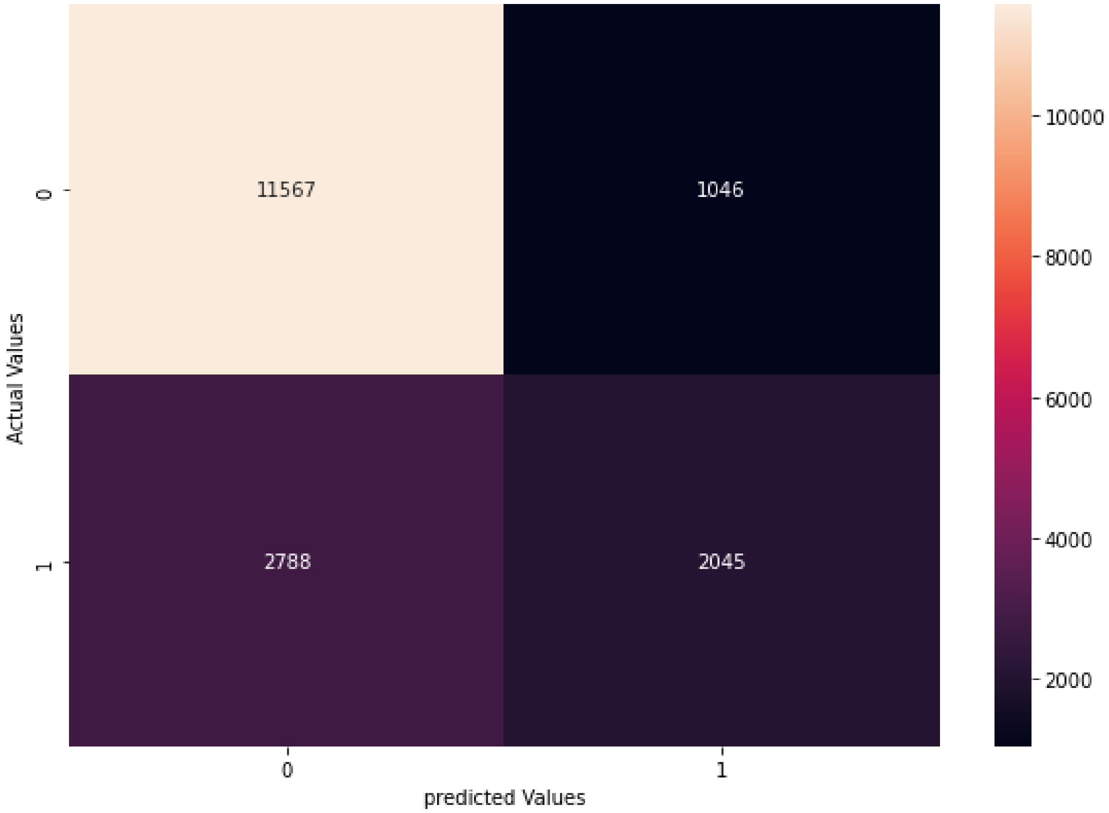
```
[105]: array([0, 0, 0, …, 0, 0, 1])
```

```
[106]: from sklearn.metrics import confusion_matrix
       matrix=confusion_matrix(y_test,model_predicted)
       matrix
```

```
[106]: array([[11567,  1046],
              [ 2788,  2045]])
```

```
[108]: plt.figure(figsize=(10,7))
       sb.heatmap(matrix,annot=True,fmt="d")
       plt.xlabel("predicted Values")
       plt.ylabel("Actual Values")
```

```
[108]: Text(69.0, 0.5, 'Actual Values')
```


Actual Values
predicted Values