'''Karthikeyan Chellamuthu '''

Assignment Week10- Hospitality Managemet for Term project Milestone-3

''' Karthikeyan Chellamuthu - Date :05-22-2022'''

In [ ]:
```
'''Karthikeyan Chellamuthu '''

# Assignment Week6- Hospitality Managemet for Term project Milestone-1 &  Milestone-

''' Karthikeyan Chellamuthu - Date :04-24-2022'''
```

'''I will be using the data set that was originally created to understand the demand of Hotel Bookings and reservations and also try to predict the result of a booking. This dataset was downloaded originally downloaded from Kaggle. I will review this dataset and use it as part of my analysis for this case study. This data set contains booking information for a city hotel and a resort hotel, and includes information such as when the booking was made, length of stay, the number of adults, children, and/or babies, and the number of available parking spaces, among other things. Kaggle link: https://www.kaggle.com/jessemostipak/hotel-booking-demand'''

In [59]:
```
# import the required libraries
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.model_selection import train_test_split
from sklearn.feature_selection import VarianceThreshold
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import f_classif

# import the Milestone#10 additional required libraries

from sklearn.dummy import DummyClassifier
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.metrics import auc, make_scorer
from sklearn.model_selection import train_test_split
from sklearn.feature_selection import VarianceThreshold
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import f_classif
from sklearn.dummy import DummyClassifier
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.metrics import auc, make_scorer
from sklearn.model_selection import KFold, cross_val_score
from sklearn.metrics import log_loss, average_precision_score, make_scorer
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import SGDClassifier
from sklearn.linear_model import LogisticRegression
import scikitplot as skplt
from sklearn.metrics import confusion_matrix,precision_recall_curve,auc,roc_auc_scor
from sklearn.metrics import classification_report
```

```
from sklearn.model_selection import train_test_split, StratifiedShuffleSplit, valida
from sklearn.pipeline import Pipeline
```

In [2]:
```
# Create a new a dataframe from the csv file
df_data = pd.read_csv('hotel_bookings.csv')
```

In [3]:
```
# verify the dimension of the table
print("The dimension of the table is: ", df_data.shape)
```

```
The dimension of the table is:  (119390, 32)
```

In [4]:
```
# display the data
print(df_data.head(5).T)
```

```
                                  0             1             2  \
hotel                    Resort Hotel  Resort Hotel  Resort Hotel
is_canceled                         0             0             0
lead_time                         342           737             7
arrival_date_year                2015          2015          2015
arrival_date_month               July          July          July
arrival_date_week_number           27            27            27
arrival_date_day_of_month           1             1             1
stays_in_weekend_nights             0             0             0
stays_in_week_nights                0             0             1
adults                              2             2             1
children                          0.0           0.0           0.0
babies                              0             0             0
meal                               BB            BB            BB
country                           PRT           PRT           GBR
market_segment                 Direct        Direct        Direct
distribution_channel           Direct        Direct        Direct
is_repeated_guest                   0             0             0
previous_cancellations              0             0             0
previous_bookings_not_canceled      0             0             0
reserved_room_type                  C             C             A
assigned_room_type                  C             C             C
booking_changes                     3             4             0
deposit_type                No Deposit    No Deposit    No Deposit
agent                              NaN           NaN           NaN
company                            NaN           NaN           NaN
days_in_waiting_list                0             0             0
customer_type               Transient     Transient     Transient
adr                               0.0           0.0          75.0
required_car_parking_spaces         0             0             0
total_of_special_requests           0             0             0
reservation_status          Check-Out     Check-Out     Check-Out
reservation_status_date     2015-07-01    2015-07-01    2015-07-02

                                  3             4
hotel                    Resort Hotel  Resort Hotel
is_canceled                         0             0
lead_time                          13            14
arrival_date_year                2015          2015
arrival_date_month               July          July
arrival_date_week_number           27            27
arrival_date_day_of_month           1             1
stays_in_weekend_nights             0             0
stays_in_week_nights                1             2
adults                              1             2
children                          0.0           0.0
```

```
babies                                0            0
meal                                 BB           BB
country                             GBR          GBR
market_segment                Corporate    Online TA
distribution_channel          Corporate        TA/TO
is_repeated_guest                     0            0
previous_cancellations                0            0
previous_bookings_not_canceled        0            0
reserved_room_type                    A            A
assigned_room_type                    A            A
booking_changes                       0            0
deposit_type                 No Deposit   No Deposit
agent                             304.0        240.0
company                             NaN          NaN
days_in_waiting_list                  0            0
customer_type                 Transient    Transient
adr                                75.0         98.0
required_car_parking_spaces           0            0
total_of_special_requests             0            1
reservation_status            Check-Out    Check-Out
reservation_status_date      2015-07-02   2015-07-03
```

In [5]:

```
# What is the type of variablesgiven in the table
print("Describe Data")
print(df_data.describe())
```

```
Describe Data
         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
```

In [6]:

```
print("Summarized Data")
print(df_data.describe(include=['O']))
```

```
Summarized Data
            hotel arrival_date_month    meal country market_segment  \
count       119390             119390  119390  118902         119390
unique           2                 12       5     177              8
top     City Hotel             August      BB     PRT      Online TA
freq         79330              13877   92310   48590          56477

       distribution_channel reserved_room_type assigned_room_type  \
count                119390             119390              119390
unique                    5                 10                  12
top                   TA/TO                  A                   A
freq                  97870              85994               74053

       deposit_type customer_type reservation_status reservation_status_date
count        119390        119390             119390                  119390
unique            3             4                  3                     926
top      No Deposit     Transient          Check-Out              2015-10-21
freq         104641         89613              75166                    1461
```

Data Dictionary:\ *Hotel*: Hotel (H1 = Resort Hotel or H2 = City Hotel)\ *is_canceled*: Value indicating if the booking was canceled (1) or not (0)\ *lead_time*: Number of days that elapsed between the entering date of the booking into the PMS and the arrival date\ *arrival_date_year*: Year of arrival date\ *arrival_date_month*: Month of arrival date\ *arrival_date_week_number*: Week number of year for arrival date\ *arrival_date_day_of_month*: Day of arrival date\ *stays_in_weekend_nights*: Number of weekend nights (Saturday or Sunday) the guest stayed or

booked to stay at the hotel\ *stays_in_week_nights*: Number of week nights (Monday to Friday) the guest stayed or booked to stay at the hotel\ *adults*: Number of adults\ *children*: Number of children\ *babies*: Number of babies\ *meal*: Type of meal booked. Categories are presented in standard hospitality meal packages: Undefined/SC – no meal package; BB – Bed & Breakfast; HB – Half board (breakfast and one other meal – usually dinner); FB – Full board (breakfast, lunch and dinner)\ *country*: Country of origin. Categories are represented in the ISO 3155–3:2013 format\ *market_segment*: Market segment designation. In categories, the term "TA" means "Travel Agents" and "TO" means "Tour Operators"\ *distribution_channel*: Booking distribution channel. The term "TA" means "Travel Agents" and "TO" means "Tour Operators"\ *is_repeated_guest*: Value indicating if the booking name was from a repeated guest (1) or not (0)\ *previous_cancellations*: Number of previous bookings that were cancelled by the customer prior to the current booking\ *previous_bookings_not_canceled*: Number of previous bookings not cancelled by the customer prior to the current booking\ *reserved_room_type*: Code of room type reserved. Code is presented instead of designation for anonymity reasons.\ *assigned_room_type*: Code for the type of room assigned to the booking. Sometimes the assigned room type differs from the reserved room type due to hotel operation reasons (e.g. overbooking) or by customer request. Code is presented instead of designation for anonymity reasons.\ *booking_changes*: Number of changes/amendments made to the booking from the moment the booking was entered on the PMS until the moment of check-in or cancellation\ *deposit_type*: Indication on if the customer made a deposit to guarantee the booking. This variable can assume three categories: No Deposit – no deposit was made; Non Refund – a deposit was made in the value of the total stay cost; Refundable – a deposit was made with a value under the total cost of stay.\ *agent*: ID of the travel agency that made the booking\ *company*: ID of the company/entity that made the booking or responsible for paying the booking. ID is presented instead of designation for anonymity reasons\ *days_in_waiting_list*: Number of days the booking was in the waiting list before it was confirmed to the customer\ *customer_type*: Type of booking, assuming one of four categories: Contract - when the booking has an allotment or other type of contract associated to it; Group – when the booking is associated to a group; Transient – when the booking is not part of a group or contract, and is not associated to other transient booking; Transient-party – when the booking is transient, but is associated to at least other transient booking\ *adr*: Average Daily Rate as defined by dividing the sum of all lodging transactions by the total number of staying nights\ *required_car_parking_spaces*: Number of car parking spaces required by the customer\ *total_of_special_requests*: Number of special requests made by the customer (e.g. twin bed or high floor)\ *reservation_status*: Reservation last status, assuming one of three categories: Canceled – booking was canceled by the customer; Check-Out – customer has checked in but already departed; No-Show – customer did not check-in and did inform the hotel of the reason why\ *reservation_status_date*: Date at which the last status was set. This variable can be used in conjunction with the ReservationStatus to understand when was the booking canceled or when did the customer checked-out of the hotel\

