EDA

August 3, 2021

[65]:
```
pip install folium
```

```
Collecting folium
  Using cached folium-0.12.1-py2.py3-none-any.whl (94 kB)
Requirement already satisfied: jinja2>=2.9 in /opt/conda/lib/python3.7/site-
packages (from folium) (2.11.2)
Requirement already satisfied: requests in /opt/conda/lib/python3.7/site-
packages (from folium) (2.23.0)
Collecting branca>=0.3.0
  Using cached branca-0.4.2-py3-none-any.whl (24 kB)
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages
(from folium) (1.18.4)
Requirement already satisfied: MarkupSafe>=0.23 in
/opt/conda/lib/python3.7/site-packages (from jinja2>=2.9->folium) (1.1.1)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/opt/conda/lib/python3.7/site-packages (from requests->folium) (1.25.9)
Requirement already satisfied: chardet<4,>=3.0.2 in
/opt/conda/lib/python3.7/site-packages (from requests->folium) (3.0.4)
Requirement already satisfied: certifi>=2017.4.17 in
/opt/conda/lib/python3.7/site-packages (from requests->folium) (2020.4.5.2)
Requirement already satisfied: idna<3,>=2.5 in /opt/conda/lib/python3.7/site-
packages (from requests->folium) (2.9)
Installing collected packages: branca, folium
Successfully installed branca-0.4.2 folium-0.12.1
Note: you may need to restart the kernel to use updated packages.
```

[66]:
```
pip install missingno
```

```
Collecting missingno
  Using cached missingno-0.5.0-py3-none-any.whl (8.8 kB)
Requirement already satisfied: matplotlib in /opt/conda/lib/python3.7/site-
packages (from missingno) (3.2.1)
Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
(from missingno) (1.4.1)
Requirement already satisfied: seaborn in /opt/conda/lib/python3.7/site-packages
(from missingno) (0.10.1)
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages
(from missingno) (1.18.4)
```

```
Requirement already satisfied: kiwisolver>=1.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->missingno) (1.2.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->missingno) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.7/site-
packages (from matplotlib->missingno) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->missingno) (2.8.1)
Requirement already satisfied: pandas>=0.22.0 in /opt/conda/lib/python3.7/site-
packages (from seaborn->missingno) (1.0.3)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
(from cycler>=0.10->matplotlib->missingno) (1.14.0)
Requirement already satisfied: pytz>=2017.2 in /opt/conda/lib/python3.7/site-
packages (from pandas>=0.22.0->seaborn->missingno) (2020.1)
Installing collected packages: missingno
Successfully installed missingno-0.5.0
Note: you may need to restart the kernel to use updated packages.
```

[67]:
```
pip install plotly
```

```
Collecting plotly
  Using cached plotly-5.1.0-py2.py3-none-any.whl (20.6 MB)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
(from plotly) (1.14.0)
Collecting tenacity>=6.2.0
  Using cached tenacity-8.0.1-py3-none-any.whl (24 kB)
Installing collected packages: tenacity, plotly
Successfully installed plotly-5.1.0 tenacity-8.0.1
Note: you may need to restart the kernel to use updated packages.
```

[68]:
```
pip install xgboost
```

```
Collecting xgboost
  Using cached xgboost-1.4.2-py3-none-manylinux2010_x86_64.whl (166.7 MB)
Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
(from xgboost) (1.4.1)
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages
(from xgboost) (1.18.4)
Installing collected packages: xgboost
Successfully installed xgboost-1.4.2
Note: you may need to restart the kernel to use updated packages.
```

[69]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import missingno as msno
import xgboost as xgb
```

```
import plotly.express as px
#import pycountry as pc
import warnings
warnings.filterwarnings('ignore')
from pandas import DataFrame, read_csv
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score, confusion_matrix,␣
↪classification_report
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier
#from catboost import CatBoostClassifier
from sklearn.ensemble import ExtraTreesClassifier
import matplotlib.ticker as mtick
pd.options.display.max_columns = None

import folium
from folium.plugins import HeatMap
#import plotly.express as px
%matplotlib inline

plt.style.use('fivethirtyeight')
%matplotlib inline
pd.set_option('display.max_columns', 32)
```

[70]:
```
df = pd.read_csv('hotel_bookings.csv')
print(df)
```

```
               hotel  is_canceled  lead_time  arrival_date_year  \
0       Resort Hotel            0        342               2015
1       Resort Hotel            0        737               2015
2       Resort Hotel            0          7               2015
3       Resort Hotel            0         13               2015
4       Resort Hotel            0         14               2015
…                …            …        …                …
119385    City Hotel            0         23               2017
119386    City Hotel            0        102               2017
119387    City Hotel            0         34               2017
119388    City Hotel            0        109               2017
119389    City Hotel            0        205               2017

       arrival_date_month  arrival_date_week_number  \
```

```
0                   July                        27
1                   July                        27
2                   July                        27
3                   July                        27
4                   July                        27
…                    …                        …
119385            August                        35
119386            August                        35
119387            August                        35
119388            August                        35
119389            August                        35

        arrival_date_day_of_month  stays_in_weekend_nights  \
0                               1                        0
1                               1                        0
2                               1                        0
3                               1                        0
4                               1                        0
…                             …                      …
119385                         30                        2
119386                         31                        2
119387                         31                        2
119388                         31                        2
119389                         29                        2

        stays_in_week_nights  adults  children  babies meal country  \
0                          0       2       0.0       0   BB     PRT
1                          0       2       0.0       0   BB     PRT
2                          1       1       0.0       0   BB     GBR
3                          1       1       0.0       0   BB     GBR
4                          2       2       0.0       0   BB     GBR
…                       …     …       …      …   …     …
119385                     5       2       0.0       0   BB     BEL
119386                     5       3       0.0       0   BB     FRA
119387                     5       2       0.0       0   BB     DEU
119388                     5       2       0.0       0   BB     GBR
119389                     7       2       0.0       0   HB     DEU

       market_segment distribution_channel  is_repeated_guest  \
0              Direct               Direct                  0
1              Direct               Direct                  0
2              Direct               Direct                  0
3           Corporate            Corporate                  0
4           Online TA                TA/TO                  0
…                 …                  …               …
119385  Offline TA/TO                TA/TO                  0
119386      Online TA                TA/TO                  0
119387      Online TA                TA/TO                  0
```

```
119388      Online TA              TA/TO                0
119389      Online TA              TA/TO                0

        previous_cancellations  previous_bookings_not_canceled  \
0                            0                               0
1                            0                               0
2                            0                               0
3                            0                               0
4                            0                               0
…                          …                             …
119385                       0                               0
119386                       0                               0
119387                       0                               0
119388                       0                               0
119389                       0                               0

       reserved_room_type assigned_room_type  booking_changes deposit_type  \
0                       C                  C                3   No Deposit
1                       C                  C                4   No Deposit
2                       A                  C                0   No Deposit
3                       A                  A                0   No Deposit
4                       A                  A                0   No Deposit
…                     …                  …              …          …
119385                  A                  A                0   No Deposit
119386                  E                  E                0   No Deposit
119387                  D                  D                0   No Deposit
119388                  A                  A                0   No Deposit
119389                  A                  A                0   No Deposit

        agent  company  days_in_waiting_list customer_type     adr  \
0         NaN      NaN                     0     Transient    0.00
1         NaN      NaN                     0     Transient    0.00
2         NaN      NaN                     0     Transient   75.00
3       304.0      NaN                     0     Transient   75.00
4       240.0      NaN                     0     Transient   98.00
…       …      …                     …            …     …
119385  394.0      NaN                     0     Transient   96.14
119386    9.0      NaN                     0     Transient  225.43
119387    9.0      NaN                     0     Transient  157.71
119388   89.0      NaN                     0     Transient  104.40
119389    9.0      NaN                     0     Transient  151.20

        required_car_parking_spaces  total_of_special_requests  \
0                                 0                          0
1                                 0                          0
2                                 0                          0
3                                 0                          0
4                                 0                          1
```

```
…                                  …                            …
119385                             0                            0
119386                             0                            2
119387                             0                            4
119388                             0                            0
119389                             0                            2

       reservation_status reservation_status_date
0               Check-Out              2015-07-01
1               Check-Out              2015-07-01
2               Check-Out              2015-07-02
3               Check-Out              2015-07-02
4               Check-Out              2015-07-03
…                     …                       …
119385          Check-Out              2017-09-06
119386          Check-Out              2017-09-07
119387          Check-Out              2017-09-07
119388          Check-Out              2017-09-07
119389          Check-Out              2017-09-07

[119390 rows x 32 columns]
```

1 New Section

[71]:
```python
df.head()
```

[71]:
```
          hotel  is_canceled  lead_time  arrival_date_year arrival_date_month  \
0  Resort Hotel            0        342               2015               July
1  Resort Hotel            0        737               2015               July
2  Resort Hotel            0          7               2015               July
3  Resort Hotel            0         13               2015               July
4  Resort Hotel            0         14               2015               July

   arrival_date_week_number  arrival_date_day_of_month  \
0                        27                          1
1                        27                          1
2                        27                          1
3                        27                          1
4                        27                          1

   stays_in_weekend_nights  stays_in_week_nights  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
```

```
  meal country market_segment distribution_channel  is_repeated_guest  \
0   BB     PRT         Direct               Direct                  0
1   BB     PRT         Direct               Direct                  0
2   BB     GBR         Direct               Direct                  0
3   BB     GBR      Corporate            Corporate                  0
4   BB     GBR      Online TA                TA/TO                  0

   previous_cancellations  previous_bookings_not_canceled reserved_room_type  \
0                       0                               0                  C
1                       0                               0                  C
2                       0                               0                  A
3                       0                               0                  A
4                       0                               0                  A

  assigned_room_type  booking_changes deposit_type  agent  company  \
0                  C                3   No Deposit    NaN      NaN
1                  C                4   No Deposit    NaN      NaN
2                  C                0   No Deposit    NaN      NaN
3                  A                0   No Deposit  304.0      NaN
4                  A                0   No Deposit  240.0      NaN

   days_in_waiting_list customer_type   adr  required_car_parking_spaces  \
0                     0     Transient   0.0                            0
1                     0     Transient   0.0                            0
2                     0     Transient  75.0                            0
3                     0     Transient  75.0                            0
4                     0     Transient  98.0                            0

   total_of_special_requests reservation_status reservation_status_date
0                          0          Check-Out              2015-07-01
1                          0          Check-Out              2015-07-01
2                          0          Check-Out              2015-07-02
3                          0          Check-Out              2015-07-02
4                          1          Check-Out              2015-07-03
```

[72]:
```
df.shape
```

[72]:
```
(119390, 32)
```

[73]:
```
df.describe()
```

[73]:
```
         is_canceled      lead_time  arrival_date_year  \
count  119390.000000  119390.000000      119390.000000
mean        0.370416     104.011416        2016.156554
std         0.482918     106.863097           0.707476
min         0.000000       0.000000        2015.000000
```

```
25%         0.000000      18.000000        2016.000000
50%         0.000000      69.000000        2016.000000
75%         1.000000     160.000000        2017.000000
max         1.000000     737.000000        2017.000000

       arrival_date_week_number  arrival_date_day_of_month  \
count             119390.000000              119390.000000
mean                  27.165173                  15.798241
std                   13.605138                   8.780829
min                    1.000000                   1.000000
25%                   16.000000                   8.000000
50%                   28.000000                  16.000000
75%                   38.000000                  23.000000
max                   53.000000                  31.000000

       stays_in_weekend_nights  stays_in_week_nights         adults  \
count            119390.000000         119390.000000  119390.000000
mean                  0.927599              2.500302       1.856403
std                   0.998613              1.908286       0.579261
min                   0.000000              0.000000       0.000000
25%                   0.000000              1.000000       2.000000
50%                   1.000000              2.000000       2.000000
75%                   2.000000              3.000000       2.000000
max                  19.000000             50.000000      55.000000

            children         babies  is_repeated_guest  \
count  119386.000000  119390.000000      119390.000000
mean        0.103890       0.007949           0.031912
std         0.398561       0.097436           0.175767
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      10.000000           1.000000

       previous_cancellations  previous_bookings_not_canceled  \
count           119390.000000                   119390.000000
mean                 0.087118                        0.137097
std                  0.844336                        1.497437
min                  0.000000                        0.000000
25%                  0.000000                        0.000000
50%                  0.000000                        0.000000
75%                  0.000000                        0.000000
max                 26.000000                       72.000000

       booking_changes          agent      company  days_in_waiting_list  \
count    119390.000000  103050.000000  6797.000000         119390.000000
```

```
mean          0.221124     86.693382   189.266735              2.321149
std           0.652306    110.774548   131.655015             17.594721
min           0.000000      1.000000     6.000000              0.000000
25%           0.000000      9.000000    62.000000              0.000000
50%           0.000000     14.000000   179.000000              0.000000
75%           0.000000    229.000000   270.000000              0.000000
max          21.000000    535.000000   543.000000            391.000000

                 adr  required_car_parking_spaces  total_of_special_requests
count  119390.000000                119390.000000              119390.000000
mean      101.831122                     0.062518                   0.571363
std        50.535790                     0.245291                   0.792798
min        -6.380000                     0.000000                   0.000000
25%        69.290000                     0.000000                   0.000000
50%        94.575000                     0.000000                   0.000000
75%       126.000000                     0.000000                   1.000000
max      5400.000000                     8.000000                   5.000000
```

37 % of the people have cancelled their booking as per the dataset. Avg. lead time is 104 days, that is almost 3.5 months. Each booking has on an average 1.8 adults and 0.1 children. Only 3% of the guests are repeated. Median lead time is 69 days.

MAJOR OBSERVATIONS:

1.Number of bookings made were highest in the month of July and August and lowest in January. 2.Bookings were more for the City hotel than the Resort hotel. 3.41.7% of the total bookings were cancelled for City hotel and 21.7% for the Resort hotel. 4.Number of days that elapsed between the entering date of the booking and the arrival date is less for the people who cancelled. 5.As the hotels are in Portugal Europe, the bookings are mostly with European countries, Highest is Portugal with 48.59k bookings. 6.77% of the bookings are made with bed and breakfast. 7.Only 3% are repeated guests.

EXPLORATORY DATA ANALYSIS

[74]:
```python
# dealing with null values
null = pd.DataFrame({'Count of Missing values' : df.isna().sum(), 'Percentage␣
 ↪of missing values' : (df.isna().sum()) / (df.shape[0]) * (100)})
null
```

[74]:
```
                                Count of Missing values  \
hotel                                                 0
is_canceled                                           0
lead_time                                             0
arrival_date_year                                     0
arrival_date_month                                    0
arrival_date_week_number                              0
arrival_date_day_of_month                             0
stays_in_weekend_nights                               0
stays_in_week_nights                                  0
```

```
adults                                0
children                              4
babies                                0
meal                                  0
country                             488
market_segment                        0
distribution_channel                  0
is_repeated_guest                     0
previous_cancellations                0
previous_bookings_not_canceled        0
reserved_room_type                    0
assigned_room_type                    0
booking_changes                       0
deposit_type                          0
agent                             16340
company                          112593
days_in_waiting_list                  0
customer_type                         0
adr                                   0
required_car_parking_spaces           0
total_of_special_requests             0
reservation_status                    0
reservation_status_date               0

                                Percentage of missing values
hotel                                               0.000000
is_canceled                                         0.000000
lead_time                                           0.000000
arrival_date_year                                   0.000000
arrival_date_month                                  0.000000
arrival_date_week_number                            0.000000
arrival_date_day_of_month                           0.000000
stays_in_weekend_nights                             0.000000
stays_in_week_nights                                0.000000
adults                                              0.000000
children                                            0.003350
babies                                              0.000000
meal                                                0.000000
country                                             0.408744
market_segment                                      0.000000
distribution_channel                                0.000000
is_repeated_guest                                   0.000000
previous_cancellations                              0.000000
previous_bookings_not_canceled                      0.000000
reserved_room_type                                  0.000000
assigned_room_type                                  0.000000
booking_changes                                     0.000000
```

