# 7COM1039-0109-2022

## Advanced Computer Science Masters Project

Prediction of hotel reservation cancellation of a customer with reservation details using Machine Learning

## Interim Progress Report (IPR)

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# Contents

## 1. Background Research

This project is titled “Prediction of hotel reservation cancellation of a customer with reservation details using machine learning”. The dataset for this project is available on Kaggle i.e. https://www.kaggle.com/datasets/ahsan81/hotel-reservations-classification-dataset.

The dataset consists of 36275 rows and 19 columns.

The aim of this project is to predict the customer who is going to cancel the hotel reservation based on the details given at the time of booking in the respective hotel. The data is readily available, but the task here is to understand the columns and their interpretation to figure out which columns are important for the analysis. Later, observe the patterns and relations between the columns to identify the reasons behind the cancellations of hotel reservations and develop a machine learning algorithm that can predict the customer who might cancel the reservation based on the customer details provided. And also, there is some interest in knowing the solution for the hypothesis “Is the customer cancelling hotel reservation due to the average price change of the same room type in between the lead time?”

Starting with understanding the columns with the description as given in [1], and then gaining information about the reasons behind the cancellations because hotels aim to make a profit by providing the services. If the customers cancelling the prebooked hotel rooms, it might affect the hotel’s reputation among the customers and will lead to a loss for the hotel [2]. According to the estimate given in [2], Since 2014, cancellation costs across all platforms have increased by 6%, reaching an estimated 40% in 2018 [2]. To reduce the economic loss for the hotels, making use of the latest technologies to automate the process to find the probability of the customer cancelling the reservation based on the information given. So that hotels can decide whether the reservation should be given to the customer or not.

After understanding the complete description behind the dataset, the missing value from the data has to be cleaned after that data visualization has to be plotted using the libraries discussed in section B of [2]. But learning how to plot the histograms and bar plots has been learned from the sources [3][4].

Before the visualization part, there is one challenge to dealing with categorical values in two columns "room_type_reserved" and "market_segment_type". These columns should be converted into number format for the computers to process the categorical data [5], it can be done by using a technique called one-hot encoding [5]. As discussed in [5], "One-hot Encoding is a type of vector representation in which all the elements in a vector are 0, except for one, which has 1 as its value, where 1 represents a boolean specifying a category of the element."

Later the splitting the data is done using train_test_split function from the sklearn library, but code for this block has been referred from [7] which clearly explains the procedure to implement. Standardization has been applied to all the columns in training data, testing data and unseen data.

One thing this project wants to make sure of is to play with the hyperparameters using cross-validation techniques to achieve the best parameters which give the best result. GridSearchCV [7] has been used to experiment with some selected parameters and fitted to machine learning algorithms selected as baseline models (Random Forest Classifier as first priority and Decision Tree Classifier as a second option).