In [7]:
```
# Verify if there are any missing values
df_data.isnull().sum()
```

Out[7]:
```
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
dtype: int64
```

In [8]:

```
# From above result set, we can see Children, Country, Agent and Company having miss
# For Children we will default the missing values to 0
# For country we will default the missing value to Unknown
# agent: If no agency is given, booking was most likely made without one.
# company: If none given, it was most likely private.
nan_replace = {"children:": 0.0,"country": "Unknown", "agent": 0, "company": 0}
hotel_data = df_data.fillna(nan_replace)

# "meal" contains values "Undefined", which is equal to SC.
hotel_data["meal"].replace("Undefined", "SC", inplace=True)

# Some rows contain entries with 0 adults, 0 children and 0 babies. These are invali
no_guests = list(hotel_data.loc[hotel_data["adults"]
                  + hotel_data["children"]
                  + hotel_data["babies"]==0].index)
hotel_data.drop(hotel_data.index[no_guests], inplace=True)
```

In [9]:

```
# Update the data in is_canceled column, by changing value of 1 to canceled and 0 to
hotel_data['is_canceled'].replace({1: 'canceled', 0: 'not canceled'}, inplace = True
```

In [10]:

```
# We will now create different dataframes for Resort and City hotel for future analy
# To know the actual visitor numbers, only bookings that were not canceled are inclu
resort_hotel = hotel_data.loc[(hotel_data["hotel"] == "Resort Hotel") & (hotel_data[
city_hotel = hotel_data.loc[(hotel_data["hotel"] == "City Hotel") & (hotel_data["is_
```

Graph Analysis for term project -Milestone1

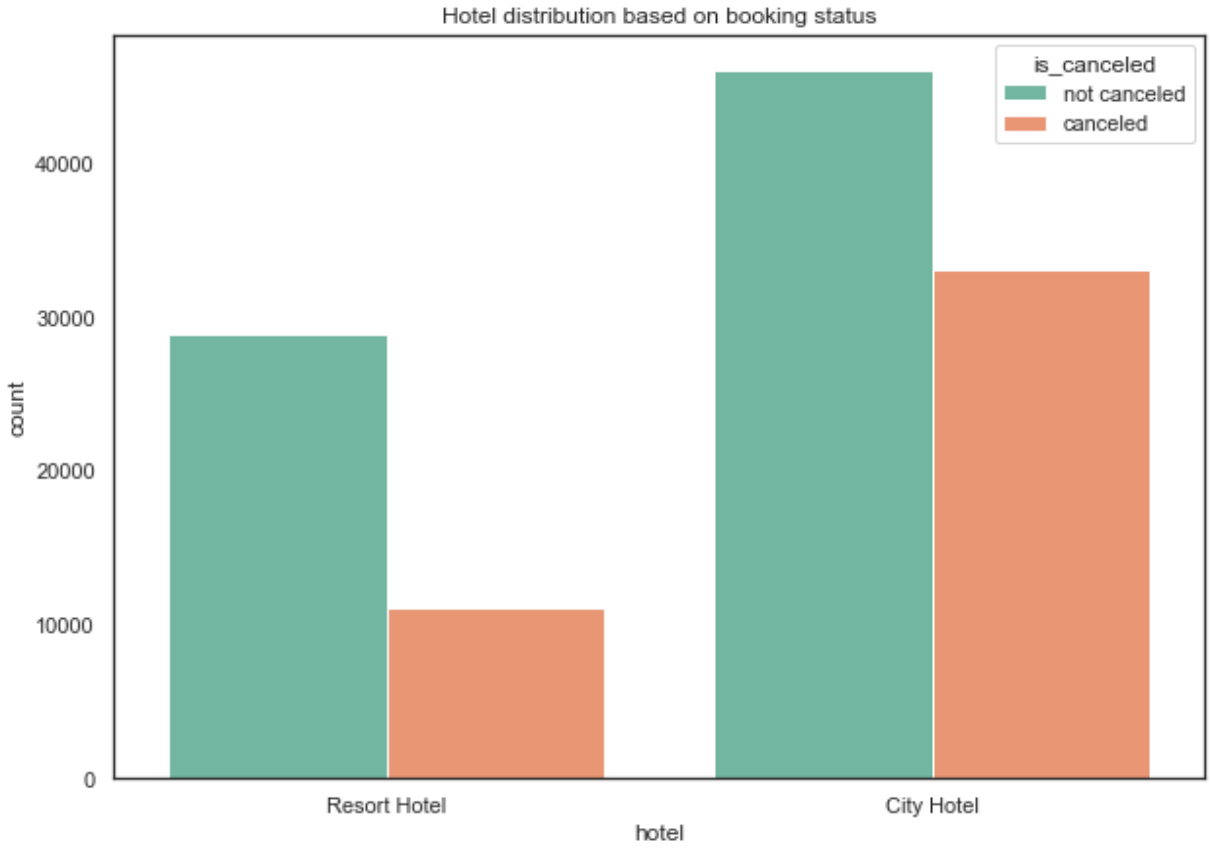
In [11]:

```
# Bar chart - Hotel distribution based on booking status
plt.rcParams['figure.figsize'] = [10, 7]
sns.set(style = 'white')
```

```
dist = sns.countplot(hotel_data['hotel'], hue = 'is_canceled', data = hotel_data, pa
dist.set(title = "Hotel distribution based on booking status")
```