```
deposit_type                      0.000000
agent                            13.686238
company                          94.306893
days_in_waiting_list              0.000000
customer_type                     0.000000
adr                               0.000000
required_car_parking_spaces       0.000000
total_of_special_requests         0.000000
reservation_status                0.000000
reservation_status_date           0.000000
```

There are 32 columns, 12 were Categorical and 20 Numerical There are 4 columns with the missing values namely- country, agent, company, children 'company' column has maximum null values which is 94Dealing with missing values

[75]:
```python
hotel = df.drop(columns=['company'])
hotel
```

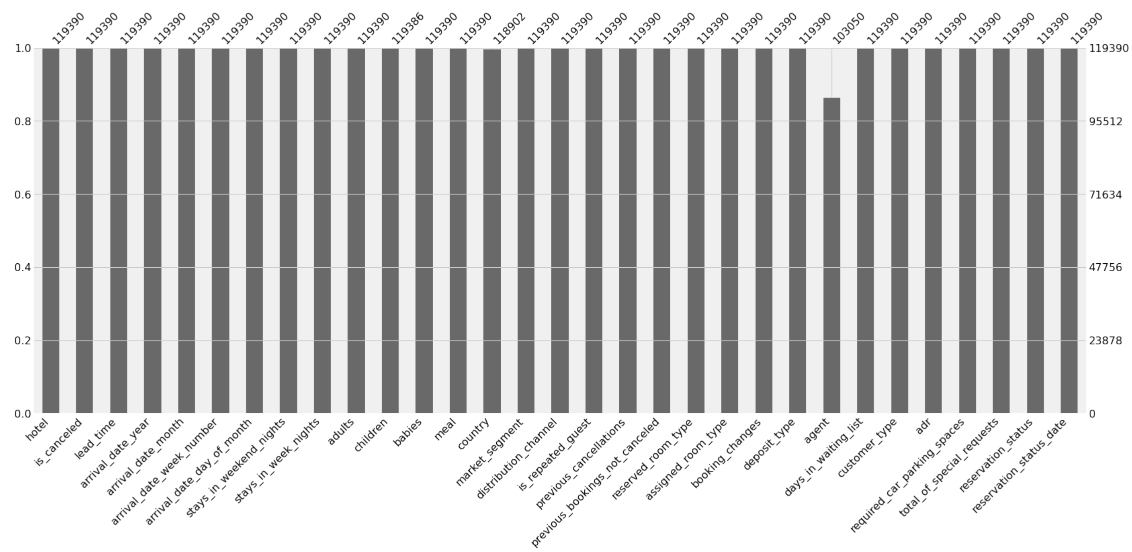
[75]:
```
               hotel  is_canceled  lead_time  arrival_date_year  \
0       Resort Hotel            0        342               2015
1       Resort Hotel            0        737               2015
2       Resort Hotel            0          7               2015
3       Resort Hotel            0         13               2015
4       Resort Hotel            0         14               2015
…                …            …        …                  …
119385    City Hotel            0         23               2017
119386    City Hotel            0        102               2017
119387    City Hotel            0         34               2017
119388    City Hotel            0        109               2017
119389    City Hotel            0        205               2017

       arrival_date_month  arrival_date_week_number  \
0                    July                        27
1                    July                        27
2                    July                        27
3                    July                        27
4                    July                        27
…                     …                       …
119385             August                        35
119386             August                        35
119387             August                        35
119388             August                        35
119389             August                        35

        arrival_date_day_of_month  stays_in_weekend_nights  \
0                               1                        0
1                               1                        0
```

```
2                         1                    0
3                         1                    0
4                         1                    0
…                       …                    …
119385                   30                    2
119386                   31                    2
119387                   31                    2
119388                   31                    2
119389                   29                    2

        stays_in_week_nights  adults  children  babies meal country  \
0                          0       2       0.0       0   BB     PRT
1                          0       2       0.0       0   BB     PRT
2                          1       1       0.0       0   BB     GBR
3                          1       1       0.0       0   BB     GBR
4                          2       2       0.0       0   BB     GBR
…                        …     …       …     …  …     …
119385                     5       2       0.0       0   BB     BEL
119386                     5       3       0.0       0   BB     FRA
119387                     5       2       0.0       0   BB     DEU
119388                     5       2       0.0       0   BB     GBR
119389                     7       2       0.0       0   HB     DEU

       market_segment distribution_channel  is_repeated_guest  \
0              Direct               Direct                  0
1              Direct               Direct                  0
2              Direct               Direct                  0
3           Corporate            Corporate                  0
4           Online TA                TA/TO                  0
…                 …                  …                …
119385  Offline TA/TO                TA/TO                  0
119386      Online TA                TA/TO                  0
119387      Online TA                TA/TO                  0
119388      Online TA                TA/TO                  0
119389      Online TA                TA/TO                  0

        previous_cancellations  previous_bookings_not_canceled  \
0                            0                               0
1                            0                               0
2                            0                               0
3                            0                               0
4                            0                               0
…                          …                             …
119385                       0                               0
119386                       0                               0
119387                       0                               0
119388                       0                               0
```

```
119389                        0                               0

       reserved_room_type assigned_room_type  booking_changes deposit_type  \
0                       C                  C                3   No Deposit
1                       C                  C                4   No Deposit
2                       A                  C                0   No Deposit
3                       A                  A                0   No Deposit
4                       A                  A                0   No Deposit
…                     …                …              …           …
119385                  A                  A                0   No Deposit
119386                  E                  E                0   No Deposit
119387                  D                  D                0   No Deposit
119388                  A                  A                0   No Deposit
119389                  A                  A                0   No Deposit

        agent  days_in_waiting_list customer_type     adr  \
0         NaN                     0     Transient    0.00
1         NaN                     0     Transient    0.00
2         NaN                     0     Transient   75.00
3       304.0                     0     Transient   75.00
4       240.0                     0     Transient   98.00
…       …                   …           …      …
119385  394.0                     0     Transient   96.14
119386    9.0                     0     Transient  225.43
119387    9.0                     0     Transient  157.71
119388   89.0                     0     Transient  104.40
119389    9.0                     0     Transient  151.20

        required_car_parking_spaces  total_of_special_requests  \
0                                 0                          0
1                                 0                          0
2                                 0                          0
3                                 0                          0
4                                 0                          1
…                             …                        …
119385                            0                          0
119386                            0                          2
119387                            0                          4
119388                            0                          0
119389                            0                          2

       reservation_status reservation_status_date
0               Check-Out              2015-07-01
1               Check-Out              2015-07-01
2               Check-Out              2015-07-02
3               Check-Out              2015-07-02
4               Check-Out              2015-07-03
```

```
…                   …                          …
119385          Check-Out               2017-09-06
119386          Check-Out               2017-09-07
119387          Check-Out               2017-09-07
119388          Check-Out               2017-09-07
119389          Check-Out               2017-09-07

[119390 rows x 31 columns]
```

[76]:
```
#Lets use Missingno library which offers a fair visualization of the␣
 ↪distribution of NaN values.
msno.bar(hotel)
plt.show()
```



We have almost 120,000 observations, its kind of difficult to make any observation regarding the columns containing NaN values. So, we shall check the distribution of these coloumns individually.

[77]:
```
hotel['children'].value_counts()
```

[77]:
```
0.0     110796
1.0       4861
2.0       3652
3.0         76
10.0         1
Name: children, dtype: int64
```

[78]:
```
hotel['children'].fillna(0,inplace=True) #In order to deal with the missing␣
 ↪information in childres's column, we fill it with 0 as we see maximum␣
 ↪travellers had 0 children
```

[79]:
```python
hotel['country'].value_counts()
```

[79]:
```
PRT    48590
GBR    12129
FRA    10415
ESP     8568
DEU     7287
       …
MDG        1
BWA        1
MRT        1
SMR        1
FJI        1
Name: country, Length: 177, dtype: int64
```

[80]:
```python
hotel['country'].fillna(hotel['country'].mode()[0], inplace=True) # Since, only␣
↪0.4% rows are missing from 'country' column we shall replace it using its␣
↪mode value
```

[81]:
```python
hotel['agent'].value_counts()
```

[81]:
```
9.0      31961
240.0    13922
1.0       7191
14.0      3640
7.0       3539
         …
213.0        1
433.0        1
197.0        1
367.0        1
337.0        1
Name: agent, Length: 333, dtype: int64
```

[82]:
```python
hotel['agent'].fillna(0,inplace=True) # For the sake of simplicity, we shall␣
↪replace the 13% Nan values in column agent with '0'
```

[83]:
```python
#Rechecking if the null values are handled properly
missing = pd.DataFrame({'Count of Missing values' : hotel.isna().sum()})
missing
```

[83]:

	Count of Missing values
hotel	0
is_canceled	0
lead_time	0
arrival_date_year	0
arrival_date_month	0

```
arrival_date_week_number                        0
arrival_date_day_of_month                       0
stays_in_weekend_nights                         0
stays_in_week_nights                            0
adults                                          0
children                                        0
babies                                          0
meal                                            0
country                                         0
market_segment                                  0
distribution_channel                            0
is_repeated_guest                               0
previous_cancellations                          0
previous_bookings_not_canceled                  0
reserved_room_type                              0
assigned_room_type                              0
booking_changes                                 0
deposit_type                                    0
agent                                           0
days_in_waiting_list                            0
customer_type                                   0
adr                                             0
required_car_parking_spaces                     0
total_of_special_requests                       0
reservation_status                              0
reservation_status_date                         0
```

[84]:
```python
# There are a few rows where  number of adults is zero, Hence, trying to remove
 ↪such rows
filter = (hotel.children == 0) & (hotel.adults == 0) & (hotel.babies == 0)
hotel[filter]
```

[84]:
```
               hotel  is_canceled  lead_time  arrival_date_year  \
2224    Resort Hotel            0          1               2015
2409    Resort Hotel            0          0               2015
3181    Resort Hotel            0         36               2015
3684    Resort Hotel            0        165               2015
3708    Resort Hotel            0        165               2015
…                …           …          …                  …
115029    City Hotel            0        107               2017
115091    City Hotel            0          1               2017
116251    City Hotel            0         44               2017
116534    City Hotel            0          2               2017
117087    City Hotel            0        170               2017

       arrival_date_month  arrival_date_week_number  \
2224              October                        41
```

```
2409             October                      42
3181            November                      47
3684            December                      53
3708            December                      53
…                  …                      …
115029              June                      26
115091              June                      26
116251              July                      28
116534              July                      28
117087              July                      30

        arrival_date_day_of_month  stays_in_weekend_nights  \
2224                            6                        0
2409                           12                        0
3181                           20                        1
3684                           30                        1
3708                           30                        2
…                            …                      …
115029                         27                        0
115091                         30                        0
116251                         15                        1
116534                         15                        2
117087                         27                        0

        stays_in_week_nights  adults  children  babies meal country  \
2224                       3       0       0.0       0   SC     PRT
2409                       0       0       0.0       0   SC     PRT
3181                       2       0       0.0       0   SC     ESP
3684                       4       0       0.0       0   SC     PRT
3708                       4       0       0.0       0   SC     PRT
…                      …     …       …       …  …     …
115029                     3       0       0.0       0   BB     CHE
115091                     1       0       0.0       0   SC     PRT
116251                     1       0       0.0       0   SC     SWE
116534                     5       0       0.0       0   SC     RUS
117087                     2       0       0.0       0   BB     BRA

       market_segment distribution_channel  is_repeated_guest  \
2224        Corporate            Corporate                  0
2409        Corporate            Corporate                  0
3181           Groups                TA/TO                  0
3684           Groups                TA/TO                  0
3708           Groups                TA/TO                  0
…               …                  …                …
115029      Online TA                TA/TO                  0
115091  Complementary               Direct                  0
116251      Online TA                TA/TO                  0
```

```
116534      Online TA              TA/TO                 0
117087  Offline TA/TO              TA/TO                 0

        previous_cancellations  previous_bookings_not_canceled  \
2224                         0                               0
2409                         0                               0
3181                         0                               0
3684                         0                               0
3708                         0                               0
…                          …                             …
115029                       0                               0
115091                       0                               0
116251                       0                               0
116534                       0                               0
117087                       0                               0

       reserved_room_type assigned_room_type  booking_changes deposit_type  \
2224                    A                  I                1   No Deposit
2409                    A                  I                0   No Deposit
3181                    A                  C                0   No Deposit
3684                    A                  A                1   No Deposit
3708                    A                  C                1   No Deposit
…                     …                  …              …           …
115029                  A                  A                1   No Deposit
115091                  E                  K                0   No Deposit
116251                  A                  K                2   No Deposit
116534                  A                  K                1   No Deposit
117087                  A                  A                0   No Deposit

        agent  days_in_waiting_list    customer_type     adr  \
2224      0.0                     0  Transient-Party    0.00
2409      0.0                     0        Transient    0.00
3181     38.0                     0  Transient-Party    0.00
3684    308.0                   122  Transient-Party    0.00
3708    308.0                   122  Transient-Party    0.00
…       …                    …                …     …
115029    7.0                     0        Transient  100.80
115091    0.0                     0        Transient    0.00
116251  425.0                     0        Transient   73.80
116534    9.0                     0  Transient-Party   22.86
117087   52.0                     0        Transient    0.00

        required_car_parking_spaces  total_of_special_requests  \
2224                              0                          0
2409                              0                          0
3181                              0                          0
3684                              0                          0
```

```
3708                                0                         0
...                                ...                       ...
115029                              0                         0
115091                              1                         1
116251                              0                         0
116534                              0                         1
117087                              0                         0

       reservation_status reservation_status_date
2224             Check-Out              2015-10-06
2409             Check-Out              2015-10-12
3181             Check-Out              2015-11-23
3684             Check-Out              2016-01-04
3708             Check-Out              2016-01-05
...                    ...                     ...
115029           Check-Out              2017-06-30
115091           Check-Out              2017-07-01
116251           Check-Out              2017-07-17
116534           Check-Out              2017-07-22
117087           Check-Out              2017-07-29

[180 rows x 31 columns]
```

[85]:
```
#Removing these rows with 0 adults, 0 children and babies
hotel = hotel[~filter]
hotel
```

[85]:
```
               hotel  is_canceled  lead_time  arrival_date_year  \
0       Resort Hotel            0        342               2015
1       Resort Hotel            0        737               2015
2       Resort Hotel            0          7               2015
3       Resort Hotel            0         13               2015
4       Resort Hotel            0         14               2015
...              ...          ...        ...                ...
119385    City Hotel            0         23               2017
119386    City Hotel            0        102               2017
119387    City Hotel            0         34               2017
119388    City Hotel            0        109               2017
119389    City Hotel            0        205               2017

       arrival_date_month  arrival_date_week_number  \
0                    July                        27
1                    July                        27
2                    July                        27
3                    July                        27
4                    July                        27
...                   ...                       ...
```

```
119385              August                        35
119386              August                        35
119387              August                        35
119388              August                        35
119389              August                        35

        arrival_date_day_of_month  stays_in_weekend_nights  \
0                               1                        0
1                               1                        0
2                               1                        0
3                               1                        0
4                               1                        0
…                             …                      …
119385                         30                        2
119386                         31                        2
119387                         31                        2
119388                         31                        2
119389                         29                        2

        stays_in_week_nights  adults  children  babies meal country  \
0                          0       2       0.0       0   BB     PRT
1                          0       2       0.0       0   BB     PRT
2                          1       1       0.0       0   BB     GBR
3                          1       1       0.0       0   BB     GBR
4                          2       2       0.0       0   BB     GBR
…                        …     …       …     …  …      …
119385                     5       2       0.0       0   BB     BEL
119386                     5       3       0.0       0   BB     FRA
119387                     5       2       0.0       0   BB     DEU
119388                     5       2       0.0       0   BB     GBR
119389                     7       2       0.0       0   HB     DEU

       market_segment distribution_channel  is_repeated_guest  \
0              Direct               Direct                  0
1              Direct               Direct                  0
2              Direct               Direct                  0
3           Corporate            Corporate                  0
4           Online TA                TA/TO                  0
…                 …                  …                …
119385  Offline TA/TO                TA/TO                  0
119386      Online TA                TA/TO                  0
119387      Online TA                TA/TO                  0
119388      Online TA                TA/TO                  0
119389      Online TA                TA/TO                  0

        previous_cancellations  previous_bookings_not_canceled  \
0                            0                               0
```

```
1                          0                              0
2                          0                              0
3                          0                              0
4                          0                              0
…                      …                              …
119385                     0                              0
119386                     0                              0
119387                     0                              0
119388                     0                              0
119389                     0                              0

       reserved_room_type assigned_room_type  booking_changes deposit_type  \
0                       C                  C                3   No Deposit
1                       C                  C                4   No Deposit
2                       A                  C                0   No Deposit
3                       A                  A                0   No Deposit
4                       A                  A                0   No Deposit
…                  …                  …               …           …
119385                  A                  A                0   No Deposit
119386                  E                  E                0   No Deposit
119387                  D                  D                0   No Deposit
119388                  A                  A                0   No Deposit
119389                  A                  A                0   No Deposit

        agent  days_in_waiting_list customer_type     adr  \
0         0.0                     0     Transient    0.00
1         0.0                     0     Transient    0.00
2         0.0                     0     Transient   75.00
3       304.0                     0     Transient   75.00
4       240.0                     0     Transient   98.00
…       …                     …          …     …
119385  394.0                     0     Transient   96.14
119386    9.0                     0     Transient  225.43
119387    9.0                     0     Transient  157.71
119388   89.0                     0     Transient  104.40
119389    9.0                     0     Transient  151.20

        required_car_parking_spaces  total_of_special_requests  \
0                                 0                          0
1                                 0                          0
2                                 0                          0
3                                 0                          0
4                                 0                          1
…                             …                          …
119385                            0                          0
119386                            0                          2
119387                            0                          4
```

```
119388                            0                          0
119389                            0                          2

       reservation_status reservation_status_date
0               Check-Out              2015-07-01
1               Check-Out              2015-07-01
2               Check-Out              2015-07-02
3               Check-Out              2015-07-02
4               Check-Out              2015-07-03
…                   …                      …
119385          Check-Out              2017-09-06
119386          Check-Out              2017-09-07
119387          Check-Out              2017-09-07
119388          Check-Out              2017-09-07
119389          Check-Out              2017-09-07