## 2) Project Plan

# Prediction of hotel reservation cancellation of a customer with reservation details using Machine Learning

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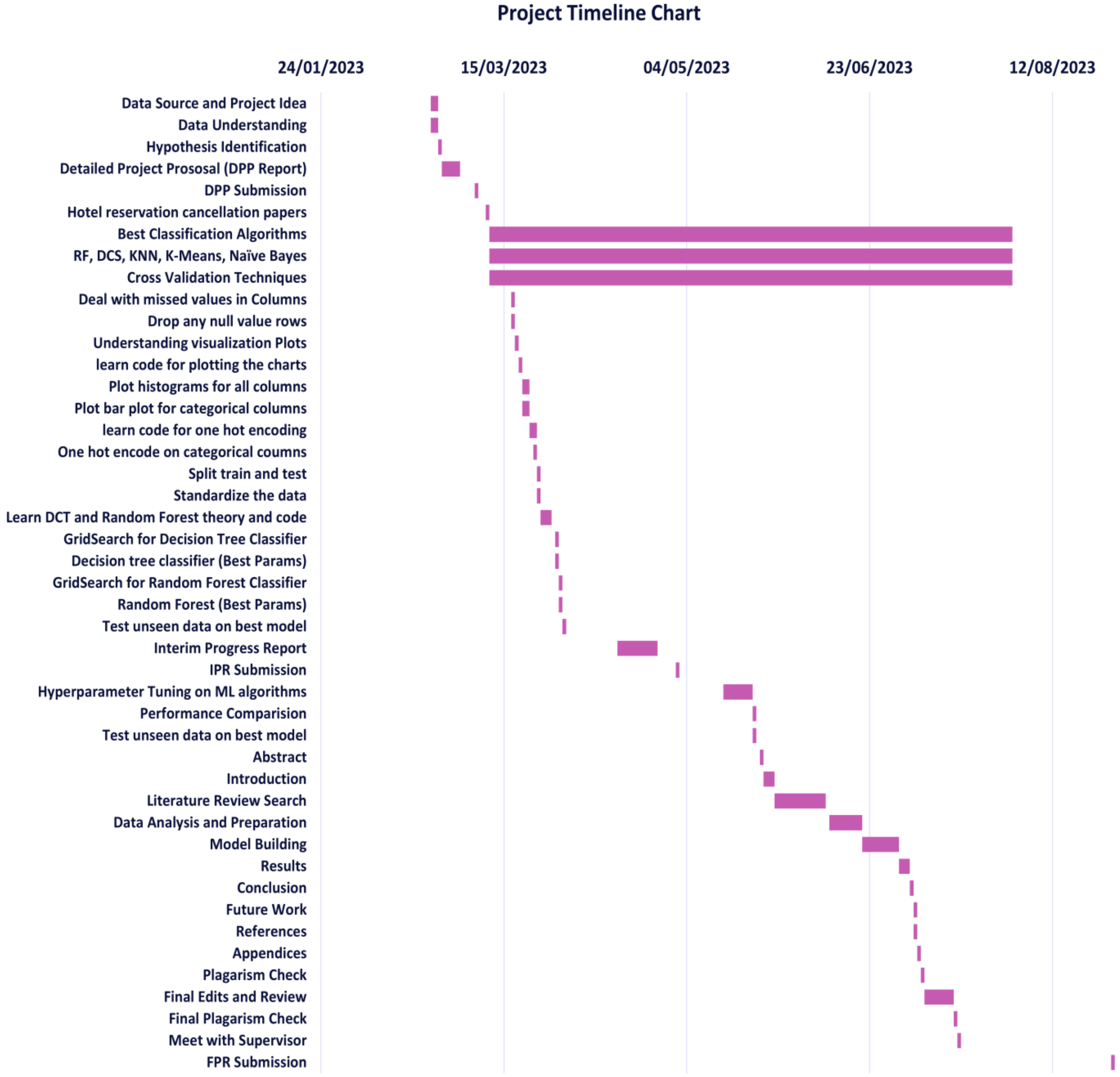
| | Milestone Description | Progress | Start | End | Days |
|---|---|---|---|---|---|
| Project Idea | Data Source and Project Idea | 100% | 23/02/2023 | 24/02/2023 | 2 |
| | Data Understanding | 100% | 23/02/2023 | 24/02/2023 | 2 |
| | Hypothesis Identification | 100% | 25/02/2023 | 25/02/2023 | 1 |
| | Detailed Project Proposal (DPP Report) | 100% | 26/02/2023 | 02/03/2023 | 5 |
| | DPP Submission | 100% | 07/03/2023 | 07/03/2023 | 1 |
| Literature Background | Hotel reservation cancellation papers | 100% | 10/03/2023 | 10/03/2023 | 1 |
| | Best Classification Algorithms | 70% | 11/03/2023 | 31/07/2023 | 143 |
| | RF, DCS, KNN, K-Means, Naïve Bayes | 80% | 11/03/2023 | 31/07/2023 | 143 |
| | Cross Validation Techniques | 80% | 11/03/2023 | 31/07/2023 | 143 |
| Data Cleaning | Deal with missed values in Columns | 100% | 17/03/2023 | 17/03/2023 | 1 |
| | Drop any null value rows | 100% | 17/03/2023 | 17/03/2023 | 1 |
| Data Preparation and Visualization | Understanding visualization Plots | 100% | 18/03/2023 | 18/03/2023 | 1 |
| | learn code for plotting the charts | 70% | 19/03/2023 | 19/03/2023 | 1 |
| | Plot histograms for all columns | 100% | 20/03/2023 | 21/03/2023 | 2 |
| | Plot bar plot for categorical columns | 90% | 20/03/2023 | 21/03/2023 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| | learn code for one hot encoding | **100%** | 22/03/2023 | 23/03/2023 | 2 |
| | One hot encode on categorical columns | **100%** | 23/03/2023 | 23/03/2023 | 1 |
| **Model Building** | Split train and test | **100%** | 24/03/2023 | 24/03/2023 | 1 |
| | Standardize the data | **100%** | 24/03/2023 | 24/03/2023 | 1 |
| | Learn DCT and Random Forest theory and code | **100%** | 25/03/2023 | 28/03/2023 | 3 |
| | GridSearch for Decision Tree Classifier | **80%** | 29/03/2023 | 29/03/2023 | 1 |
| | Decision tree classifier (Best Params) | **80%** | 29/03/2023 | 29/03/2023 | 1 |
| | GridSearch for Random Forest Classifier | **80%** | 30/03/2023 | 30/03/2023 | 1 |
| | Random Forest (Best Params) | **80%** | 30/03/2023 | 30/03/2023 | 1 |
| | Test unseen data on best model | **80%** | 31/03/2023 | 31/03/2023 | 1 |
| | Interim Progress Report | **100%** | 15/04/2023 | 25/04/2023 | 11 |
| | IPR Submission | **100%** | 01/05/2023 | 01/05/2023 | 1 |
| | Hyperparameter Tuning on ML algorithms | | 14/05/2023 | 21/05/2023 | 8 |
| | Performance Comparision | | 22/05/2023 | 22/05/2023 | 1 |
| | Test unseen data on best model | | 22/05/2023 | 22/05/2023 | 1 |
| **FPR Report** | Abstract | | 24/05/2023 | 24/05/2023 | 1 |
| | Introduction | | 25/05/2023 | 27/05/2023 | 3 |
| | Literature Review Search | | 28/05/2023 | 10/06/2023 | 14 |
| | Data Analysis and Preparation | | 12/06/2023 | 20/06/2023 | 9 |
| | Model Building | | 21/06/2023 | 30/06/2023 | 10 |
| | Results | | 01/07/2023 | 03/07/2023 | 3 |
| | Conclusion | | 04/07/2023 | 04/07/2023 | 1 |
| | Future Work | | 05/07/2023 | 05/07/2023 | 1 |
| | References | | 05/07/2023 | 05/07/2023 | 1 |
| | Appendices | | 06/07/2023 | 06/07/2023 | 1 |
| | Plagiarism Check | | 07/07/2023 | 07/07/2023 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| | Final Edits and Review | | 08/07/2023 | 15/07/2023 | 8 |
| | Final Plagiarism Check | | 16/07/2023 | 16/07/2023 | 1 |
| | Meet with Supervisor | | 17/07/2023 | 17/07/2023 | 1 |
| | FPR Submission | | 28/08/2023 | 28/08/2023 | 1 |