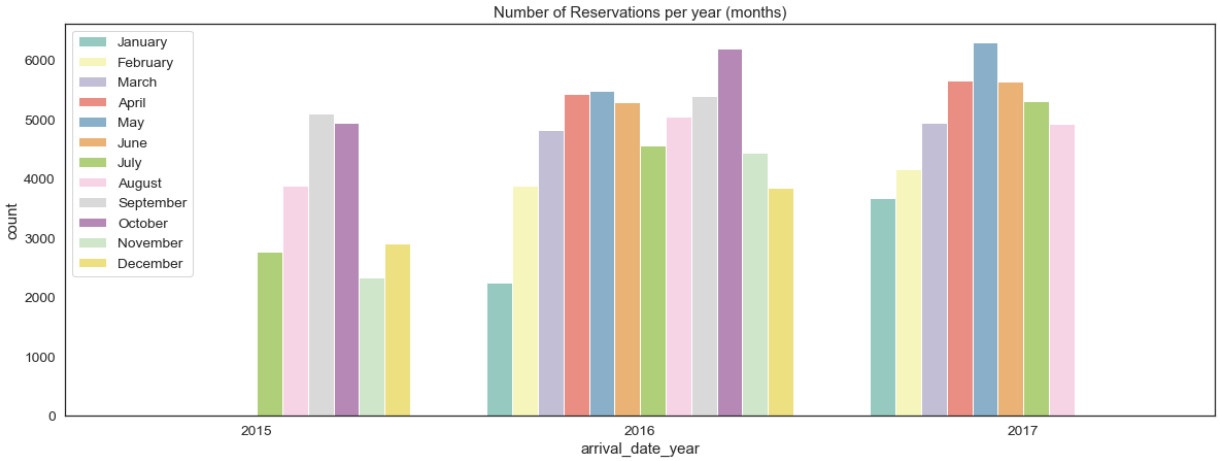
```
C:\Users\LENOVO\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarnin
g: Pass the following variable as a keyword arg: x. From version 0.12, the only vali
d positional argument will be `data`, and passing other arguments without an explici
t keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[11]:
```
[Text(0.5, 1.0, 'Hotel distribution based on booking status')]
```



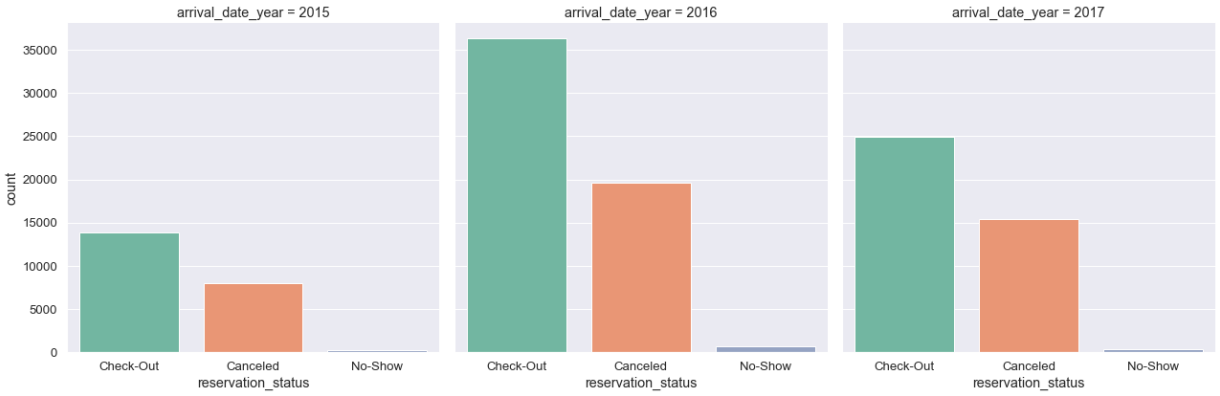
In [12]:
```
# parameters
plt.rcParams['figure.figsize'] = [20, 7]
sns.set(style = 'white', font_scale = 1.25)

# plot
arrival = sns.countplot(hotel_data['arrival_date_year'], hue = 'arrival_date_month',
            hue_order = ['January', 'February', 'March', 'April', 'May', 'June',
                         'July', 'August', 'September', 'October', 'November', 'Dec
arrival.set(title = "Number of Reservations per year (months)")
plt.legend(loc='upper left');
```

```
C:\Users\LENOVO\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarnin
g: Pass the following variable as a keyword arg: x. From version 0.12, the only vali
d positional argument will be `data`, and passing other arguments without an explici
t keyword will result in an error or misinterpretation.
  warnings.warn(
```



In [13]:

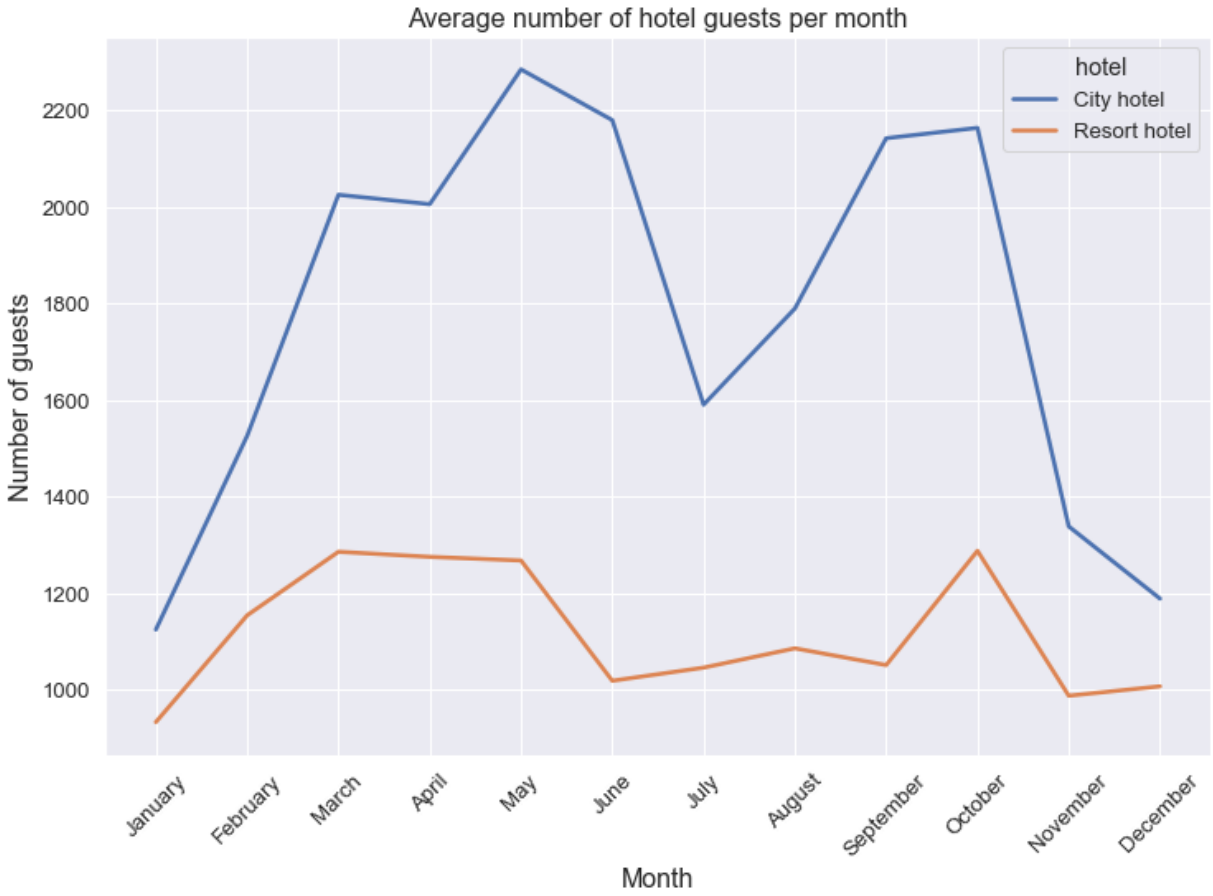
```
# Including Parameters
plt.rcParams['figure.figsize'] = [15, 7]
sns.set(style = 'darkgrid', font_scale = 1.2)