[119210 rows x 31 columns]
```

After dealing with the null values and dropping few unwanted rows the new shape of our dataset is **(119210,31)**

[86]:
```
## Converting Datatype: Children are listed as float datatypre but in reality␣
↪its interger, so needs to be changed

hotel['children'] = hotel['children'].astype('int64')
hotel['agent'] = hotel['agent'].astype('int64')
hotel['country'] = hotel['country'].astype('str')
hotel ['reservation_status_date'] = hotel['reservation_status_date'].
↪astype('datetime64')
#looking at the reservation_status_date we can see it doesnt have correct␣
↪Dtype, hence we need to change it to datetime 64
hotel.info()
```

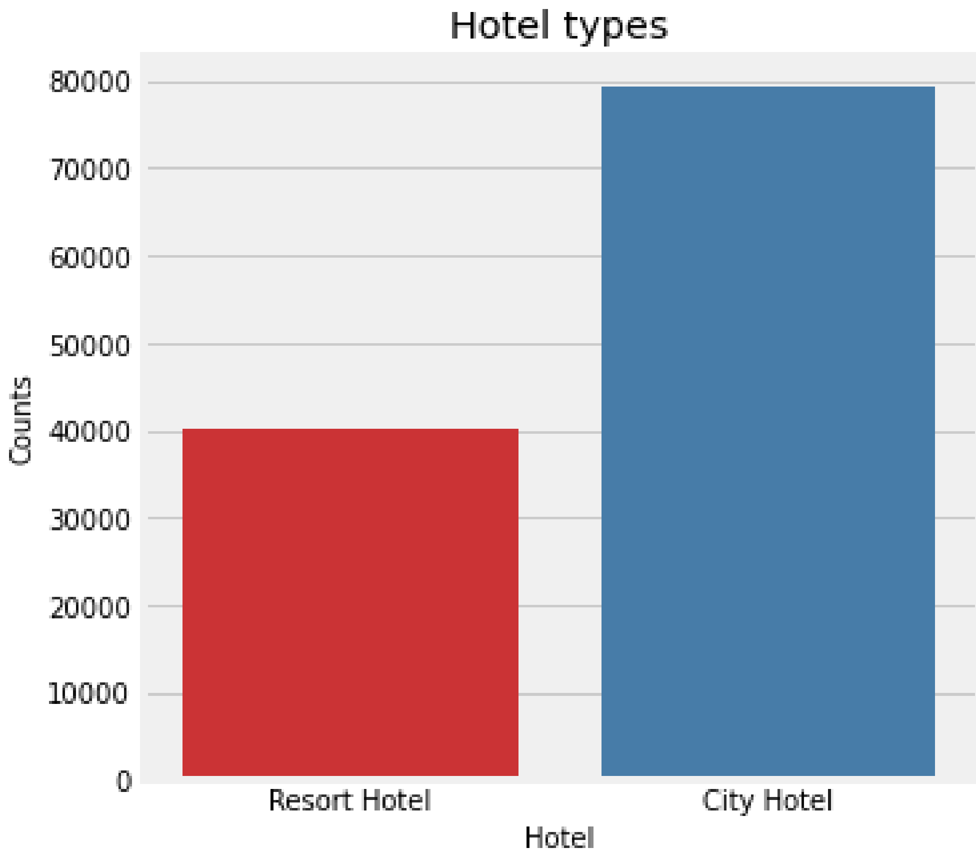
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 31 columns):
 #   Column                          Non-Null Count   Dtype
---  ------                          --------------   -----
 0   hotel                           119210 non-null  object
 1   is_canceled                     119210 non-null  int64
 2   lead_time                       119210 non-null  int64
 3   arrival_date_year               119210 non-null  int64
 4   arrival_date_month              119210 non-null  object
 5   arrival_date_week_number        119210 non-null  int64
 6   arrival_date_day_of_month       119210 non-null  int64
 7   stays_in_weekend_nights         119210 non-null  int64
 8   stays_in_week_nights            119210 non-null  int64
```

```
 9   adults                          119210 non-null  int64
 10  children                        119210 non-null  int64
 11  babies                          119210 non-null  int64
 12  meal                            119210 non-null  object
 13  country                         119210 non-null  object
 14  market_segment                  119210 non-null  object
 15  distribution_channel            119210 non-null  object
 16  is_repeated_guest               119210 non-null  int64
 17  previous_cancellations          119210 non-null  int64
 18  previous_bookings_not_canceled  119210 non-null  int64
 19  reserved_room_type              119210 non-null  object
 20  assigned_room_type              119210 non-null  object
 21  booking_changes                 119210 non-null  int64
 22  deposit_type                    119210 non-null  object
 23  agent                           119210 non-null  int64
 24  days_in_waiting_list            119210 non-null  int64
 25  customer_type                   119210 non-null  object
 26  adr                             119210 non-null  float64
 27  required_car_parking_spaces     119210 non-null  int64
 28  total_of_special_requests       119210 non-null  int64
 29  reservation_status              119210 non-null  object
 30  reservation_status_date         119210 non-null  datetime64[ns]
dtypes: datetime64[ns](1), float64(1), int64(18), object(11)
memory usage: 29.1+ MB
```

Data Visualization

[87]:
```
plt.figure(figsize=(5,5))
sns.countplot(x = 'hotel', data = hotel, palette = 'Set1')
plt.title('Hotel types')
plt.xlabel('Hotel', fontsize = 10)
plt.ylabel('Counts', fontsize = 10)
```

[87]:
```
Text(0, 0.5, 'Counts')
```



[88]:
```
hotel['hotel'].value_counts()/hotel.shape[0]*100
```

[88]:
```
City Hotel      66.406342
Resort Hotel    33.593658
Name: hotel, dtype: float64
```

66 % reservations were made for city hotel and the remaining 34% for the Resort Hotel, which means higher number of reservations were made for the City Hotel

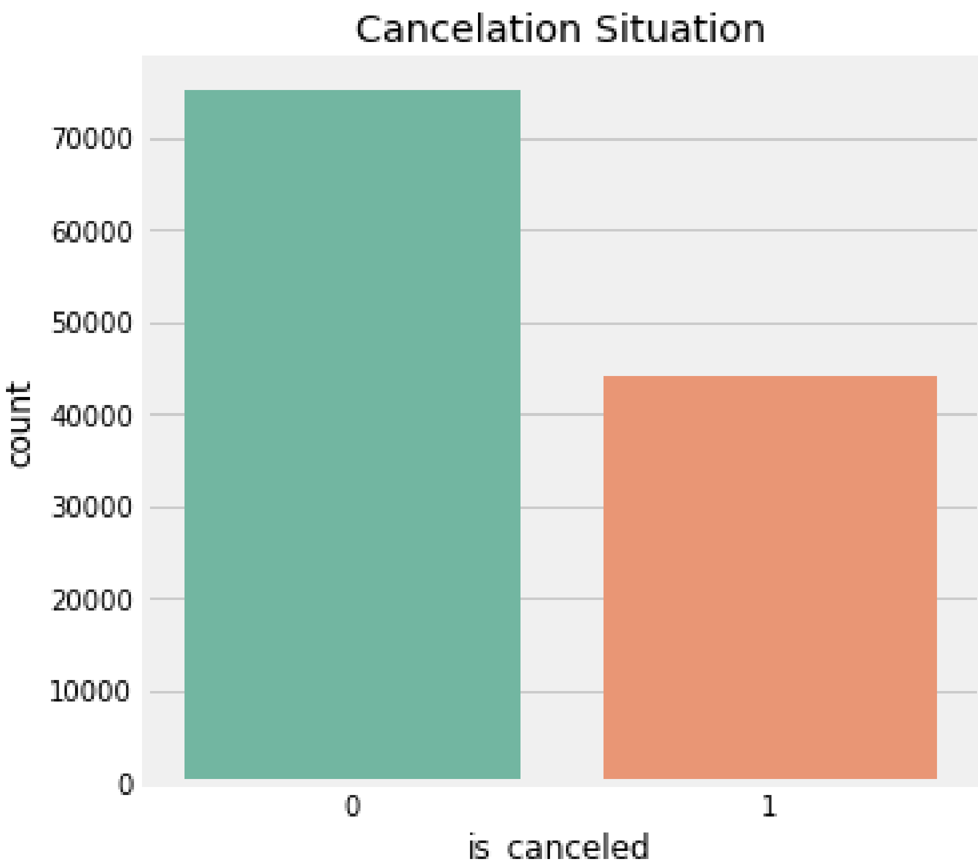
[89]:
```
hotel['is_canceled'].value_counts()/hotel.shape[0]*100
```

[89]:
```
0    62.923412
1    37.076588
Name: is_canceled, dtype: float64
```

63% of the total reservations were not canceled and 37% were canceled combined from both the hotels

[90]:
```
#Checking the cancelation status
plt.figure(figsize=(5,5))
```

```
sns.countplot(x='is_canceled' , data = hotel, palette = 'Set2')
plt.title('Cancelation Situation')
plt.show()
```



Higher number of “cancelations” and “not cancelations” were made for the City Hotel

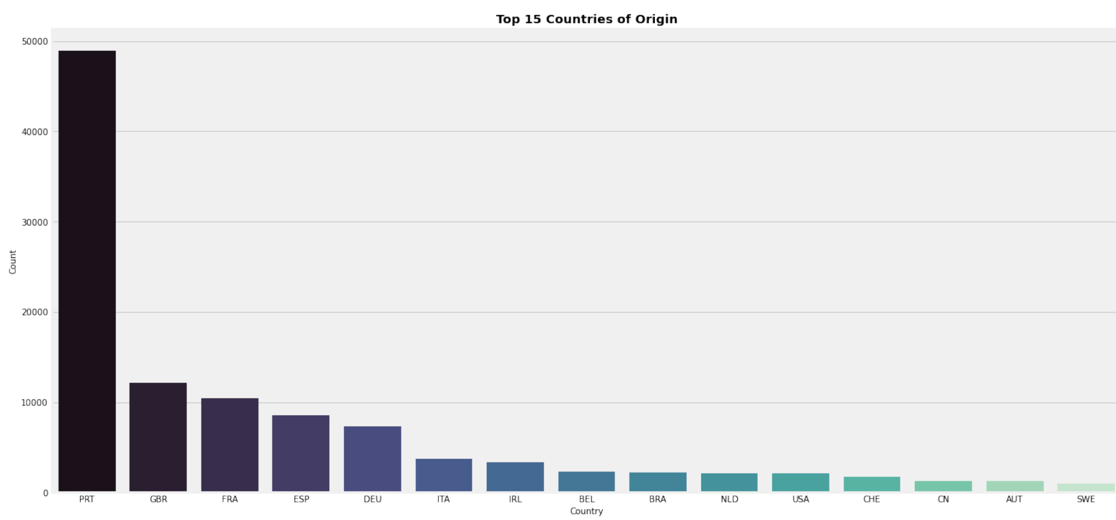
[91]:
```
#calculation of ratio of uncanceled and canceled bookings at City and Resort␣
↪Hotels
a = hotel [hotel['is_canceled']==0].groupby('hotel').is_canceled.count()
b = hotel [hotel['is_canceled']==1].groupby('hotel').is_canceled.count()

data = pd.DataFrame({'hotel':a.index,
                     '0':a.values,
                     '1':b.values
                    })
data["Ratio of uncanceled bookings"] = data['0']/( data['0']+ data['1'])
data["Ratio of canceled bookings"] = data['1']/( data['0']+ data['1'])
data
```

```
[91]:           hotel      0      1  Ratio of uncanceled bookings  \
      0    City Hotel  46084  33079                      0.582141
      1  Resort Hotel  28927  11120                      0.722326

         Ratio of canceled bookings
      0                    0.417859
      1                    0.277674
```

Looking at the ratio of cancelations it can be noted that higher cancelations were observed in City Hotel as compared to Resort Hotel.

```
[92]: # Plotting these countries on a graph
plt.figure(figsize=(20,10))
sns.countplot(x='country', data=hotel,
              order=pd.value_counts(hotel['country']).iloc[:15].
 ↪index,palette="mako")
plt.title('Top 15 Countries of Origin', weight='bold')
plt.xlabel('Country', fontsize=10)
plt.ylabel('Count', fontsize=10)
```

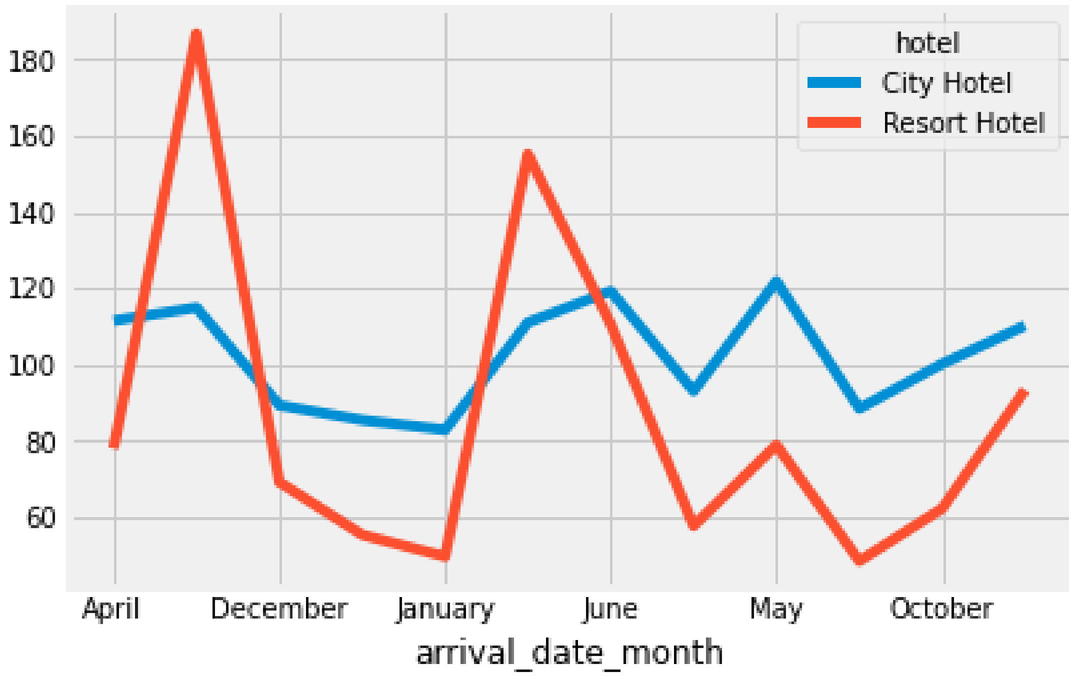
```
[92]: Text(0, 0.5, 'Count')
```



Tourists are traveling from across the globe to stay at these hotels. Home country for most of the guests is Portugal along with other countries in Europe.

```
[93]: #Comparison of average daily charges of two hotels by month
hotel.
 ↪pivot_table(values='adr',index='arrival_date_month',columns='hotel',aggfunc='mean').
 ↪plot()
```

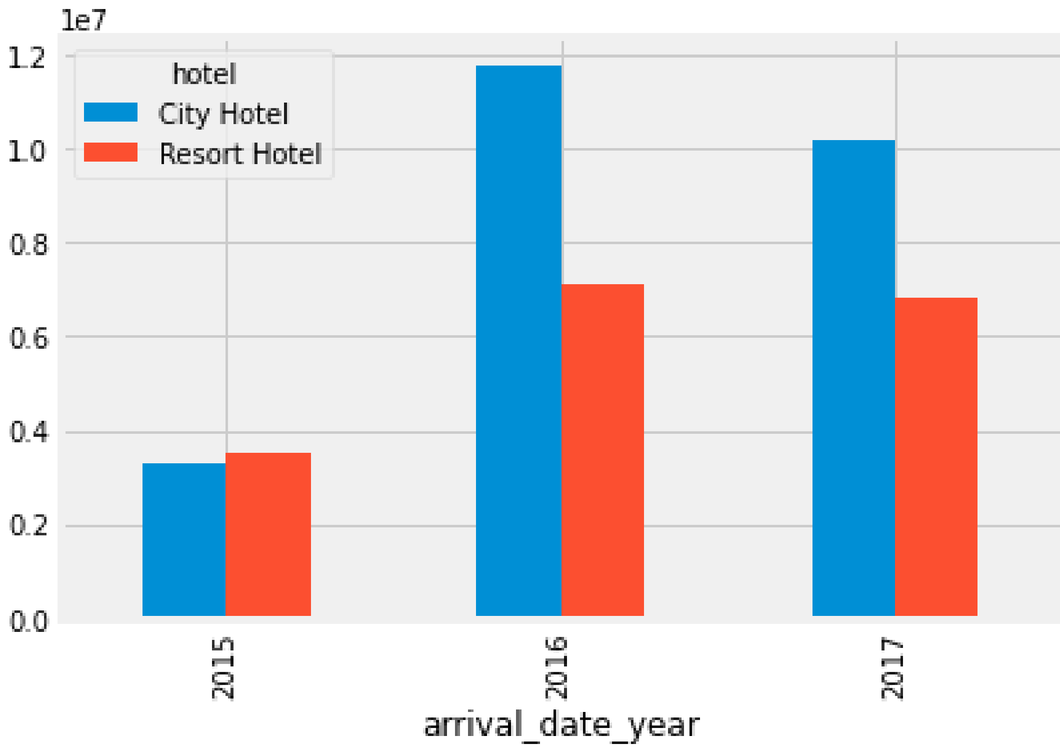
[93]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe71a9af810>



Prices at both the hotels are quite variable. It can be noted that ADR is higher in July and August months since 2015.