## A) Gantt Chart for Project Plan



## 3) Summary of Progress to Date

### A) Idea Development, Data Gathering, and Understanding

From the Kaggle source, this project has been selected because of its unique and the latest updated version available with more rows and proper description. The idea of "Prediction of hotel reservation cancellation of a customer with reservation details using machine learning" has been developed with an interesting hypothesis as mentioned in the background section. The data Set has been downloaded from Kaggle and understood the columns description given and analyzed which columns are significant for further data analysis.

### B) Literature Research

Literature research is the crucial part of the project as this is started from foundations and absolutely has no idea how to do things, with the help of lectures from research methods on how to perform a literature search. A literature search will go on till the end of the project as references are needed every time, so the timeline mentioned in above is followed. This project has progressed with a deep understanding of the dataset with the help of relevant articles to this project idea as mentioned in [2], followed by knowing machine learning classification algorithms and cross-validation techniques. Only 80% of the literature research is done, still might need their help of them while doing more experimentation on the remaining algorithms.

### C) Data Preparation and Data Visualization

The available data consists of 36275 entries and 19 columns at the start. But there are a few columns that might not add value to the analysis, so the columns “Booking_ID”, “type_of_meal_plan” has been removed from the data and one-hot encoding has been applied for two categorical columns.

To understand the patterns of the data in every column, a histogram has been plotted. It is identified that lead time and average price room columns have great relationships and might be a reason for a reservation cancellation, but this is just the assumption made from the visualization detailed inspection is yet to be done. Output variable Booking Status has some data imbalance which needs to be rectified by finding some solution, its effect on the algorithm performance has to analyzed with the results and then act on it.

### D) Model Building

Prepared data is split into train and test sets and later all of them are standardized before doing cross-validation for best parameters using GridSearchCV, which is performed on only selected values at random, but it needs to be experimented with a wider range of values after doing some extensive research about hyperparameter tuning. GridSearchCV is applied on both chosen baseline models i.e., Random Forest Classifier and Decision Tree Classifier. Performance results are overwhelming more than expected with the below results.

| | **Train Accuracy** | **Test Accuracy** |
|---|---|---|
| **Decision Tree Classifier** | 0.91308286074354 (**91.3%**) | 0.87531011669576 (**87.5%**) |
| **Random Forest Classifier** | 0.99428954001260 (**99.4%**) | 0.90710282091335 (**90.7%**) |

Table1: Baseline Models Performance Results

Still more experimentation has to be done on other classification algorithms as well along with hyperparameter tuning this will take time.

After the modeling part is done, Final Progress Report has to be started with all the necessary s ections as mentioned in the project plan in section 2.

## 4) Consideration of ethical, legal, professional, and social issues

This project has not considered any surveys or any kind of interviews, simply to say primary research has not been considered for this project. The secondary data has been considered from the Kaggle with all the necessary information given. This project is ethically and professionally answerable to the hypothesis question which can help hotel management to predict the customer who can cancel the reservation within the lead time given.