# Another count of catplot (countplot)
cat = sns.catplot(x = 'reservation_status', col = 'arrival_date_year', kind = 'count
            height = 6, palette = 'Set2');
```



In [14]:

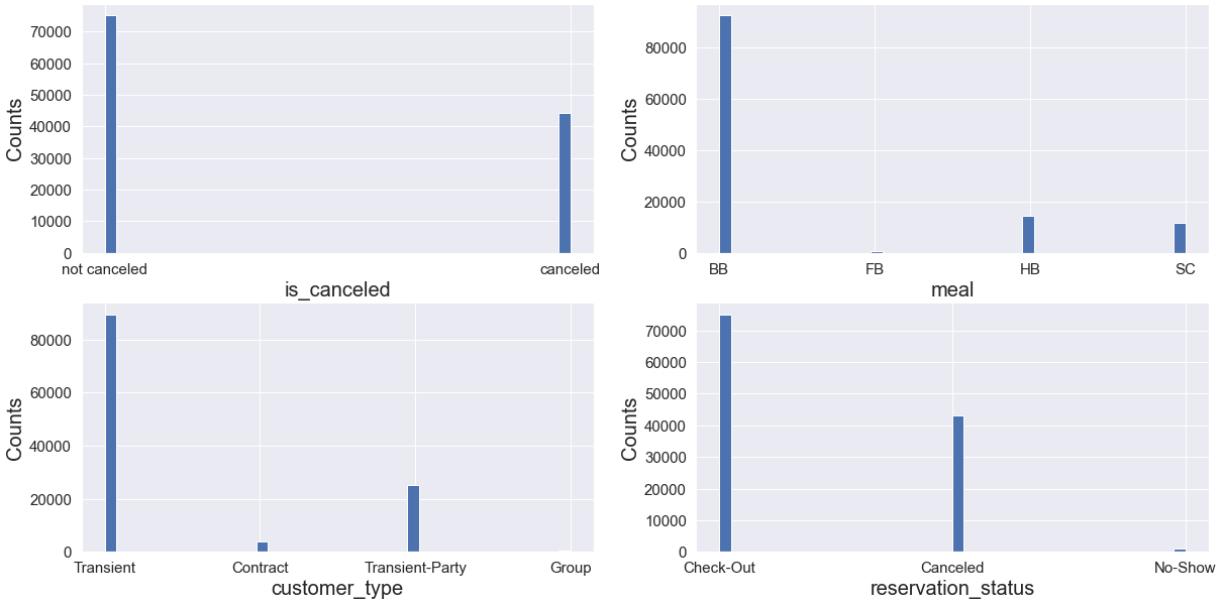
```
# We are finding the Average number of guests each month

# Create a DateFrame with the relevant data:
resort_monthly_guests = resort_hotel.groupby("arrival_date_month")["hotel"].count()
city_monthly_guests = city_hotel.groupby("arrival_date_month")["hotel"].count()

resort_guest_data = pd.DataFrame({"month": list(resort_monthly_guests.index),
                    "hotel": "Resort hotel",
                    "guests": list(resort_monthly_guests.values)})

city_guest_data = pd.DataFrame({"month": list(city_monthly_guests.index),
                    "hotel": "City hotel",
                    "guests": list(city_monthly_guests.values)})
all_guest_data = pd.concat([resort_guest_data,city_guest_data], ignore_index=True)

# order by month:
ordered_months = ["January", "February", "March", "April", "May", "June",
          "July", "August", "September", "October", "November", "December"]
all_guest_data["month"] = pd.Categorical(all_guest_data["month"], categories=ordered

# Dataset contains July and August date from 3 years, the other month from 2 years.
all_guest_data.loc[(all_guest_data["month"] == "July") | (all_guest_data["month"] ==
                    "guests"] /= 3
all_guest_data.loc[~((all_guest_data["month"] == "July") | (all_guest_data["month"]
                    "guests"] /= 2
```

```
# Line Chart to show the Average number of hotel guests per month:
plt.figure(figsize=(12, 8))
sns.lineplot(x = "month", y="guests", hue="hotel", data=all_guest_data,
             hue_order = ["City hotel", "Resort hotel"], size="hotel", sizes=(2.5, 2
plt.title("Average number of hotel guests per month", fontsize=16)
plt.xlabel("Month", fontsize=16)
plt.xticks(rotation=45)
plt.ylabel("Number of guests", fontsize=16)
plt.show()
```



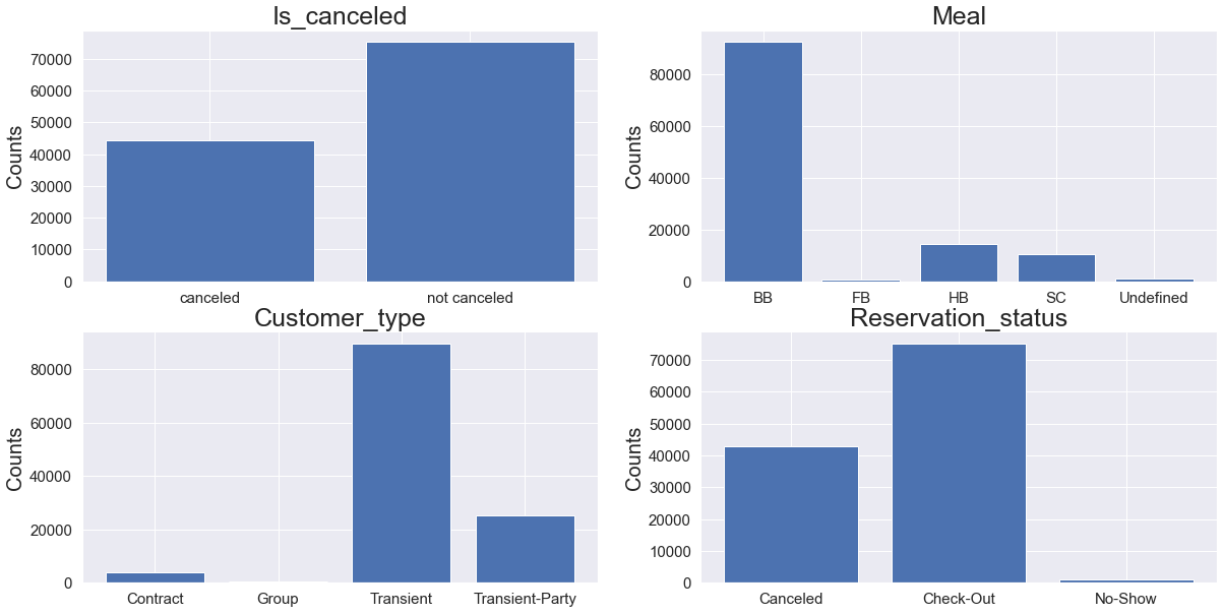
In [17]:

```
# set up the graph figure size
plt.rcParams['figure.figsize'] = (20, 10)
# make additional subplots
fig, axes = plt.subplots(nrows = 2, ncols = 2)
# Specify the area of interest
num_features = ['is_canceled', 'meal', 'customer_type', 'reservation_status']
xaxes = num_features
yaxes = ['Counts', 'Counts', 'Counts', 'Counts']
# create the histograms
axes = axes.ravel()
for idx, ax in enumerate(axes):
    ax.hist(hotel_data[num_features[idx]].dropna(), bins=40)
    ax.set_xlabel(xaxes[idx], fontsize=20)
    ax.set_ylabel(yaxes[idx], fontsize=20)
    ax.tick_params(axis='both', labelsize=15)
```



In [20]:

```
#  set up the figure size
#Barcharts:
plt.rcParams['figure.figsize'] = (20, 10)
# make subplots
fig, axes = plt.subplots(nrows = 2, ncols = 2)

# make the data read to feed into the visulizer
X_is_canceled = df_data.replace({'is_canceled': {1: 'canceled', 0: 'not canceled'}})
Y_is_canceled = df_data.replace({'is_canceled': {1: 'canceled', 0: 'not canceled'}})
# make the bar plot
axes[0, 0].bar(X_is_canceled, Y_is_canceled)
axes[0, 0].set_title('Is_canceled', fontsize=25)
axes[0, 0].set_ylabel('Counts', fontsize=20)
axes[0, 0].tick_params(axis='both', labelsize=15)