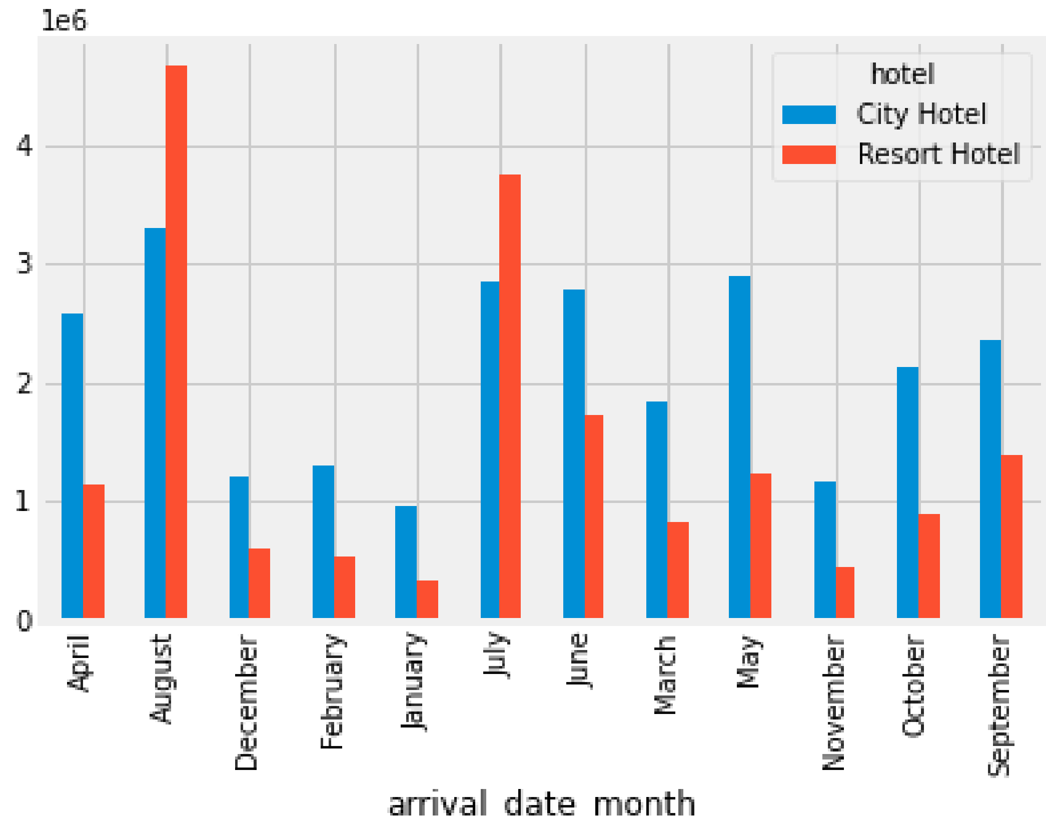
Comparing the turnover of two hotels from 2015-2017

[94]:
```
hotel['total_adr']=(hotel['stays_in_weekend_nights']+hotel['stays_in_week_nights'])*hotel['adr
hotel.
↪pivot_table(values='total_adr',index='arrival_date_year',columns='hotel',aggfunc='sum').
↪plot.bar()
plt.show()
```



The turnover in the 2016 and 2017 was higher for City hotel, but lower in 2015 as compared Resort Hotel

[95]:
```
hotel.
 ↪pivot_table(values='total_adr',index='arrival_date_month',columns='hotel',aggfunc='sum').
 ↪plot.bar()
plt.show()
plt.figure(figsize=(10,10))
```



[95]: <Figure size 720x720 with 0 Axes>

```
<Figure size 720x720 with 0 Axes>
```

Resort Hotel has higher turnover than City Hotel in the months July and August and in the rest of the months City Hotel makes higher revenues.

Rearranging the data by 'Month'

[96]:
```
pip install sort-dataframeby-monthorweek
```

```
Processing ./.cache/pip/wheels/de/e1/ad/5fe265a9780676079c4b8caaaffaa8d5c4ab2f37
cf823e8aa8/sort_dataframeby_monthorweek-0.4-py3-none-any.whl
Installing collected packages: sort-dataframeby-monthorweek
Successfully installed sort-dataframeby-monthorweek-0.4
Note: you may need to restart the kernel to use updated packages.
```

[97]:
```
pip install sorted-months-weekdays
```

```
Processing ./.cache/pip/wheels/4f/4f/78/3f1b8fc72651f7c766a6f73d667fccb12a8aabe2
40b38df7a4/sorted_months_weekdays-0.2-py3-none-any.whl
```

```
Installing collected packages: sorted-months-weekdays
Successfully installed sorted-months-weekdays-0.2
Note: you may need to restart the kernel to use updated packages.
```

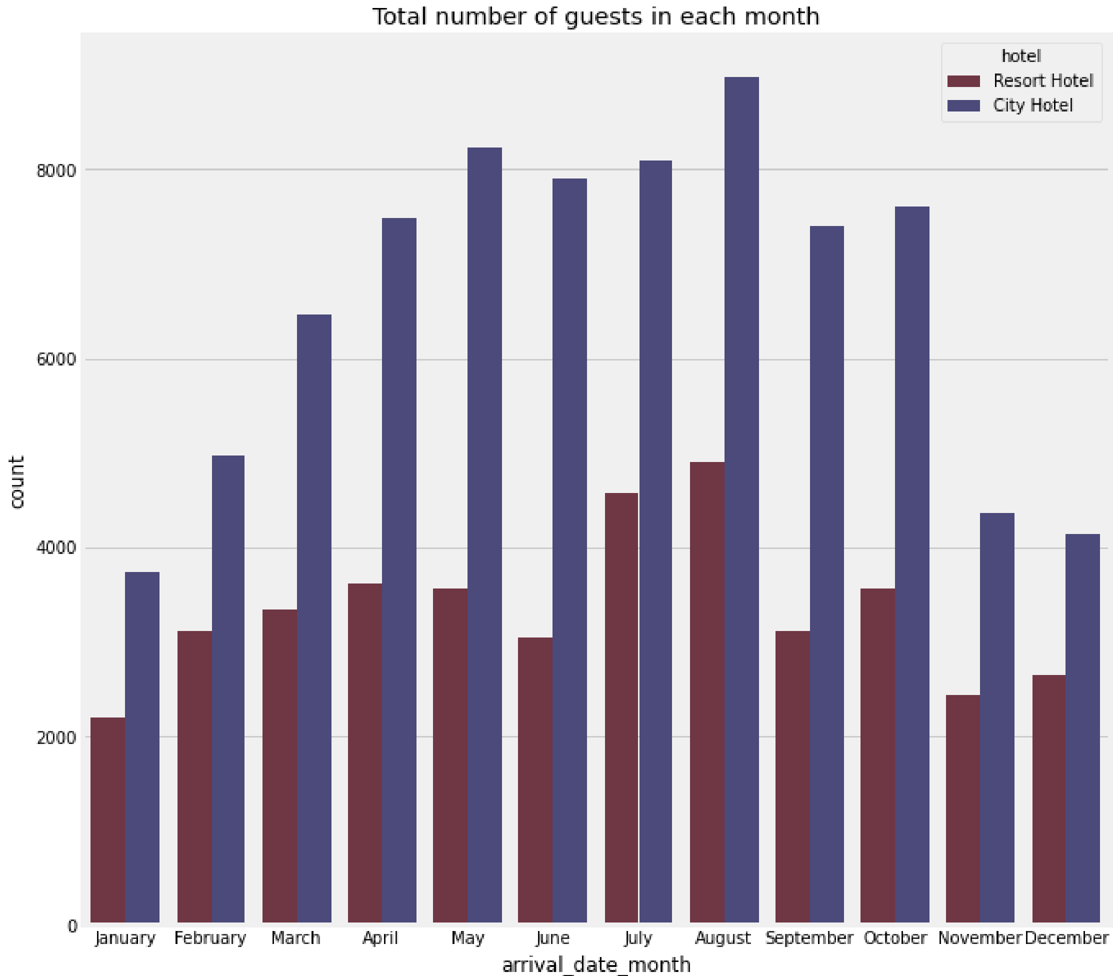
[98]:
```python
from sorted_months_weekdays import *

from sort_dataframeby_monthorweek import *

final = Sort_Dataframeby_Month(df=df,monthcolumnname='arrival_date_month')
final.head()
```

[98]:
```
          hotel  is_canceled  lead_time  arrival_date_year arrival_date_month  \
0  Resort Hotel            0        109               2016            January
1  Resort Hotel            0        109               2016            January
2  Resort Hotel            1          2               2016            January
3  Resort Hotel            0         88               2016            January
4  Resort Hotel            1         20               2016            January

   arrival_date_week_number  arrival_date_day_of_month  \
0                         1                          1
1                         1                          1
2                         1                          1
3                         1                          1
4                         1                          1

   stays_in_weekend_nights  stays_in_week_nights  adults  children  babies  \
0                        0                     1       2       0.0       0
1                        0                     1       2       2.0       0
2                        0                     1       2       0.0       0
3                        0                     2       2       0.0       0
4                        0                     2       2       2.0       0

  meal country market_segment distribution_channel  is_repeated_guest  \
0   BB     RUS      Online TA                TA/TO                  0
1   BB     RUS      Online TA                TA/TO                  0
2   BB     PRT      Online TA                TA/TO                  0
3   HB     ARG      Online TA                TA/TO                  0
4   BB     PRT      Online TA                TA/TO                  0

   previous_cancellations  previous_bookings_not_canceled reserved_room_type  \
0                       0                               0                  A
1                       0                               0                  H
2                       0                               0                  D
3                       0                               0                  A
4                       0                               0                  G

  assigned_room_type  booking_changes deposit_type  agent  company  \
```

```
0                  D                0   No Deposit  240.0      NaN
1                  H                0   No Deposit  240.0      NaN
2                  D                0   No Deposit  240.0      NaN
3                  D                0   No Deposit  241.0      NaN
4                  G                0   No Deposit  240.0      NaN

   days_in_waiting_list    customer_type     adr  required_car_parking_spaces  \
0                     0  Transient-Party   59.94                            0
1                     0  Transient-Party  116.10                            1
2                     0        Transient   89.00                            0
3                     0        Transient   73.46                            0
4                     0        Transient  119.00                            0

   total_of_special_requests reservation_status reservation_status_date
0                          1          Check-Out              2016-01-02
1                          1          Check-Out              2016-01-02
2                          1            No-Show              2016-01-01
3                          2          Check-Out              2016-01-03
4                          0           Canceled              2015-12-22
```

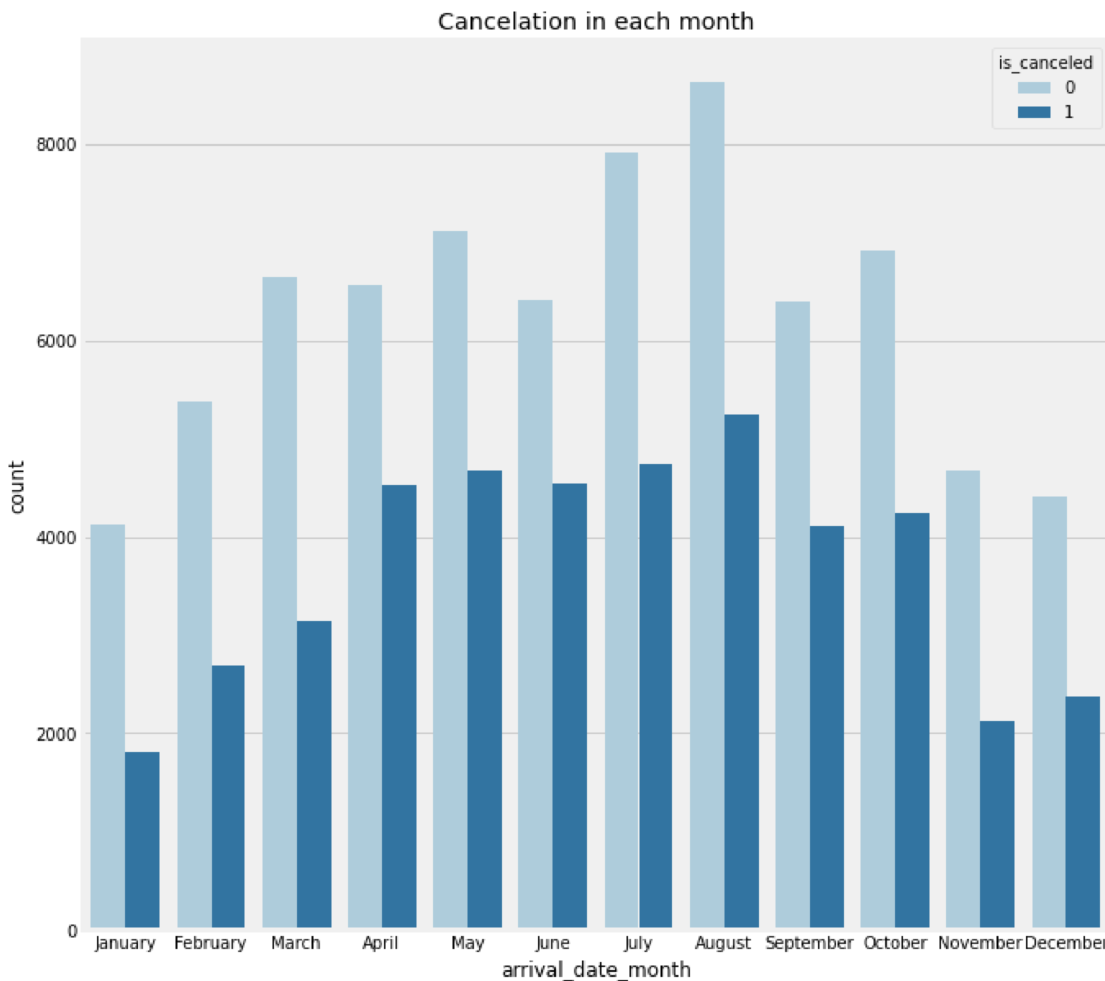
[99]:

```
plt.figure(figsize=(10,10))
sns.countplot(x='arrival_date_month',  hue= 'hotel', data= final, palette =␣
 ↪"icefire_r")
plt.title('Total number of guests in each month')
plt.show()
```



Observing the bar chart we can see that Resort Hotel gets busy in July and September, whereas demand in the city hotel stays from May to October.

[100]:
```
plt.figure(figsize=(10,10))
sns.countplot(x='arrival_date_month',  hue= 'is_canceled', data= final, palette␣
↪= "Paired")
plt.title('Cancelation in each month')
plt.show()
```



[101]:
```
country_wise_guests = hotel[hotel['is_canceled'] == 0]['country'].
    ↪value_counts().reset_index()
country_wise_guests.columns = ['Country', 'Total no of guests']
country_wise_guests
```

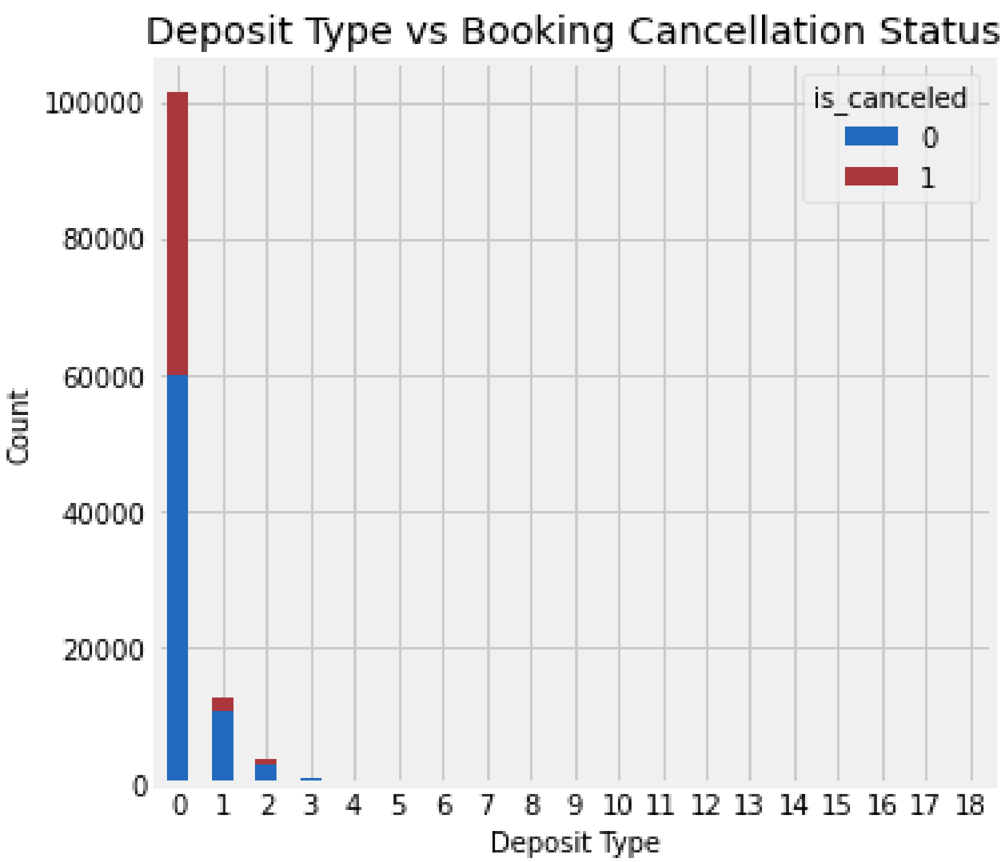
[101]:

	Country	Total no of guests
0	PRT	21398
1	GBR	9668
2	FRA	8468
3	ESP	6383
4	DEU	6067
..	…	…
160	LCA	1
161	NPL	1
162	AIA	1
163	MAC	1

```
164      MMR                    1

[165 rows x 2 columns]
```

[103]:
```python
group_deposit = hotel.groupby(['booking_changes', 'is_canceled']).size().
↪unstack(fill_value=0)
group_deposit.plot(kind='bar', stacked=True, cmap='vlag', figsize=(5,5))
plt.title('Deposit Type vs Booking Cancellation Status')
plt.xlabel('Deposit Type', fontsize=10)
plt.xticks(rotation=360)
plt.ylabel('Count', fontsize=10)
```

[103]:
```
Text(0, 0.5, 'Count')
```



Price variation per night at both the hotels

[104]:
```python
data_city =final[(final['hotel'] == 'City Hotel') & (final['is_canceled'] == 0)]
data_resort =final[(final['hotel'] == 'Resort Hotel') & (final['is_canceled']␣
↪== 0)]
```

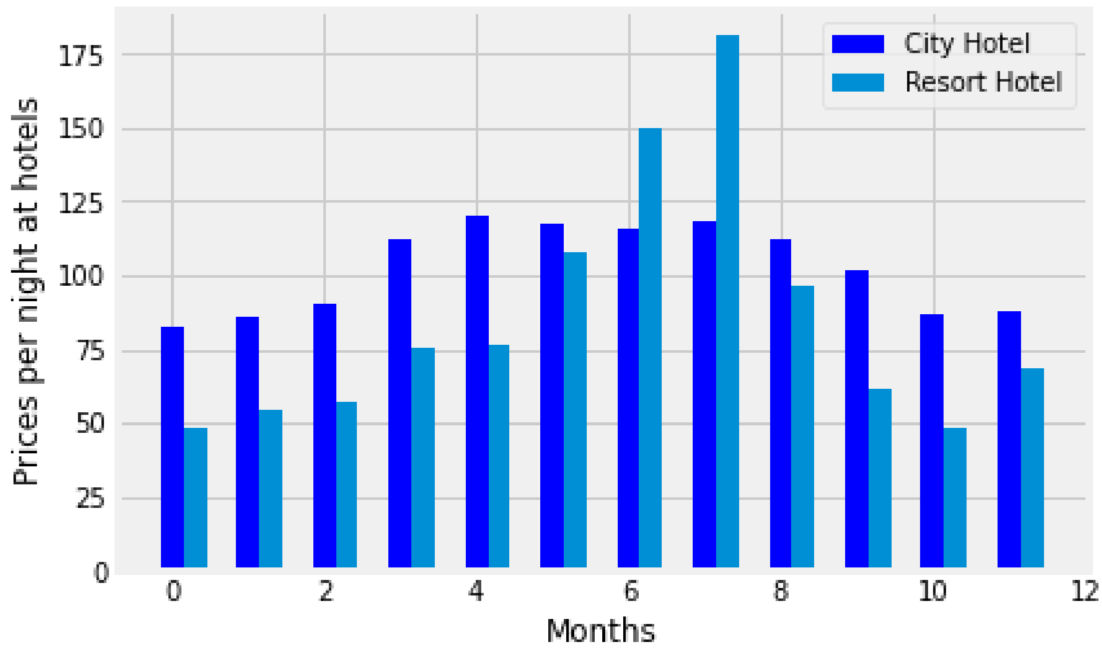
```
city_hotel = data_city.groupby(['arrival_date_month'])['adr'].mean().
 ↪reset_index()
resort_hotel = data_resort.groupby(['arrival_date_month'])['adr'].mean().
 ↪reset_index()

final_hotel = city_hotel.merge(resort_hotel, on = 'arrival_date_month')
final_hotel.columns = ['arrival_month', 'price_for_city_hotel',␣
 ↪'price_for_resort_hotel']
price_per_night =␣
 ↪Sort_Dataframeby_Month(df=final_hotel,monthcolumnname='arrival_month')
price_per_night
```

[104]:

	arrival_month	price_for_city_hotel	price_for_resort_hotel
0	January	82.160634	48.708919
1	February	86.183025	54.147478
2	March	90.170722	57.012487
3	April	111.856824	75.867816
4	May	120.445842	76.657558
5	June	117.702075	107.921869
6	July	115.563810	150.122528
7	August	118.412083	181.205892
8	September	112.598452	96.416860
9	October	101.745956	61.727505
10	November	86.500456	48.681640
11	December	87.856764	68.322236

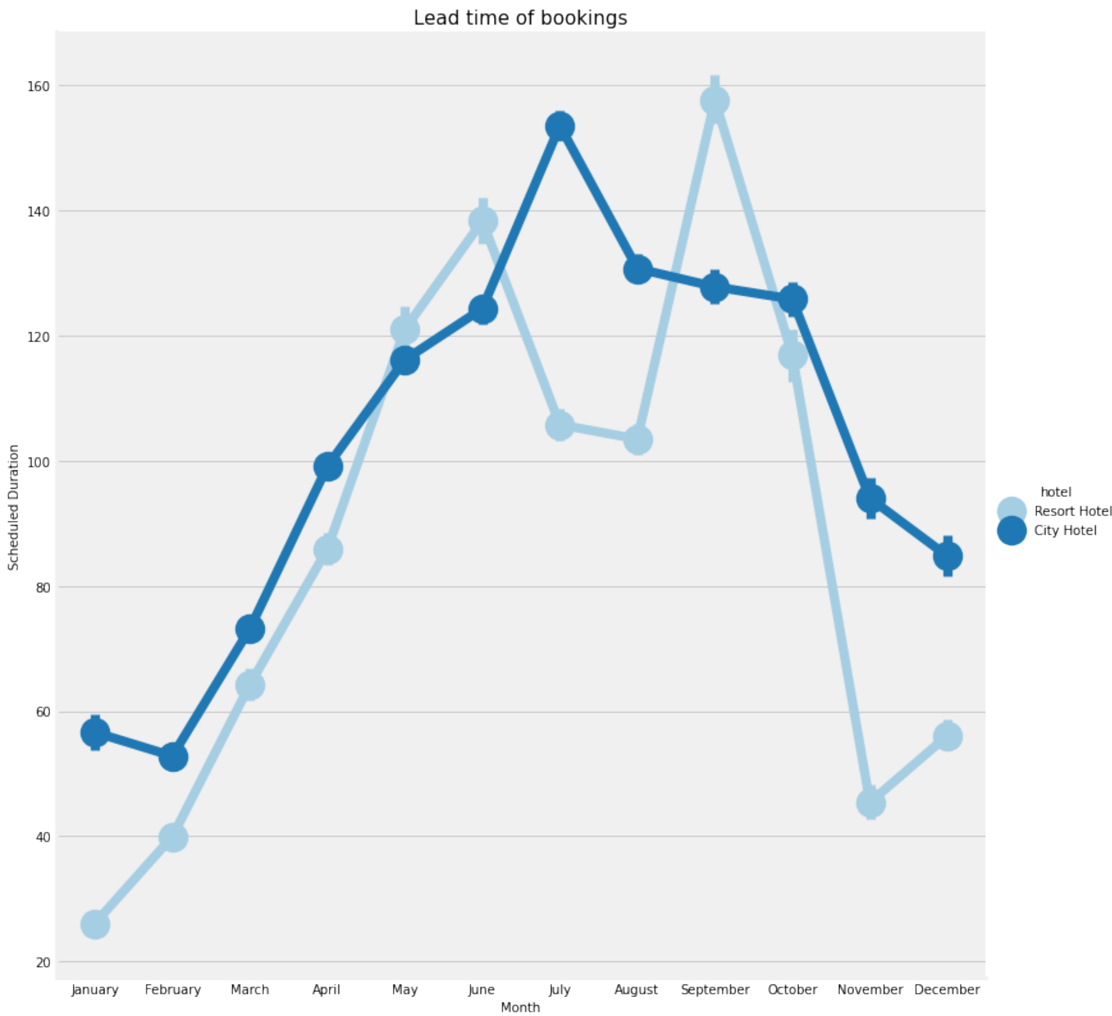
[105]:

```
w = 0.3
x = price_per_night.arrival_month
bar1 = np.arange(len(x))
bar2 = [i+w for i in bar1]
plt.bar(bar1,price_per_night.price_for_city_hotel,w,color="blue",label="City␣
 ↪Hotel")
plt.bar(bar2,price_per_night.price_for_resort_hotel,w,label="Resort Hotel")
plt.xlabel("Months")
plt.ylabel("Prices per night at hotels")
plt.legend()
plt.show()
```



Throughout the year price per night was higher at City Hotel in comparison to Resort Hotel, except for the months 'July and August.

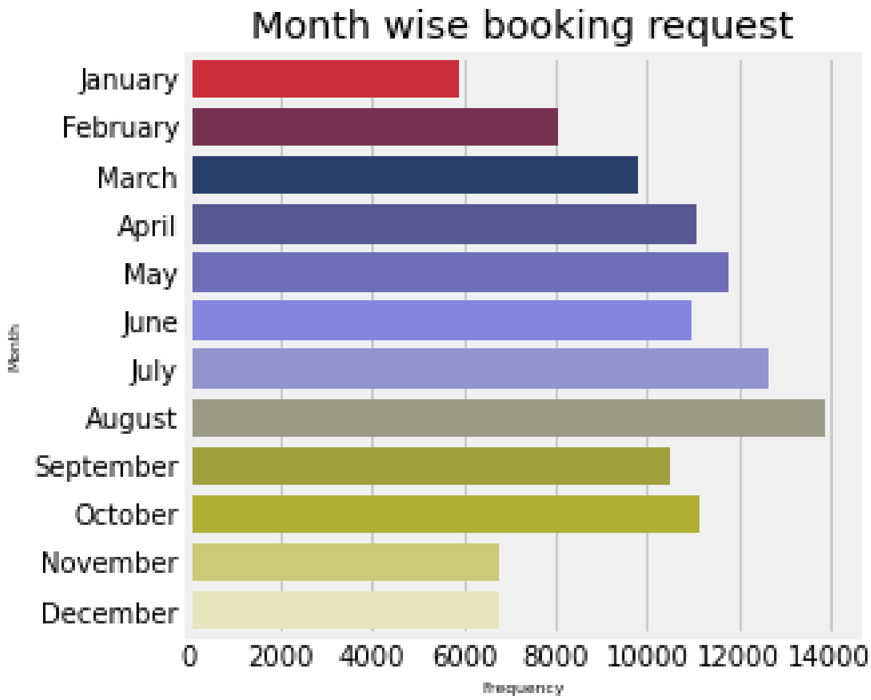
[106]:
```
sns.factorplot(x='arrival_date_month',y='lead_time', hue='hotel', palette =␣
↪'Paired', data =final,size=11)
plt.title("Lead time of bookings", fontsize=15)
plt.xlabel("Month", fontsize=10)
plt.ylabel("Scheduled Duration", fontsize=10)
plt.show()
```



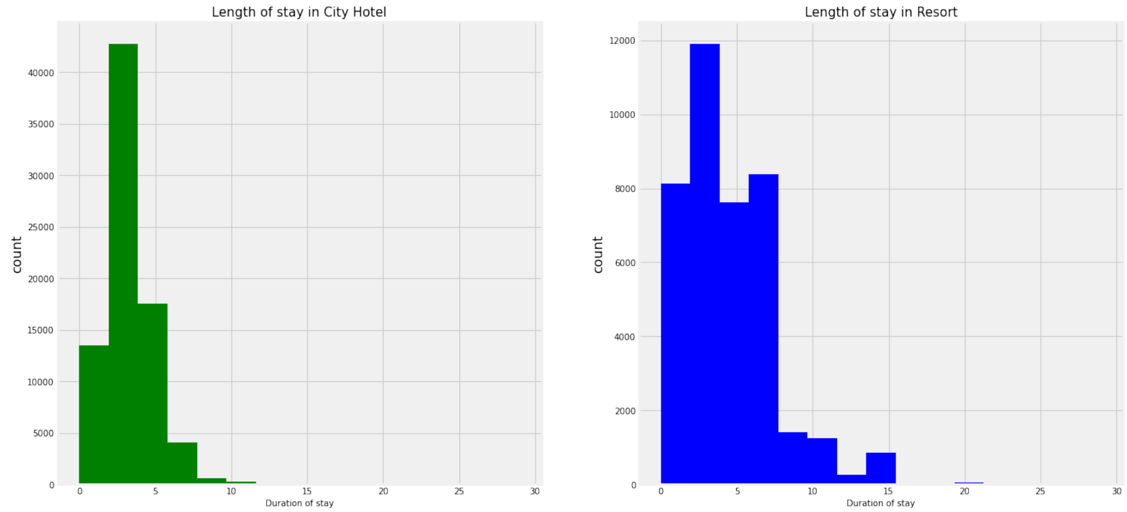
Guests tend to make reservations in advance for June to October in City and Hotel and June and September for Resort Hotel

[107]:
```
#Cumulative Monthwise bookings for 3 years
plt.figure(figsize=(4,4))
sns.countplot(y='arrival_date_month', data= final, palette='gist_stern', orient␣
↪= 'v')
plt.title('Month wise booking request')
plt.xlabel('Frequency', fontsize=6)
plt.ylabel('Month', fontsize=6)
```

[107]: Text(0, 0.5, 'Month')



[108]:
```
hotel['total_stay']=hotel['stays_in_weekend_nights']+hotel['stays_in_week_nights']
plt.figure(figsize=(20,10))
plt.subplot(1,2,1)
hotel.query("total_stay<30&hotel=='City Hotel'").total_stay.plot.
    ↪hist(bins=15,color='g')
plt.title("Length of stay in City Hotel", fontsize=15)
plt.xlabel("Duration of stay", fontsize=10)
plt.ylabel("count", fontsize=16)
plt.subplot(1,2,2)
hotel.query("total_stay<30&hotel=='Resort Hotel'").total_stay.plot.
    ↪hist(bins=15,color='b')
plt.title("Length of stay in Resort", fontsize=15)
plt.xlabel("Duration of stay", fontsize=10)
plt.ylabel("count", fontsize=16)
plt.show()
```



Guests prefer to stay longer in Resort Hotel as compared to City Hotel. On an average, guests syat at City Hotel for 2.92 nights and 4.14 nights at Resort Hotel. For resort hotel, often 1-4 nights are booked for both City and Resort Hotels.

[109]:
```python
#Reserved Room Type vs Assigned Room Type
df2 = pd.crosstab(index = hotel['reserved_room_type'], columns =␣
↪hotel['assigned_room_type'],normalize='index').round(2)*100
df2
```

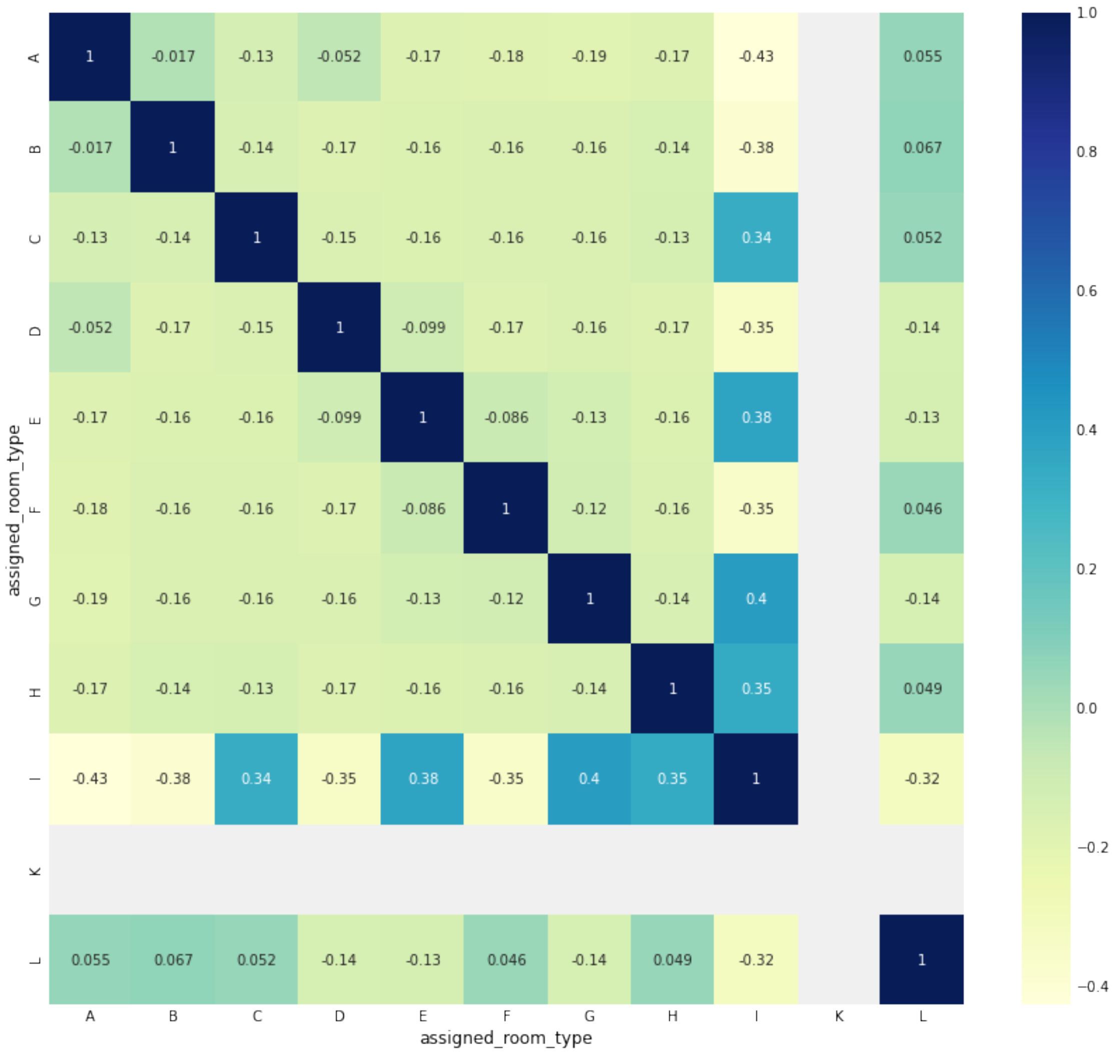
[109]:

assigned_room_type reserved_room_type	A	B	C	D	E	F	G	H	I	K	L
A	86.0	1.0	2.0	9.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
B	10.0	88.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
C	1.0	0.0	95.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0
D	2.0	0.0	0.0	92.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	91.0	6.0	2.0	0.0	1.0	0.0	0.0
F	0.0	0.0	0.0	0.0	1.0	94.0	4.0	0.0	0.0	0.0	0.0
G	0.0	0.0	0.0	0.0	0.0	1.0	98.0	0.0	1.0	0.0	0.0
H	0.0	0.0	0.0	0.0	0.0	0.0	2.0	97.0	1.0	0.0	
L	17.0	17.0	17.0	0.0	0.0	17.0	0.0	17.0	0.0	0.0	