# make the data read to feed into the visulizer
X_meal = df_data.replace({'meal': {1: 'BB', 2: 'FB', 3: 'HB', 4: 'SC'}}).groupby('me
Y_meal = df_data.replace({'meal': {1: 'BB', 2: 'FB', 3: 'HB', 4: 'SC'}}).groupby('me
# make the bar plot
axes[0, 1].bar(X_meal, Y_meal)
axes[0, 1].set_title('Meal', fontsize=25)
axes[0, 1].set_ylabel('Counts', fontsize=20)
axes[0, 1].tick_params(axis='both', labelsize=15)

# make the data read to feed into the visulizer
X_customer_type = df_data.replace({'customer_type': {1: 'Transient', 2: 'Contract',
Y_customer_type = df_data.replace({'customer_type': {1: 'Transient', 2: 'Contract',
# make the bar plot
axes[1, 0].bar(X_customer_type, Y_customer_type)
axes[1, 0].set_title('Customer_type', fontsize=25)
axes[1, 0].set_ylabel('Counts', fontsize=20)
axes[1, 0].tick_params(axis='both', labelsize=15)

# make the data read to feed into the visulizer
X_reservation_status = df_data.replace({'reservation_status': {1: 'Check-Out', 2: 'C
Y_reservation_status = df_data.replace({'reservation_status': {1: 'Check-Out', 2: 'C
# make the bar plot
axes[1, 1].bar(X_reservation_status, Y_reservation_status)
axes[1, 1].set_title('Reservation_status', fontsize=25)
axes[1, 1].set_ylabel('Counts', fontsize=20)
axes[1, 1].tick_params(axis='both', labelsize=15)
```



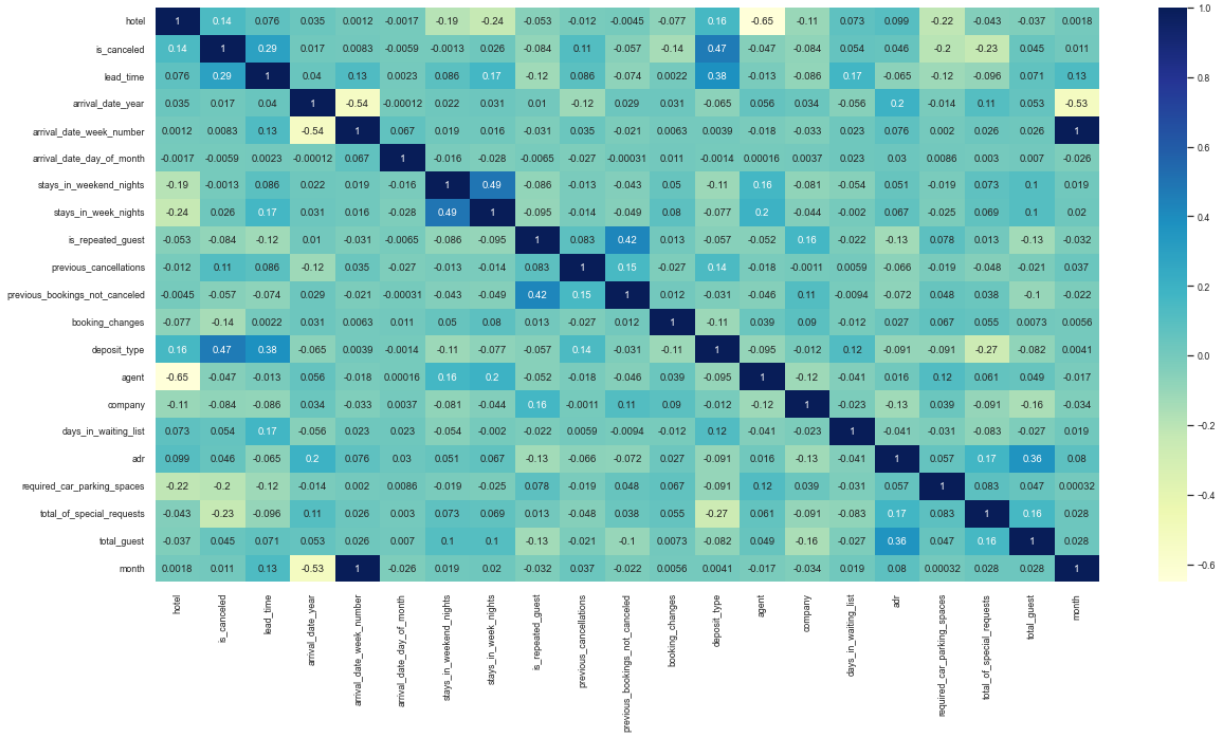
In [1]:
```
### Project Milestone-2
```

In [ ]:
```
'''Karthikeyan Chellamuthu '''

# Assignment Week8- Hospitality Managemet for Term project Milestone-2

''' Karthikeyan Chellamuthu - Date :05-08-2022'''
```

In [ ]:
```
'''
1. Drop any features that are not useful for your model building and explain why the
2. Perform any data extraction/selection steps.
3. Transform features if necessary.
4. Engineer new useful features.
5. Deal with missing data (do not just drop rows or columns without justifying this)
6. Create dummy variables if necessary.
'''
```

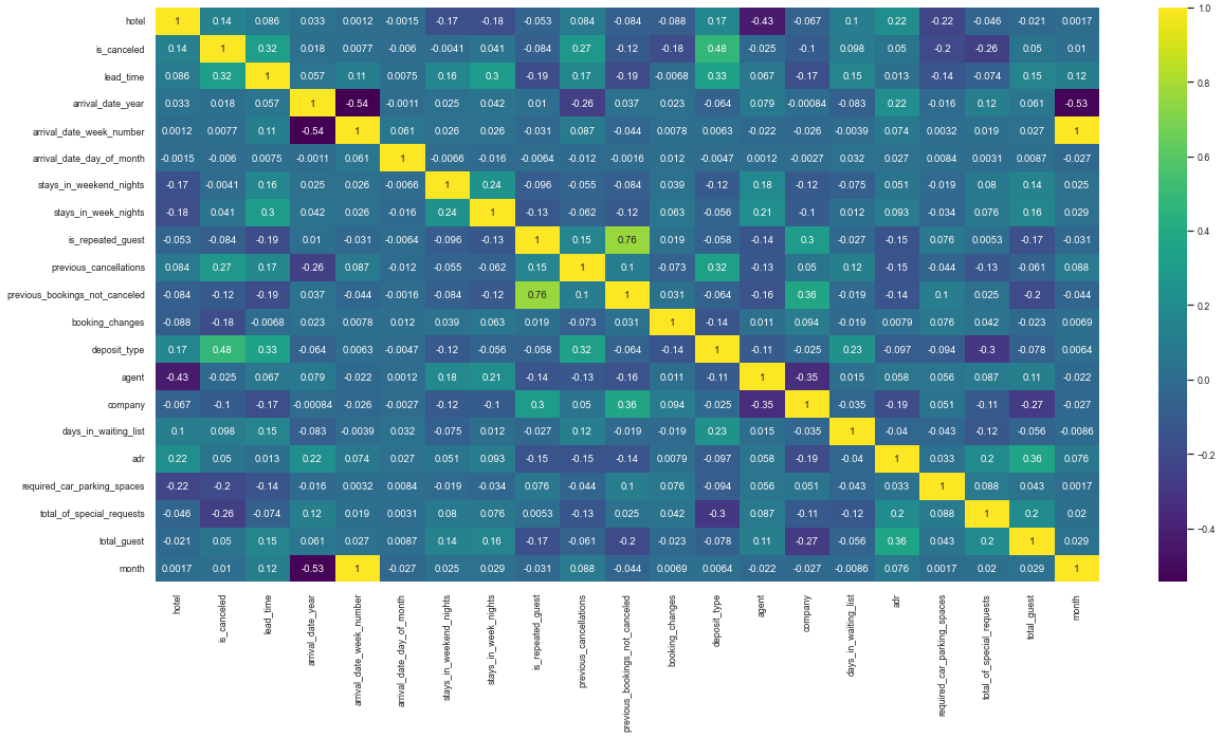
In [28]:
```
# Feature and Dimensionality Reduction