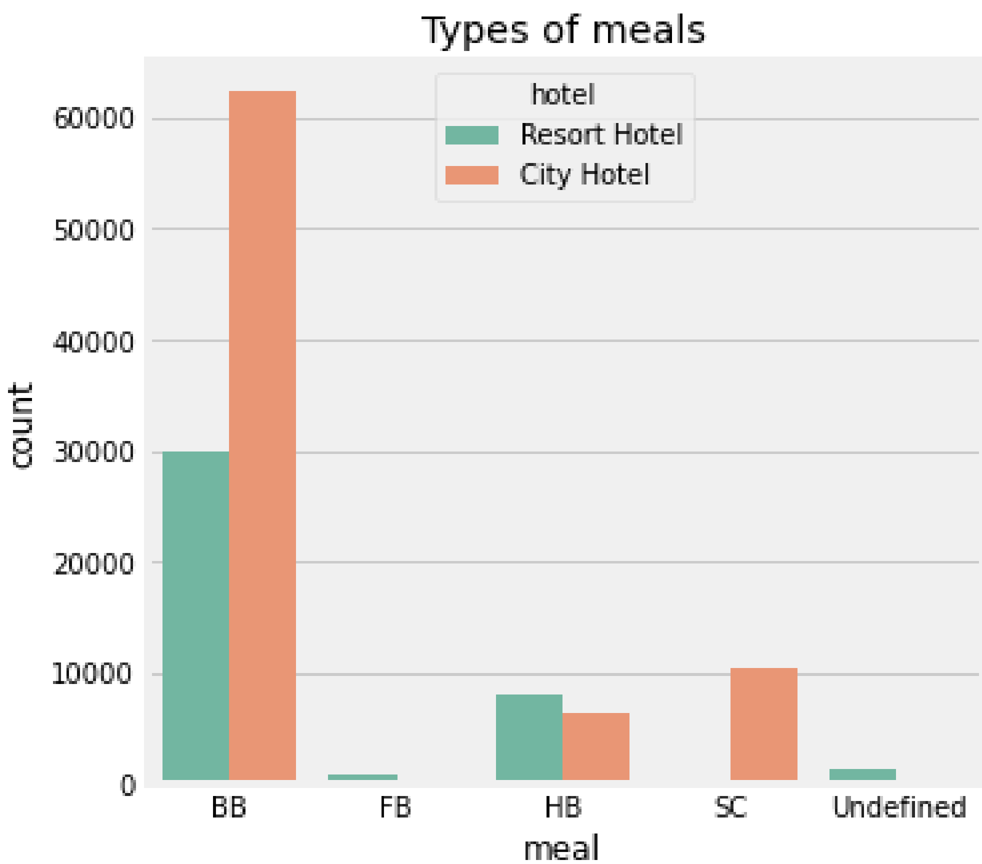
```
H                       0.0
L                      17.0
```

The above cross table shows the reserved type of room distribution over assigned room type. Almost at all the occassions guests received the same room type as they booked.

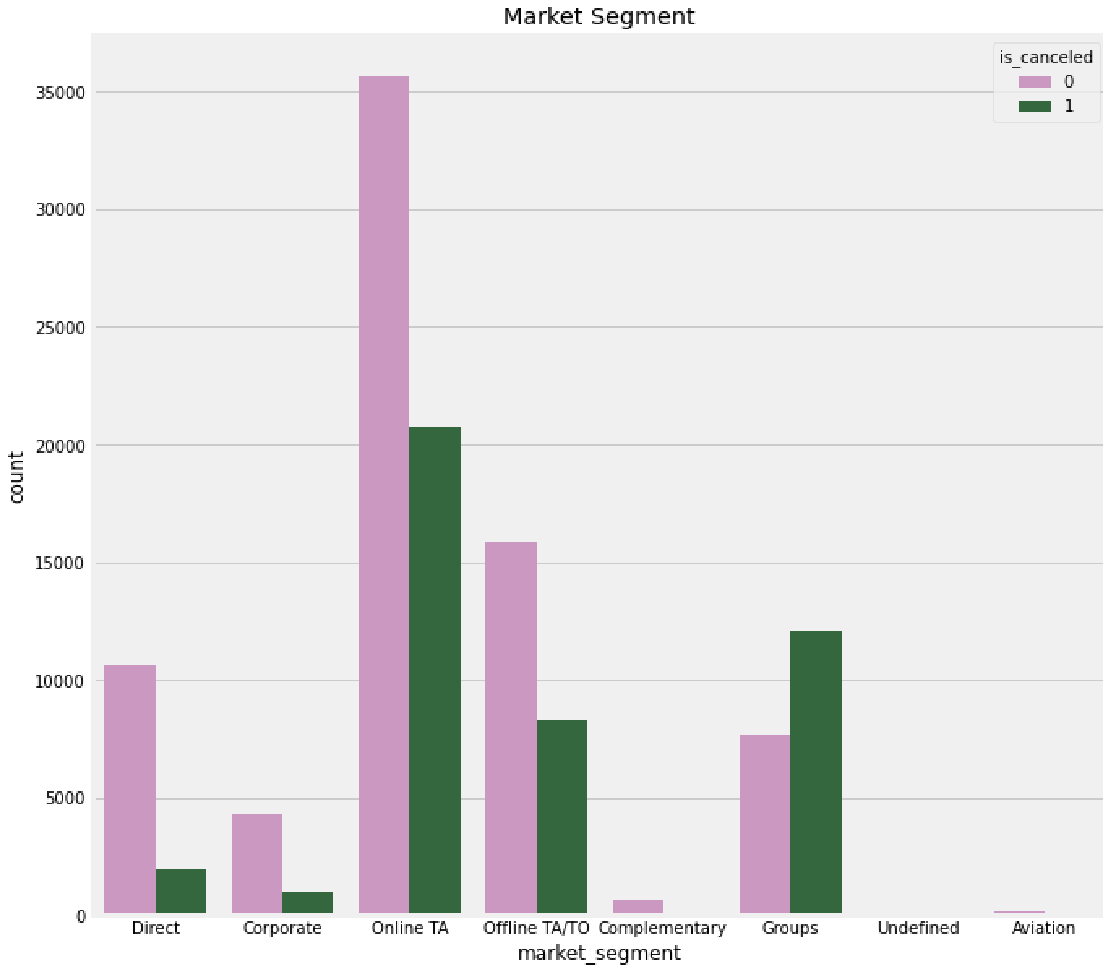
[110]:
```python
#Heatmap for the dataset of Reserved Room Type vs Assigned Room Type
plt.figure(figsize=(13,13))
dataplot = sns.heatmap(df2.corr(), cmap="YlGnBu", annot=True)
```



[111]:
```python
plt.figure(figsize=(5,5))
sns.countplot(x='meal',  hue= 'hotel', data= hotel, palette = "Set2")
plt.title('Types of meals')
plt.show()
```



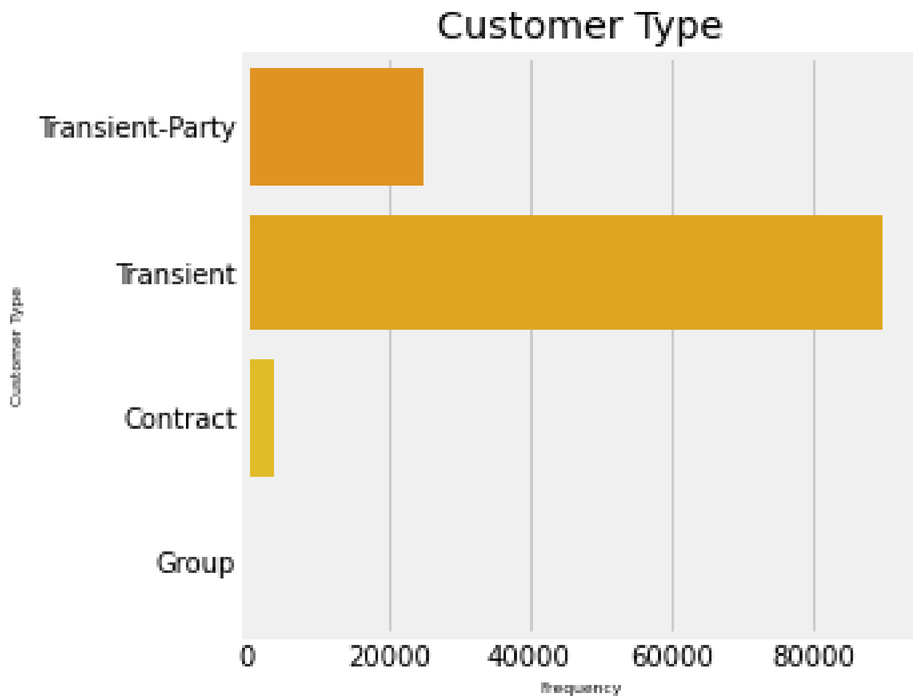
[112]:
```
plt.figure(figsize=(10,10))
sns.countplot(x='market_segment',  hue= 'is_canceled', data= hotel, palette =␣
 ↪"cubehelix_r")
plt.title('Market Segment')
plt.show()
```



Maximum tourists requested for ‘Bed and Breakfast’ at both the hotels

[113]:
```
#Customer type
plt.figure(figsize=(4,4))
sns.countplot(y='customer_type', data= final, palette='Wistia_r', orient = 's')
plt.title('Customer Type')
plt.xlabel('Frequency', fontsize=6)
plt.ylabel('Customer Type', fontsize=6)
```

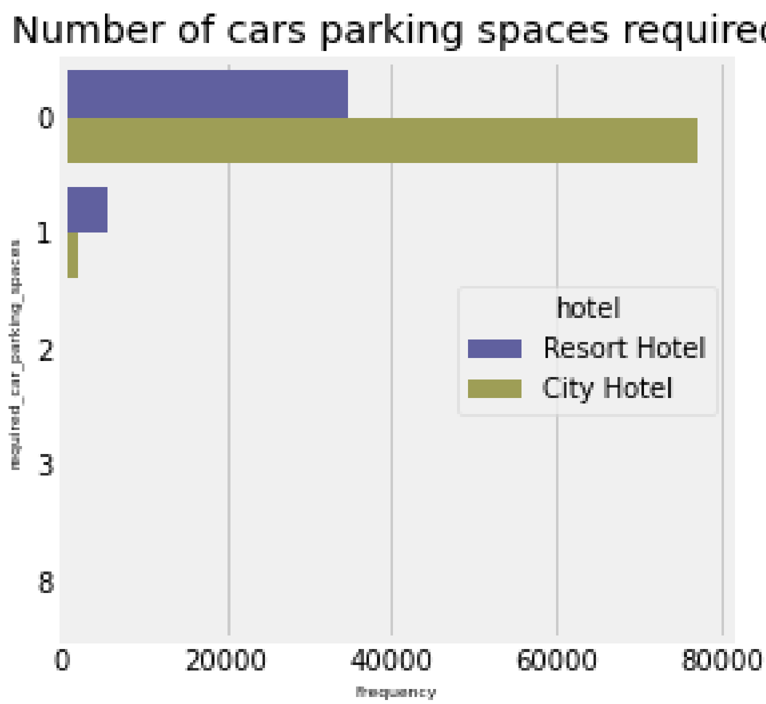
[113]:
```
Text(0, 0.5, 'Customer Type')
```



Most of the guests are transiet, which indicates that they are walk-in guests or they booked last muinute.

[114]:
```
#Required parking spaces
plt.figure(figsize=(4,4))
sns.countplot(y='required_car_parking_spaces', hue = 'hotel', data= hotel,␣
 ↪palette='gist_stern', orient = 'v')
plt.title('Number of cars parking spaces required')
plt.xlabel('Frequency', fontsize=6)
plt.ylabel('required_car_parking_spaces', fontsize=6)
```

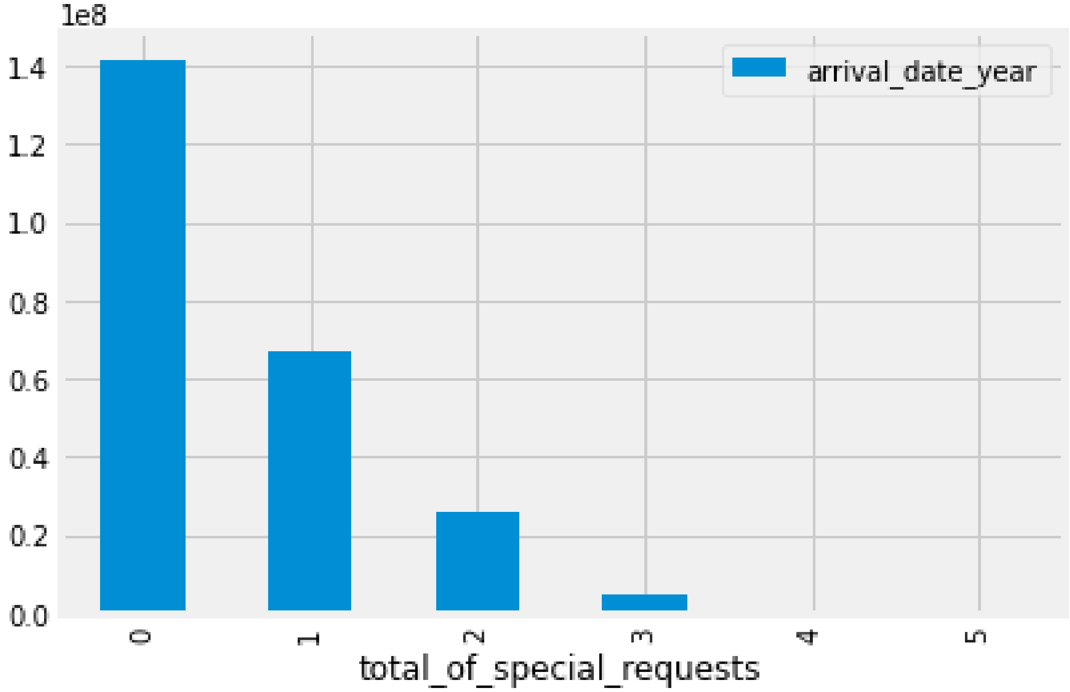
[114]:
```
Text(0, 0.5, 'required_car_parking_spaces')
```



Majority of the guests travelling to these hotels donot require car parking spaces. Few guests need 1 car parking at Resort Hotel as per the graph.

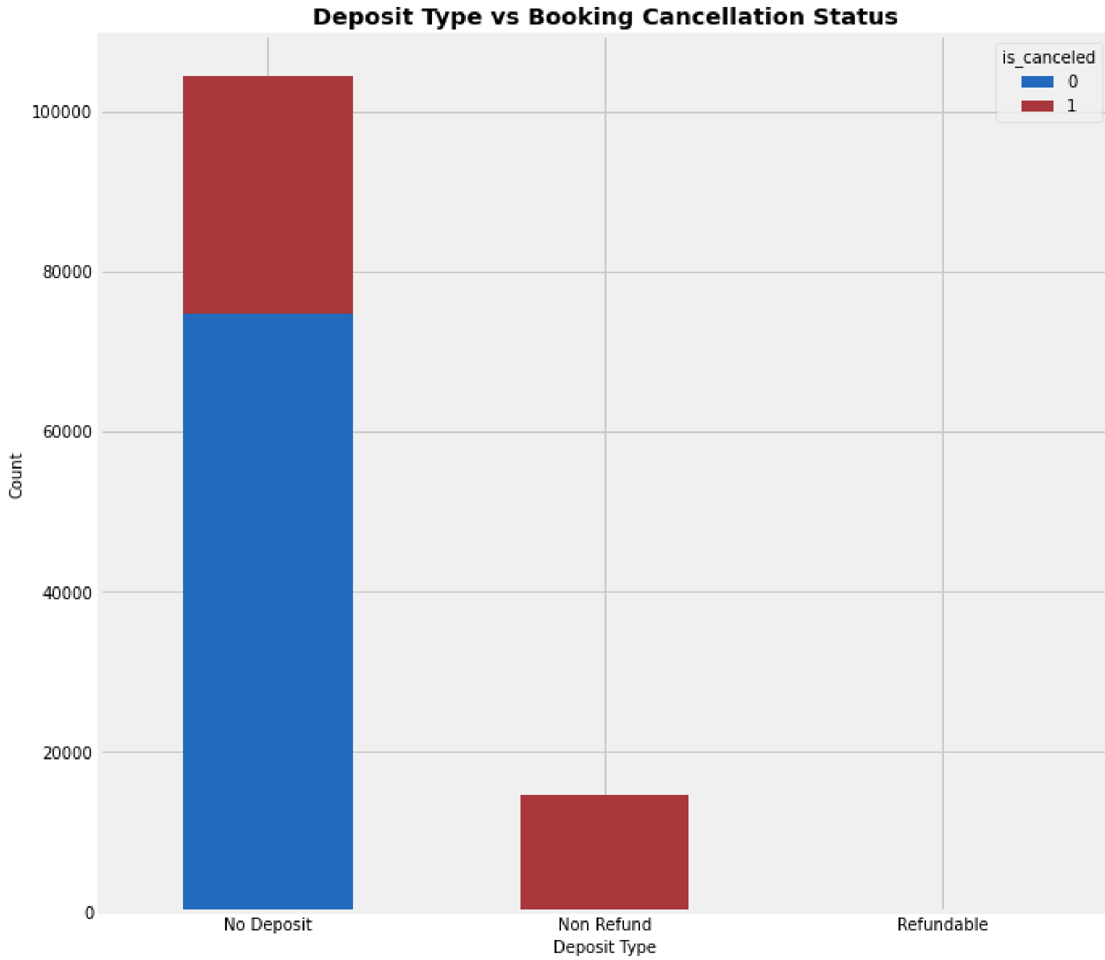
[115]:
```
#Number of special requests :
hotel.
 ↪pivot_table(values='arrival_date_year',index='total_of_special_requests',aggfunc='sum').
 ↪plot.bar()
```

[115]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe7131746d0>



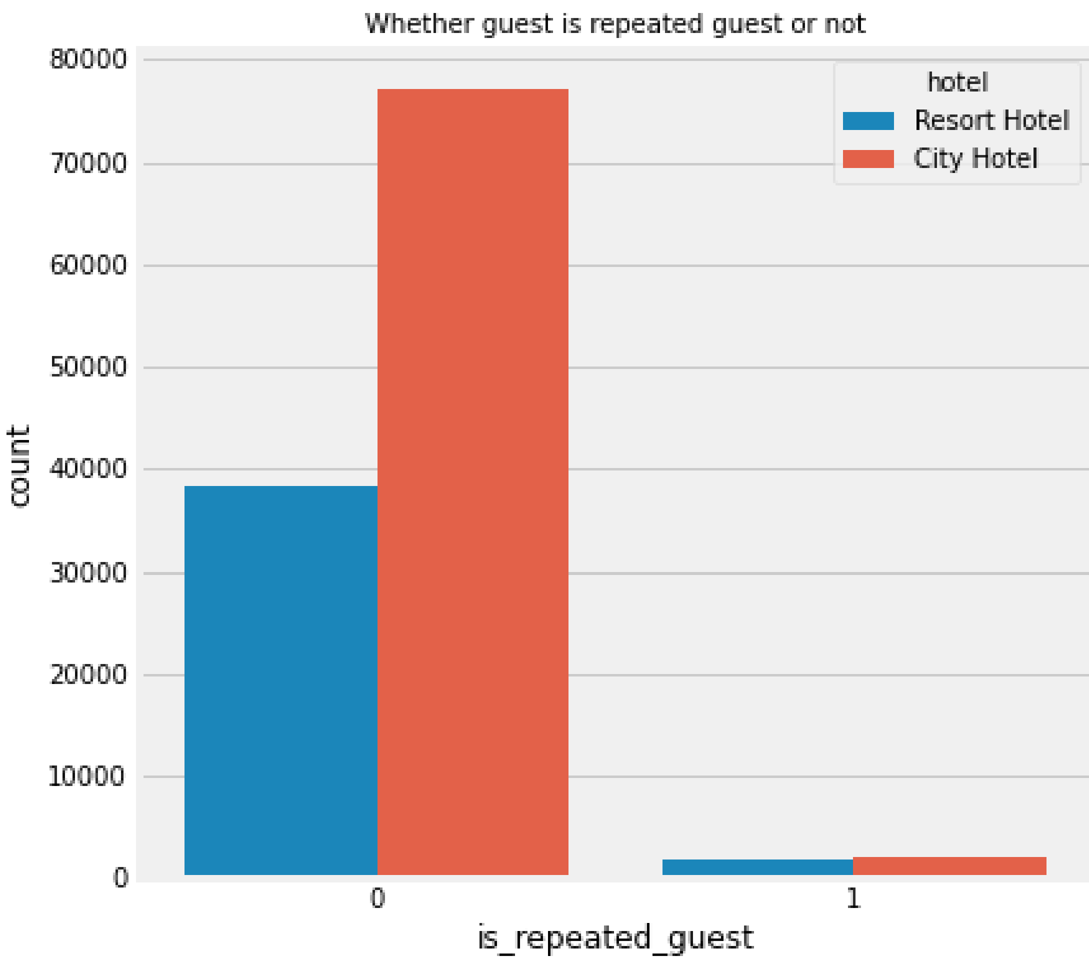
[116]:
```
group_deposit = hotel.groupby(['deposit_type', 'is_canceled']).size().
    ↪unstack(fill_value=0)
group_deposit.plot(kind='bar', stacked=True, cmap='vlag', figsize=(10,10))
plt.title('Deposit Type vs Booking Cancellation Status', weight='bold')
plt.xlabel('Deposit Type', fontsize=10)
plt.xticks(rotation=360)
plt.ylabel('Count', fontsize=10)
```

[116]:
```
Text(0, 0.5, 'Count')
```



For the variable 'is_canceled' 1(red) color stands for booking was canceled, we observe that lower bookings were canceled even when No Deposit was made for the booking

[117]:
```
plt.figure(figsize=(6,6))
sns.countplot(data = hotel, x = 'is_repeated_guest', hue = 'hotel').
 ↪set_title('Whether guest is repeated guest or not', fontsize = 10)
plt.show()
```



There weren't many repeated guests at both the hotels.

Correlation Matrix

Next, categorical varibales shall be converted to numerical form in order to utilize such variables in maching readable form. For this purpose, Label Encoding method will be implemented, it is an important pre-processing step for the structured dataset in supervised machine learning algorithms.

[118]:
```
from sklearn import preprocessing

label_encoder = preprocessing.LabelEncoder()

# Encode labels in all the categorical columns
hotel['hotel']= label_encoder.fit_transform(hotel['hotel'])
hotel['arrival_date_month']= label_encoder.
 ↪fit_transform(hotel['arrival_date_month'])
hotel['meal']= label_encoder.fit_transform(hotel['meal'])
hotel['country']= label_encoder.fit_transform(hotel['country'])
```

```
hotel['market_segment']= label_encoder.fit_transform(hotel['market_segment'])
hotel['distribution_channel']= label_encoder.
 ↪fit_transform(hotel['distribution_channel'])
hotel['is_repeated_guest']= label_encoder.
 ↪fit_transform(hotel['is_repeated_guest'])
hotel['reserved_room_type']= label_encoder.
 ↪fit_transform(hotel['reserved_room_type'])
hotel['assigned_room_type']= label_encoder.fit_transform(hotel['deposit_type'])
hotel['deposit_type']= label_encoder.fit_transform(hotel['is_repeated_guest'])
hotel['agent']= label_encoder.fit_transform(hotel['agent'])
hotel['customer_type']= label_encoder.fit_transform(hotel['customer_type'])
hotel['reservation_status']= label_encoder.
 ↪fit_transform(hotel['reservation_status'])
```

[119]:
```
hotel = hotel.
 ↪drop(['stays_in_week_nights','stays_in_weekend_nights','reservation_status_date','adr'],axi
 ↪= 1)
hotel.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 29 columns):
 #   Column                          Non-Null Count   Dtype
---  ------                          --------------   -----
 0   hotel                           119210 non-null  int64
 1   is_canceled                     119210 non-null  int64
 2   lead_time                       119210 non-null  int64
 3   arrival_date_year               119210 non-null  int64
 4   arrival_date_month              119210 non-null  int64
 5   arrival_date_week_number        119210 non-null  int64
 6   arrival_date_day_of_month       119210 non-null  int64
 7   adults                          119210 non-null  int64
 8   children                        119210 non-null  int64
 9   babies                          119210 non-null  int64
 10  meal                            119210 non-null  int64
 11  country                         119210 non-null  int64
 12  market_segment                  119210 non-null  int64
 13  distribution_channel            119210 non-null  int64
 14  is_repeated_guest               119210 non-null  int64
 15  previous_cancellations          119210 non-null  int64
 16  previous_bookings_not_canceled  119210 non-null  int64
 17  reserved_room_type              119210 non-null  int64
 18  assigned_room_type              119210 non-null  int64
 19  booking_changes                 119210 non-null  int64
 20  deposit_type                    119210 non-null  int64
 21  agent                           119210 non-null  int64
 22  days_in_waiting_list            119210 non-null  int64
```

```
 23   customer_type                   119210 non-null  int64
 24   required_car_parking_spaces     119210 non-null  int64
 25   total_of_special_requests       119210 non-null  int64
 26   reservation_status              119210 non-null  int64
 27   total_adr                       119210 non-null  float64
 28   total_stay                      119210 non-null  int64
dtypes: float64(1), int64(28)
memory usage: 32.3 MB
```

[120]:

```
#Creating new dataframe for categorical data
hotel_categorical_data =␣
↪hotel[['hotel','is_canceled','arrival_date_month','meal',
                                                     ␣
↪'country','market_segment','distribution_channel',
                                    'is_repeated_guest', 'reserved_room_type',
                                                     ␣
↪'assigned_room_type','deposit_type','agent',
                                    'customer_type','reservation_status']]
hotel_categorical_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 14 columns):
 #   Column                Non-Null Count   Dtype
---  ------                --------------   -----
 0   hotel                 119210 non-null  int64
 1   is_canceled           119210 non-null  int64
 2   arrival_date_month    119210 non-null  int64
 3   meal                  119210 non-null  int64
 4   country               119210 non-null  int64
 5   market_segment        119210 non-null  int64
 6   distribution_channel  119210 non-null  int64
 7   is_repeated_guest     119210 non-null  int64
 8   reserved_room_type    119210 non-null  int64
 9   assigned_room_type    119210 non-null  int64
 10  deposit_type          119210 non-null  int64
 11  agent                 119210 non-null  int64
 12  customer_type         119210 non-null  int64
 13  reservation_status    119210 non-null  int64
dtypes: int64(14)
memory usage: 18.6 MB
```

[121]:

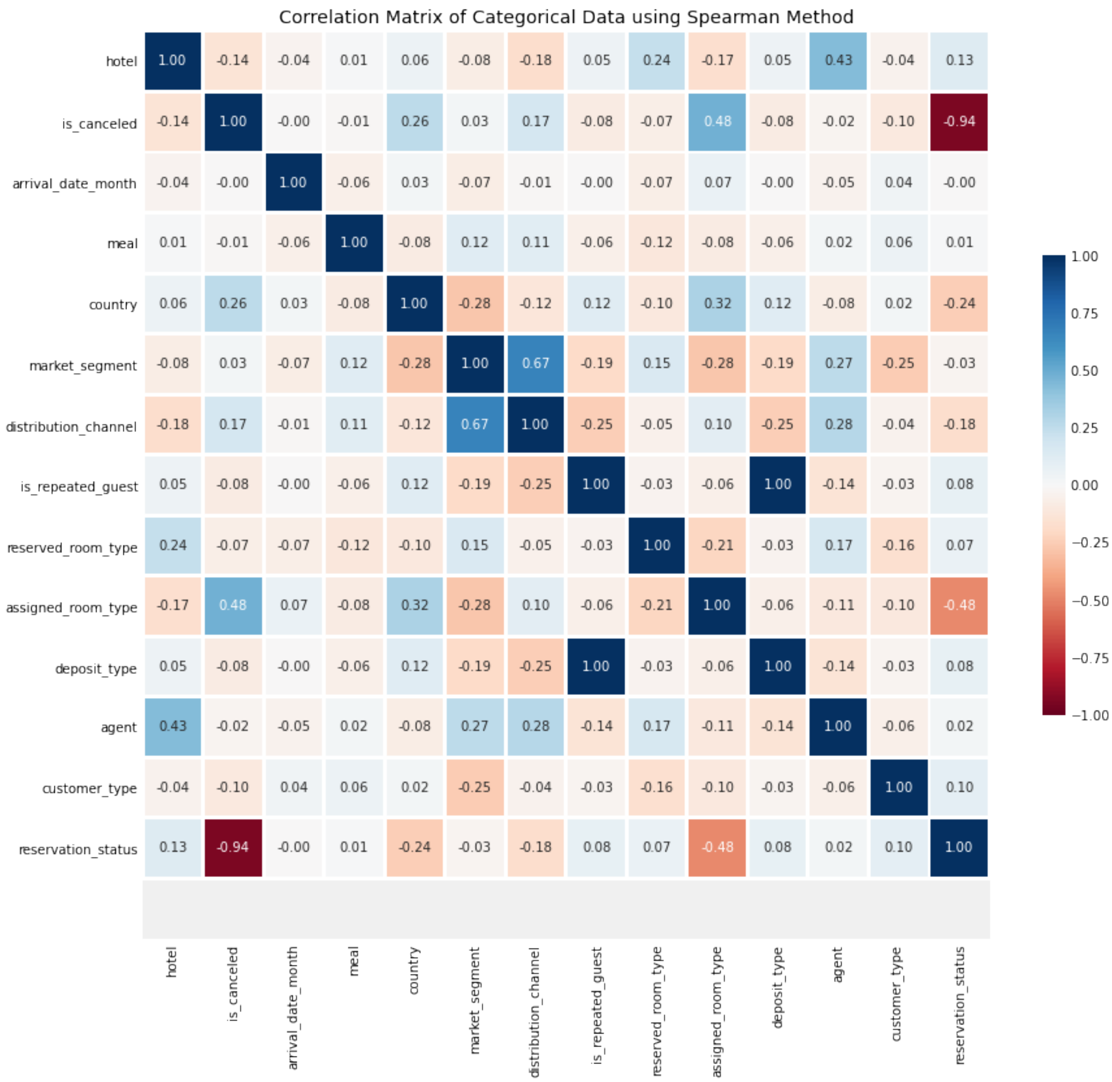
```
#Creating new dataframe for numerical data
hotel_numerical_data= hotel.drop(['hotel','is_canceled',␣
↪'arrival_date_month','meal',
                                                       ␣
↪'country','market_segment','distribution_channel',
```

```
                                         'is_repeated_guest',␣
↪'reserved_room_type',
                                        ␣
↪'assigned_room_type','deposit_type','agent',
                                         'customer_type','reservation_status'],␣
↪axis = 1)
hotel_numerical_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 15 columns):
 #   Column                          Non-Null Count   Dtype
---  ------                          --------------   -----
 0   lead_time                       119210 non-null  int64
 1   arrival_date_year               119210 non-null  int64
 2   arrival_date_week_number        119210 non-null  int64
 3   arrival_date_day_of_month       119210 non-null  int64
 4   adults                          119210 non-null  int64
 5   children                        119210 non-null  int64
 6   babies                          119210 non-null  int64
 7   previous_cancellations          119210 non-null  int64
 8   previous_bookings_not_canceled  119210 non-null  int64
 9   booking_changes                 119210 non-null  int64
 10  days_in_waiting_list            119210 non-null  int64
 11  required_car_parking_spaces     119210 non-null  int64
 12  total_of_special_requests       119210 non-null  int64
 13  total_adr                       119210 non-null  float64
 14  total_stay                      119210 non-null  int64
dtypes: float64(1), int64(14)
memory usage: 19.6 MB
```