# Update the data in is_canceled column, by changing value of canceled back to 1 and
hotel_data['is_canceled'].replace({'canceled': 1, 'not canceled': 0}, inplace = True
```

In [32]:
```
# Pearson Heatmap with co-relations
plt.rcParams['figure.figsize'] == [18, 16]
sns.set(font_scale = 0.8)

sns.heatmap(hotel_data.corr(method = 'pearson'), annot = True, cmap = "YlGnBu");
```



In [33]:

```
# Spearman  Heatmap Correlaton
sns.heatmap(hotel_data.corr(method = 'spearman'), annot = True, cmap = "viridis");
```



In [36]:

```
df_data.head()
```

Out[36]:

	hotel	is_canceled	lead_time	arrival_date_year	arrival_date_month	arrival_date_week_number	a
0	Resort Hotel	0	342	2015	July	27	
1	Resort Hotel	0	737	2015	July	27	
2	Resort Hotel	0	7	2015	July	27	

	hotel	is_canceled	lead_time	arrival_date_year	arrival_date_month	arrival_date_week_number	a
3	Resort Hotel	0	13	2015	July	27	
4	Resort Hotel	0	14	2015	July	27	

5 rows × 32 columns

In [87]:
```
# Create a new a dataframe from the csv file
df_data = pd.read_csv('hotel_bookings1.csv')
#Create a dataframe form the original df to do the feature reductions.
hotel_data=df_data
```

```
C:\Users\LENOVO\anaconda3\lib\site-packages\IPython\core\interactiveshell.py:3444: D
typeWarning: Columns (0,4,12,13,14,15,19,20,22,26,30,31) have mixed types.Specify dt
ype option on import or set low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
```

In [103…
```
hotel_data.head()
```

Out[103…

	hotel	is_canceled	lead_time	arrival_date_year	arrival_date_month	arrival_date_week_number	ar
0	0.0	0.0	342.0	2015.0	July	27.0	
1	0.0	0.0	737.0	2015.0	July	27.0	
2	0.0	0.0	7.0	2015.0	July	27.0	
3	0.0	0.0	13.0	2015.0	July	27.0	
4	0.0	0.0	14.0	2015.0	July	27.0	

5 rows × 31 columns

In [88]:
```
#Replacing 0's with 1's in the adult column on the assumption that an adult must che
hotel_data['adults'].replace({0:1}, inplace=True)
```

In [89]:
```
# As part of Feature reduction steps, I decided to create a new column with Total Gu
hotel_data['total_guest'] = hotel_data['adults'] + hotel_data['children'] + hotel_da
hotel_data = hotel_data.drop(columns=['adults', 'children', 'babies'])
```

In [90]:
```
# Replacing NaN with a value of 1 since there should be a minimum of 1 guest
hotel_data['total_guest'].fillna(1, inplace = True)
```

In [91]:
```
# As part of Feature reduction steps, I decided to create a new column "arrival_date

#Create a month numeric column to be used to create a DateTime
d = {'January':1, 'February':2, 'March':3, 'April':4, 'May':5, 'June':6,\
     'July':7, 'August':8, 'September':9, 'October':10, 'November':11, 'December':12
hotel_data['month'] = hotel_data.arrival_date_month.map(d)
```

In [92]:
```
# Update the data in is_canceled column, by changing value of canceled back to 1 and
hotel_data['hotel'].replace({'City Hotel': 1, 'Resort Hotel': 0}, inplace = True)
```

In [93]:
```
# Update the data in deposit_type column, by changing value of No Deposit to 1, Non
hotel_data['deposit_type'].replace({'No Deposit': 1, 'Non Refund': 2, 'Refundable':
```

In [94]:
```
# drop all the non-numeric fields
hotel_data_predict = hotel_data.drop(columns=['meal', 'country' , 'market_segment',
```

In [95]:
```
# Train and test data
X=hotel_data_predict.drop(columns=["is_canceled"],axis="columns")
y=hotel_data_predict.is_canceled
```

In [96]:
```
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=.2,random_state=42)
```

In [97]:
```
X_train.shape
```

Out[97]:
```
(95512, 20)
```

In [98]:
```
X_train
```

Out[98]:

	hotel	lead_time	arrival_date_year	arrival_date_week_number	arrival_date_day_of_month	st
67702	1.0	64.0	2017.0	18.0	6.0	
115851	NaN	NaN	NaN	NaN	NaN	
57345	1.0	8.0	2016.0	39.0	24.0	
11622	0.0	251.0	2017.0	21.0	21.0	
33333	0.0	23.0	2017.0	7.0	18.0	
...	...	...	...	...	...	
76820	1.0	2.0	2016.0	28.0	8.0	
110268	NaN	NaN	NaN	NaN	NaN	
103694	NaN	NaN	NaN	NaN	NaN	
860	0.0	130.0	2015.0	31.0	1.0	
15795	0.0	16.0	2015.0	31.0	31.0	

95512 rows × 20 columns

In [105…
```
#  Engineer new useful features. Feature selection using Variance Threshold with thr
var = VarianceThreshold(threshold=.5)
var.fit(X_train,y_train)
X_train_var=var.transform(X_train)
X_test_var=var.transform(X_test)
```

In [106…
```
X_train_var.shape
```

Out[106…
```
(95512, 14)
```

In [107…
```
# Alternate way to perform feature selection and display the features
def variance_threshold_selector(data, threshold=0.5):
    selector = VarianceThreshold(threshold)
    selector.fit(data)
    return data[data.columns[selector.get_support(indices=True)]]
```

In [108…
```
variance_threshold_selector(X_train, 0.5)
```

Out[108…

	lead_time	arrival_date_week_number	arrival_date_day_of_month	stays_in_weekend_nights	st
67702	64.0	18.0	6.0	2.0	
115851	NaN	NaN	NaN	NaN	
57345	8.0	39.0	24.0	1.0	
11622	251.0	21.0	21.0	2.0	
33333	23.0	7.0	18.0	1.0	
...	...	...	...	...	
76820	2.0	28.0	8.0	0.0	
110268	NaN	NaN	NaN	NaN	
103694	NaN	NaN	NaN	NaN	
860	130.0	31.0	1.0	2.0	
15795	16.0	31.0	31.0	0.0	

95512 rows × 14 columns

In [109…
```
varth_features=var.get_support()
varth_features
```

Out[109…
```
array([False,  True, False,  True,  True,  True,  True, False,  True,
        True, False, False,  True,  True,  True,  True, False,  True,
        True,  True])
```

In [110…
```
from sklearn.feature_selection import SelectKBest
```

In [111…
```
# Feature selection using SelectKBest feature selection
skbest = SelectKBest(k=10)
```

In [112…
```
X_train
```

Out[112…

	hotel	lead_time	arrival_date_year	arrival_date_week_number	arrival_date_day_of_month	st
67702	1.0	64.0	2017.0	18.0	6.0	
115851	NaN	NaN	NaN	NaN	NaN	

	hotel	lead_time	arrival_date_year	arrival_date_week_number	arrival_date_day_of_month	st
57345	1.0	8.0	2016.0	39.0	24.0	
11622	0.0	251.0	2017.0	21.0	21.0	
33333	0.0	23.0	2017.0	7.0	18.0	
...	...	...	...	...	...	
76820	1.0	2.0	2016.0	28.0	8.0	
110268	NaN	NaN	NaN	NaN	NaN	
103694	NaN	NaN	NaN	NaN	NaN	
860	0.0	130.0	2015.0	31.0	1.0	
15795	0.0	16.0	2015.0	31.0	31.0	

95512 rows × 20 columns

In [113...]
```
y_train
```

Out[113...]
```
67702     1.0
115851    NaN
57345     1.0
11622     1.0
33333     0.0
         ...
76820     0.0
110268    NaN
103694    NaN
860       1.0
15795     0.0
Name: is_canceled, Length: 95512, dtype: float64
```

In [114...]
```
# Replacing NaN with a value of 1 since there should be a minimum of 1 guest
hotel_data['total_guest'].fillna(1, inplace = True)
```

In [ ]:
```
# Feature selection using SelectKBest feature selection
skbest = SelectKBest(k=10)
skbest.fit(X_train,y_train)
X_train_skbest=skbest.transform(X_train)
X_test_skbest=skbest.transform(X_test)
```

In [117...]
```
X_train_skbest.shape
```

Out[117...]
```
(95512, 14)
```

In [118...]
```
kbest_features=skbest.get_support()
kbest_features
```

Out[118...]
```
array([False,  True, False,  True,  True,  True,  True, False,  True,
        True, False, False,  True,  True,  True,  True, False,  True,
        True,  True])
```

In [130...]