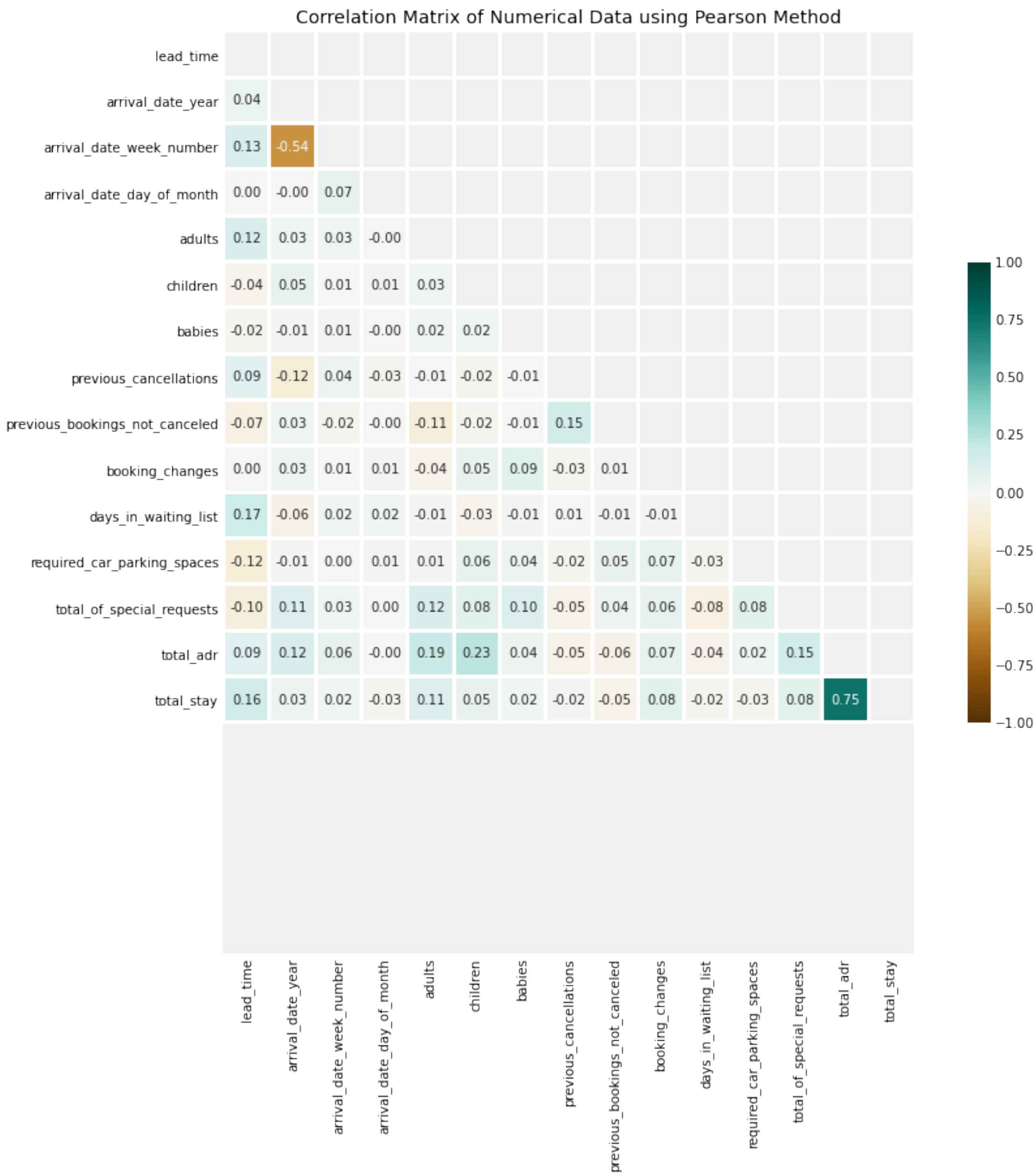
[122]:
```
# Correlation Matrix of Categorical Data with Spearman method
plt.figure(figsize=(13,13))
corr_categorical=hotel_categorical_data.corr(method='spearman')
mask_categorical = np.triu(np.ones_like(corr_categorical, dtype=np.bool))
sns.heatmap(corr_categorical, annot=True, fmt=".2f", cmap='RdBu', vmin=-1,␣
↪vmax=1, center= 0,
            square=True, linewidths=2, cbar_kws={"shrink": .5}).set(ylim=(15,␣
↪0))
plt.title("Correlation Matrix of Categorical Data using Spearman␣
↪Method",size=14)
```

[122]: Text(0.5, 1.0, 'Correlation Matrix of Categorical Data using Spearman Method')



[123]:
```python
# Correlation Matrix of Numerical Data with Spearman method
plt.figure(figsize=(13,13))
corr_numerical=hotel_numerical_data.corr(method='pearson')
mask_numerical = np.triu(np.ones_like(corr_numerical, dtype=np.bool))
sns.heatmap(corr_numerical, annot=True, fmt=".2f", cmap='BrBG', mask=␣
↪mask_numerical, vmin=-1, vmax=1, center= 0,
            square=True, linewidths=2, cbar_kws={"shrink": .5}).set(ylim=(20,␣
↪0))
plt.title("Correlation Matrix of Numerical Data using Pearson Method",size=14)
```

[123]: Text(0.5, 1.0, 'Correlation Matrix of Numerical Data using Pearson Method')



[124]:
```
corr_mask_categorical = corr_categorical.mask(mask_categorical)
corr_values_categorical = [c for c in corr_mask_categorical.columns if any␣
↪(corr_mask_categorical[c] > 0.90)]
corr_mask_numerical = corr_numerical.mask(mask_numerical)
corr_values_numerical = [c for c in corr_mask_numerical.columns if any␣
↪(corr_mask_numerical[c] > 0.90)]
print(corr_values_categorical, corr_values_numerical)
```

```
['is_repeated_guest'] []
```

Looking at the first heatmap for categorical variables 'reservation_ status' feature has very high negative correlation with 'is_canceled', so in order avoid over fitting 'reservation_ status' feature shall be dropped.

As per the results from the correlation matrix, we shall drop 'is_repeated_guest' and 'arrival_date_week_number'

[125]:
```
frames = [hotel_numerical_data,hotel_categorical_data]
```

[126]:
```
Hotel = pd.concat(frames, axis = 1)
```

[127]:
```
Hotel_data = hotel.drop(['reservation_status','arrival_date_week_number'],␣
↪axis=1)
```

[128]:
```
Hotel_data.shape
```

[128]:
```
(119210, 27)
```

[129]:
```
Hotel_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 27 columns):
 #   Column                          Non-Null Count   Dtype
---  ------                          --------------   -----
 0   hotel                           119210 non-null  int64
 1   is_canceled                     119210 non-null  int64
 2   lead_time                       119210 non-null  int64
 3   arrival_date_year               119210 non-null  int64
 4   arrival_date_month              119210 non-null  int64
 5   arrival_date_day_of_month       119210 non-null  int64
 6   adults                          119210 non-null  int64
 7   children                        119210 non-null  int64
 8   babies                          119210 non-null  int64
 9   meal                            119210 non-null  int64
 10  country                         119210 non-null  int64
 11  market_segment                  119210 non-null  int64
 12  distribution_channel            119210 non-null  int64
 13  is_repeated_guest               119210 non-null  int64
 14  previous_cancellations          119210 non-null  int64
 15  previous_bookings_not_canceled  119210 non-null  int64
 16  reserved_room_type              119210 non-null  int64
 17  assigned_room_type              119210 non-null  int64
 18  booking_changes                 119210 non-null  int64
 19  deposit_type                    119210 non-null  int64
 20  agent                           119210 non-null  int64
 21  days_in_waiting_list            119210 non-null  int64
 22  customer_type                   119210 non-null  int64
```

```
 23   required_car_parking_spaces     119210 non-null  int64
 24   total_of_special_requests       119210 non-null  int64
 25   total_adr                       119210 non-null  float64
 26   total_stay                      119210 non-null  int64
dtypes: float64(1), int64(26)
memory usage: 30.5 MB
```

Hyperparameter Tuning and Feature Importance

[130]:
```
Hotel_data_tunning = Hotel_data
y = Hotel_data_tunning.iloc[:,1]
X = pd.concat([Hotel_data_tunning.iloc[:,0],Hotel_data_tunning.iloc[:,2:26]],
 ↪axis=1)
```

[131]:
```
from sklearn.inspection import permutation_importance
```

[132]:
```
# Permutation Importance graph with XGB Classifier algorithm.
params = {
    'criterion': 'giny',
    'learning_rate': 0.01,
    'max_depth': 5,
    'n_estimators': 100,
    'objective': 'binary:logistic',
}
model = XGBClassifier(parameters=params)
# fit the model
model.fit(X, y)
# perform permutation importance
result = permutation_importance(model, X, y, scoring='accuracy', n_repeats = 5,
 ↪n_jobs=-1)
sorted_idx = result.importances_mean.argsort()
```

```
[14:51:36] WARNING: ../src/learner.cc:573:
Parameters: { "parameters" } might not be used.

  This may not be accurate due to some parameters are only used in language
bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through
this
  verification. Please open an issue if you find above cases.


[14:51:36] WARNING: ../src/learner.cc:1095: Starting in XGBoost 1.3.0, the
default evaluation metric used with the objective 'binary:logistic' was changed
from 'error' to 'logloss'. Explicitly set eval_metric if you'd like to restore
the old behavior.
```

[133]:
```
# Permutation Importance graph with XGB Classifier algorithm.

params = {
    'criterion': 'giny',
    'learning_rate': 0.01,
    'max_depth': 5,
    'n_estimators': 100,
    'objective': 'binary:logistic',
}
model = XGBClassifier(parameters=params)
# fit the model
model.fit(X, y)
# perform permutation importance
result = permutation_importance(model, X, y, scoring='accuracy', n_repeats = 5,
 ↪n_jobs=-1)
sorted_idx = result.importances_mean.argsort()
```

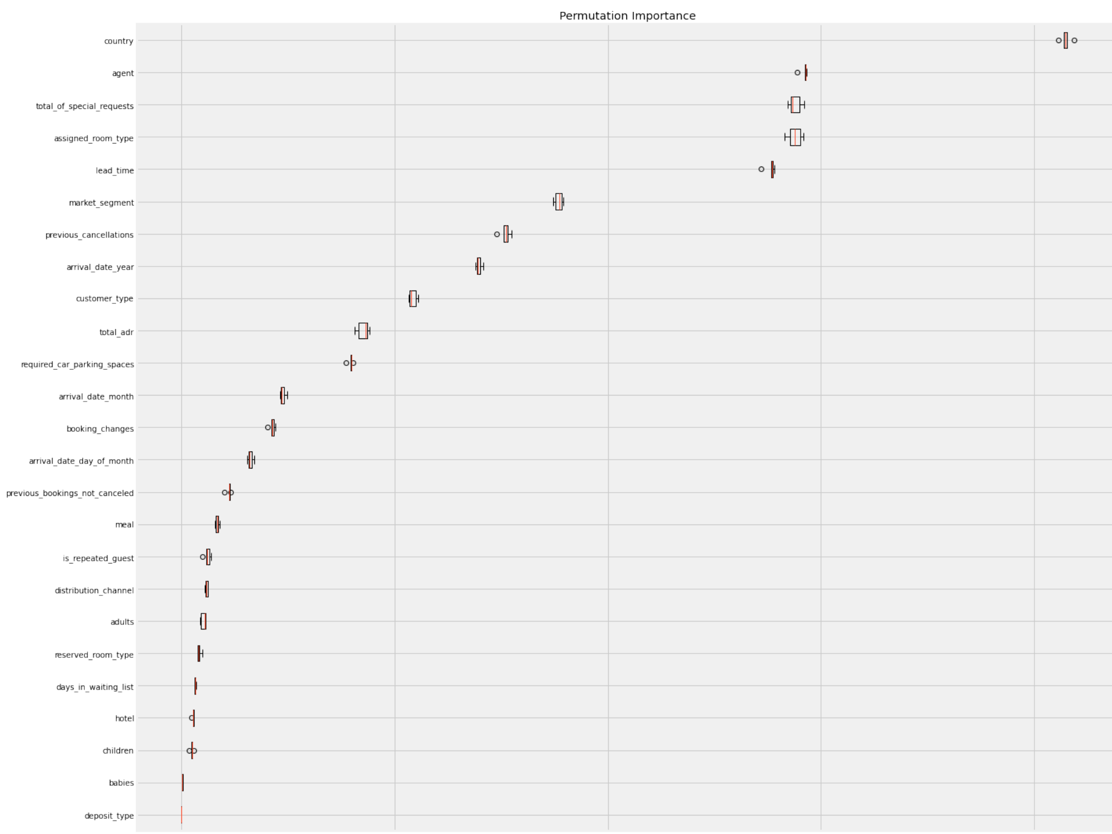
```
[14:52:14] WARNING: ../src/learner.cc:573:
Parameters: { "parameters" } might not be used.

  This may not be accurate due to some parameters are only used in language
bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through
this
  verification. Please open an issue if you find above cases.


[14:52:14] WARNING: ../src/learner.cc:1095: Starting in XGBoost 1.3.0, the
default evaluation metric used with the objective 'binary:logistic' was changed
from 'error' to 'logloss'. Explicitly set eval_metric if you'd like to restore
the old behavior.
```

[134]:
```
# Feature scores table
for i,v in enumerate(sorted_idx):
    print('Feature: %0d, Score: %.5f' % (i,v))
```

```
Feature: 0, Score: 18.00000
Feature: 1, Score: 7.00000
Feature: 2, Score: 6.00000
Feature: 3, Score: 0.00000
Feature: 4, Score: 20.00000
Feature: 5, Score: 15.00000
Feature: 6, Score: 5.00000
Feature: 7, Score: 11.00000
Feature: 8, Score: 12.00000
Feature: 9, Score: 8.00000
Feature: 10, Score: 14.00000
```

```
Feature: 11, Score: 4.00000
Feature: 12, Score: 17.00000
Feature: 13, Score: 3.00000
Feature: 14, Score: 22.00000
Feature: 15, Score: 24.00000
Feature: 16, Score: 21.00000
Feature: 17, Score: 2.00000
Feature: 18, Score: 13.00000
Feature: 19, Score: 10.00000
Feature: 20, Score: 1.00000
Feature: 21, Score: 16.00000
Feature: 22, Score: 23.00000
Feature: 23, Score: 19.00000
Feature: 24, Score: 9.00000
```

[135]:
```python
#Permutation Importance graph
fig, ax = plt.subplots(figsize=(20,15))
ax.boxplot(result.importances[sorted_idx].T,
           vert=False, labels=X.columns[sorted_idx])
ax.set_title("Permutation Importance")
fig.tight_layout()
plt.show()
```



[136]:
```
hotel_model = Hotel_data_tunning.drop(['babies', 'deposit_type'], axis = 1)
```

[137]:
```
hotel_model.head()
```

[137]:
```
   hotel  is_canceled  lead_time  arrival_date_year  arrival_date_month  \
0      1            0        342               2015                   5
1      1            0        737               2015                   5
2      1            0          7               2015                   5
3      1            0         13               2015                   5
4      1            0         14               2015                   5

   arrival_date_day_of_month  adults  children  meal  country  market_segment  \
0                          1       2         0     0      135               3
1                          1       2         0     0      135               3
2                          1       1         0     0       59               3
3                          1       1         0     0       59               2
4                          1       2         0     0       59               6

   distribution_channel  is_repeated_guest  previous_cancellations  \
0                     1                  0                       0
1                     1                  0                       0
2                     1                  0                       0
3                     0                  0                       0
4                     3                  0                       0

   previous_bookings_not_canceled  reserved_room_type  assigned_room_type  \
0                               0                   2                   0
1                               0                   2                   0
2                               0                   0                   0
3                               0                   0                   0
4                               0                   0                   0

   booking_changes  agent  days_in_waiting_list  customer_type  \
0                3      0                     0              2
1                4      0                     0              2
2                0      0                     0              2
3                0    221                     0              2
4                0    174                     0              2

   required_car_parking_spaces  total_of_special_requests  total_adr  \
0                            0                          0        0.0
1                            0                          0        0.0
2                            0                          0       75.0
3                            0                          0       75.0
4                            0                          1      196.0
```

```
   total_stay
0           0
1           0
2           1
3           1
4           2
```

[138]:
```
hotel_model.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 119210 entries, 0 to 119389
Data columns (total 25 columns):
 #   Column                          Non-Null Count   Dtype
---  ------                          --------------   -----
 0   hotel                           119210 non-null  int64
 1   is_canceled                     119210 non-null  int64
 2   lead_time                       119210 non-null  int64
 3   arrival_date_year               119210 non-null  int64
 4   arrival_date_month              119210 non-null  int64
 5   arrival_date_day_of_month       119210 non-null  int64
 6   adults                          119210 non-null  int64
 7   children                        119210 non-null  int64
 8   meal                            119210 non-null  int64
 9   country                         119210 non-null  int64
 10  market_segment                  119210 non-null  int64
 11  distribution_channel            119210 non-null  int64
 12  is_repeated_guest               119210 non-null  int64
 13  previous_cancellations          119210 non-null  int64
 14  previous_bookings_not_canceled  119210 non-null  int64
 15  reserved_room_type              119210 non-null  int64
 16  assigned_room_type              119210 non-null  int64
 17  booking_changes                 119210 non-null  int64
 18  agent                           119210 non-null  int64
 19  days_in_waiting_list            119210 non-null  int64
 20  customer_type                   119210 non-null  int64
 21  required_car_parking_spaces     119210 non-null  int64
 22  total_of_special_requests       119210 non-null  int64
 23  total_adr                       119210 non-null  float64
 24  total_stay                      119210 non-null  int64
dtypes: float64(1), int64(24)
memory usage: 28.6 MB
```