```
# SelectKBest to determine 10 best features
best_features = SelectKBest(score_func=f_classif, k=10)
fit = best_features.fit(X_train,y_train)
df_scores = pd.DataFrame(fit.scores_)
df_columns = pd.DataFrame(X_train.columns)
# concatenate dataframes
feature_scores = pd.concat([df_columns, df_scores],axis=1)
feature_scores.columns = ['Feature_Name','Score']  # name output columns
print(feature_scores.nlargest(10,'Score'))         # print 10 best features
```

```
                     Feature_Name         Score
11                   deposit_type  26849.743593
1                       lead_time   8917.683060
17       total_of_special_requests   5593.493295
16     required_car_parking_spaces   3730.453374
10                  booking_changes   2034.273401
0                             hotel   1810.499652
8           previous_cancellations   1184.390357
7                is_repeated_guest    668.337403
13                         company    651.244405
9   previous_bookings_not_canceled    312.704213
```

In [2]:
```
### Project Milestone-3
```

In [ ]:
```
'''Karthikeyan Chellamuthu '''

# Assignment Week10- Hospitality Managemet for Term project Milestone-3

''' Karthikeyan Chellamuthu - Date :05-22-2022'''
```

Part 3 - Process of model evaluation and selection

In [40]:
```
# calculate precision recall area under curve
def preci_auc(y_true, pred_prob):
   # calculate precision-recall curve
    p, r, _ = precision_recall_curve(y_true, pred_prob)
    # calculate area under curve
    return auc(r, p)
```

In [41]:
```
# Evaluate a model
def evaluate_model(X, y, model):
    # Define evaluation procedure
    CV = RepeatedStratifiedKFold(n_splits=10, n_repeats=3, random_state=1)
    # Define the model evaluation the metric
    metric = make_scorer(preci_auc, needs_proba=True)
    # Evaluate model
    scores = cross_val_score(model, X, y, scoring='roc_auc', cv=CV, n_jobs=-1)
    return scores
```

In [42]:
```
# Define reference model
model = DummyClassifier(strategy='constant', constant=1)
```

In the Feature Selection part, Variance threshold had returned 14 features. I'll be using this training and test data for further process.

In [43]:
```
# define the reference model
```

```
model = DummyClassifier(strategy='constant', constant=1)
# Evaluate the model
scores = evaluate_model(X_train_var, y_train, model)
# summarize performance
print('Mean area under curve: %.3f (%.3f)' % (mean(scores), std(scores)))
```

```
Mean area under curve: 0.500 (0.000)
```

From above, the baseline score is 0.50. Hence the model selected should be atleast above this score.

Since the values are of PCA transformation, it is better to normalize the data as it could impact the performance of the model.

In [44]:

```
# Normalize the input
scaler = StandardScaler()
scaler.fit(X_train_var)
X_train_norm = scaler.transform(X_train_var)
X_test_norm = scaler.transform(X_test_var)
```

Model selection - One of the common models is Logistic regression. Few other models are compared to see the results. Cross validation method is used.

In [45]:

```
def model_val(X, y, classifier, scor, show):
  X = np.array(X)
  y = np.array(y)

  scores = cross_val_score(classifier, X, y, scoring=scor)

  if show == True:
    print("Score: {:.2f} (+/- {:.2f})".format(scores.mean(), scores.std()))

  return scores.mean()
```

In [46]:

```
# List of models
rfc = RandomForestClassifier()
ctc = DecisionTreeClassifier()
sglc = SGDClassifier()
lr = LogisticRegression()

model = []
score = []

# Check model score
for classifier in (rfc, ctc, sglc, lr):
    model.append(classifier.__class__.__name__)
    score.append(model_val(X_train_norm, y_train, classifier, scor='roc_auc', show=T

pd.DataFrame(data=score, index=model, columns=['roc_auc'])
```

```
Score: 0.91 (+/- 0.00)
Score: 0.79 (+/- 0.00)
Score: 0.75 (+/- 0.00)
Score: 0.76 (+/- 0.00)
```

Out[46]:

	roc_auc
RandomForestClassifier	0.913651
DecisionTreeClassifier	0.793755

	roc_auc
SGDClassifier	0.748714
LogisticRegression	0.759874

Random Forest Model Evaluation

In [47]:
```
# In my upcoming week, I would like to test and validate my features using the above

pipeline_rf = Pipeline([
    ('model', RandomForestClassifier(n_jobs=-1, random_state=1))
])
```

As the time taken to process the large dataset is more, just specified the number of estimators instead of hyperparameter grid search.

In [48]:
```
parm_gridscv_rf = {'model__n_estimators': [75]}
```

In [49]:
```
grid_rf = GridSearchCV(estimator=pipeline_rf, param_grid=parm_gridscv_rf, scoring='r
                       pre_dispatch='2*n_jobs', cv=5, verbose=1, return_train_score=
```

In [50]:
```
grid_rf.fit(X_train_norm, y_train)
```

```
Fitting 5 folds for each of 1 candidates, totalling 5 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 4 concurrent workers.
[Parallel(n_jobs=-1)]: Done   5 out of   5 | elapsed:   20.5s finished
```

Out[50]:
```
GridSearchCV(cv=5, error_score=nan,
             estimator=Pipeline(memory=None,
                                steps=[('model',
                                        RandomForestClassifier(bootstrap=True,
                                                               ccp_alpha=0.0,
                                                               class_weight=None,
                                                               criterion='gini',
                                                               max_depth=None,
                                                               max_features='auto',
                                                               max_leaf_nodes=None,
                                                               max_samples=None,
                                                               min_impurity_decrease
=0.0,
                                                               min_impurity_split=No
ne,
                                                               min_samples_leaf=1,
                                                               min_samples_split=2,
                                                               min_weight_fraction_l
eaf=0.0,
                                                               n_estimators=100,
                                                               n_jobs=-1,
                                                               oob_score=False,
                                                               random_state=1,
                                                               verbose=0,
                                                               warm_start=False))],
                                verbose=False),
             iid='deprecated', n_jobs=-1,
             param_grid={'model__n_estimators': [75]}, pre_dispatch='2*n_jobs',
             refit=True, return_train_score=False, scoring='roc_auc',
             verbose=1)
```

In [51]:
```
pd.DataFrame(grid_rf.cv_results_)
```

Out[51]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_model__n_estimators	
0	13.238883	4.67311	0.581922	0.189321	75	{'model

In [52]:
```
grid_rf.best_score_, grid_rf.best_params_
```

Out[52]:
```
(0.9129746915729022, {'model__n_estimators': 75})
```

Test Random Forest model

In [53]:
```
y_pred = grid_rf.predict(X_test_norm)
# Decimal places based on number of samples
dec = np.int64(np.ceil(np.log10(len(y_test))))

print('Confusion Matrix')
print(confusion_matrix(y_test, y_pred), '\n')

print('Classification report')
print(classification_report(y_test, y_pred, digits=dec))

print('Scalar Metrics')
format_str = '%%13s = %%.%if' % dec
if y_test.nunique() <= 2: # metrics for binary classification
    try:
        y_score = grid_rf.predict_proba(X_test_norm)[:,1]
    except:
        y_score = grid_rf.decision_function(X_test_norm)
    print(format_str % ('AUROC', roc_auc_score(y_test, y_score)))
```

```
Confusion Matrix
[[13946  1012]
 [ 2354  6530]] 

Classification report
              precision    recall  f1-score   support

           0    0.85558   0.93234   0.89232     14958
           1    0.86582   0.73503   0.79508      8884

    accuracy                        0.85882     23842
   macro avg    0.86070   0.83369   0.84370     23842
weighted avg    0.85940   0.85882   0.85608     23842

Scalar Metrics
        AUROC = 0.91734
```

Plot confusion matrix

skplt.metrics.plot_confusion_matrix(y_test, y_pred)

In [54]:
```
log_loss(y_test, y_pred)
```

Out[54]:
```
4.876198747498898
```

Logistic Regression Model Evaluation

In [55]:
```
# Logistic regression model with different C values
parameters = {
    'tol': [0.00001, 0.0001, 0.001],
    'C': [1, 50, 100]
}

lgr = GridSearchCV(LogisticRegression(random_state=101, n_jobs=1, max_iter=1000),
                   param_grid=parameters,
                   cv=3,
                   n_jobs=1,
                   scoring='roc_auc'
                  )
lgr.fit(X_train_norm, y_train)
clf = lgr.best_estimator_

print(lgr.best_estimator_)
print("The best classifier score:",lgr.best_score_)
```

```
LogisticRegression(C=50, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=1000,
                   multi_class='auto', n_jobs=1, penalty='l2', random_state=101,
                   solver='lbfgs', tol=1e-05, verbose=0, warm_start=False)
The best classifier score: 0.7597565062708697
```

Test Logistic Regression Model

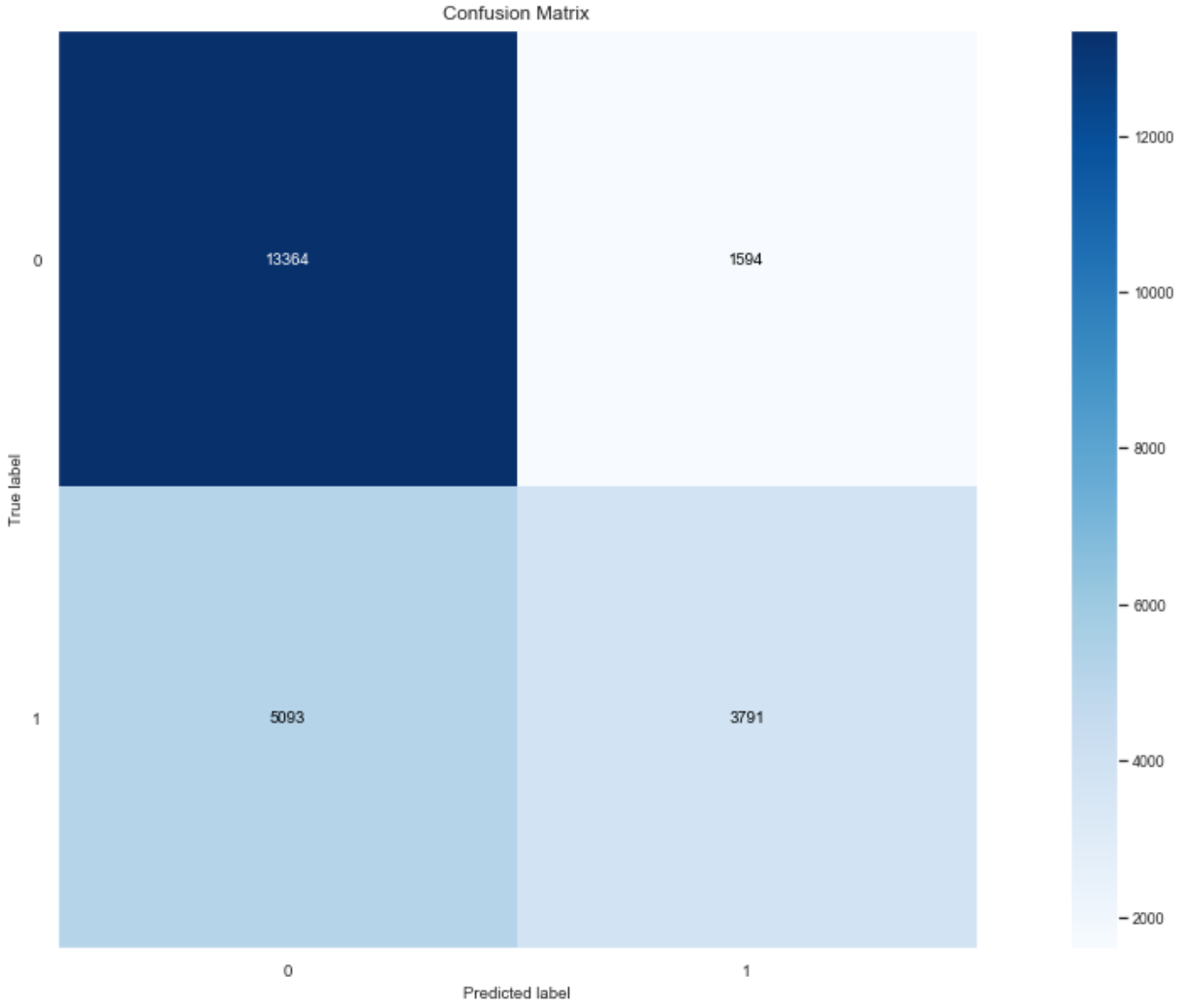
In [56]:
```
y_pred1 = clf.predict(X_test_norm)
# Decimal places based on number of samples
dec = np.int64(np.ceil(np.log10(len(y_test))))

print('Confusion Matrix')
print(confusion_matrix(y_test, y_pred1), '\n')

print('Classification report')
print(classification_report(y_test, y_pred1, digits=dec))

print('Scalar Metrics')
format_str = '%%13s = %%.%if' % dec
if y_test.nunique() <= 2: # metrics for binary classification
    try:
        y_score1 = clf.predict_proba(X_test_norm)[:,1]
    except:
        y_score1 = clf.decision_function(X_test_norm)
    print(format_str % ('AUROC', roc_auc_score(y_test, y_score1)))
```

```
Confusion Matrix
[[13364  1594]
 [ 5093  3791]] 

Classification report
              precision    recall  f1-score   support

           0    0.72406   0.89343   0.79988     14958
           1    0.70399   0.42672   0.53136      8884

    accuracy                        0.71953     23842
   macro avg    0.71403   0.66008   0.66562     23842
weighted avg    0.71658   0.71953   0.69982     23842
```

```
Scalar Metrics
        AUROC = 0.76038
```

In [57]:
```
# Plot confusion matrix
skplt.metrics.plot_confusion_matrix(y_test, y_pred1)
```

Out[57]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a2c186e90>
```



In [58]:
```
log_loss(y_test, y_pred1)
```

Out[58]:
```
9.687193704851584
```

In [ ]:
```

```