Socially, if the customers cancelling the reservations and if that news spread across people, there might be damage to the hotel’s reputation, which will lead to economic loss. Hence, this project helps hotels prevent social, ethical, and professional issues.

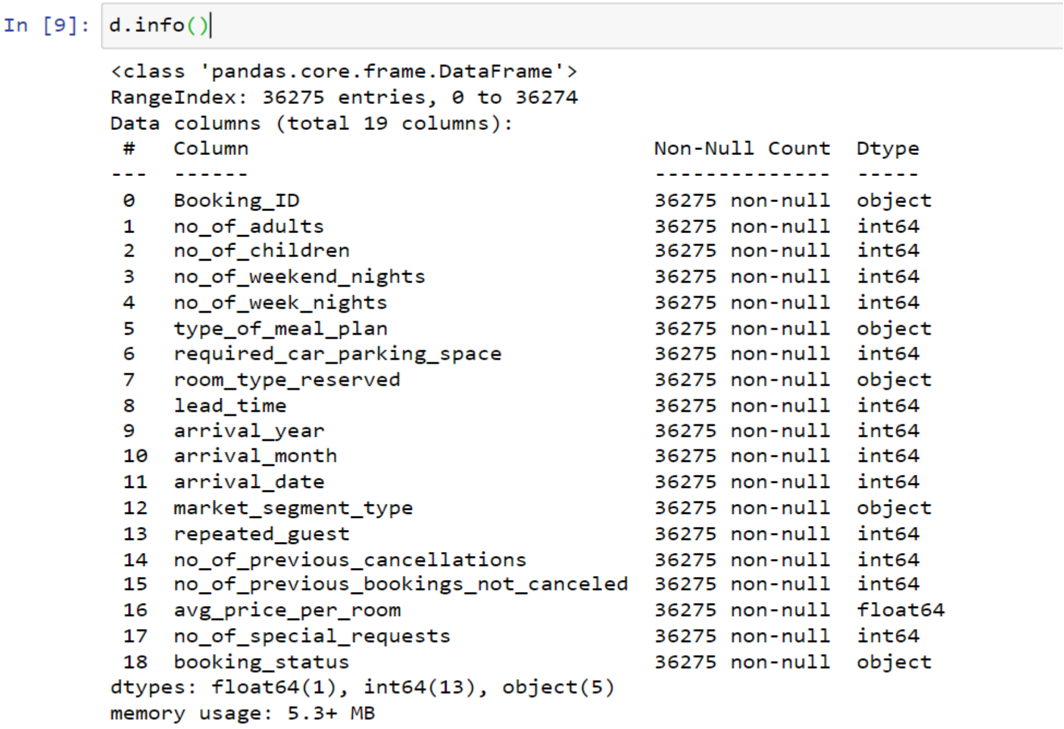
# Appendices

### Importing Necessary Libraries

```
import pandas as pd
import numpy as np
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
import matplotlib.pyplot as plt

from sklearn.preprocessing import OneHotEncoder
```

### # Loading the data

```
d = pd.read_csv("Hotel Reservations.csv")
d.head()
```



```
In [9]: d.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 36275 entries, 0 to 36274
Data columns (total 19 columns):
 #   Column                                Non-Null Count  Dtype  
---  ------                                --------------  -----  
 0   Booking_ID                            36275 non-null  object 
 1   no_of_adults                          36275 non-null  int64  
 2   no_of_children                        36275 non-null  int64  
 3   no_of_weekend_nights                  36275 non-null  int64  
 4   no_of_week_nights                     36275 non-null  int64  
 5   type_of_meal_plan                     36275 non-null  object 
 6   required_car_parking_space            36275 non-null  int64  
 7   room_type_reserved                    36275 non-null  object 
 8   lead_time                             36275 non-null  int64  
 9   arrival_year                          36275 non-null  int64  
 10  arrival_month                         36275 non-null  int64  
 11  arrival_date                          36275 non-null  int64  
 12  market_segment_type                   36275 non-null  object 
 13  repeated_guest                        36275 non-null  int64  
 14  no_of_previous_cancellations          36275 non-null  int64  
 15  no_of_previous_bookings_not_canceled  36275 non-null  int64  
 16  avg_price_per_room                    36275 non-null  float64
 17  no_of_special_requests                36275 non-null  int64  
 18  booking_status                        36275 non-null  object 
dtypes: float64(1), int64(13), object(5)
memory usage: 5.3+ MB
```

```
# Check the misssing data from the dataset in all the columns, if there are any null values, isnull() will show that as TRUE.
# If there are no null values, it will show false.

d.columns.isnull()
```

Since there are no null values in the dataset for 36275 rows across all the 19 columns, data is full.

**Remove Unwanted Columns**

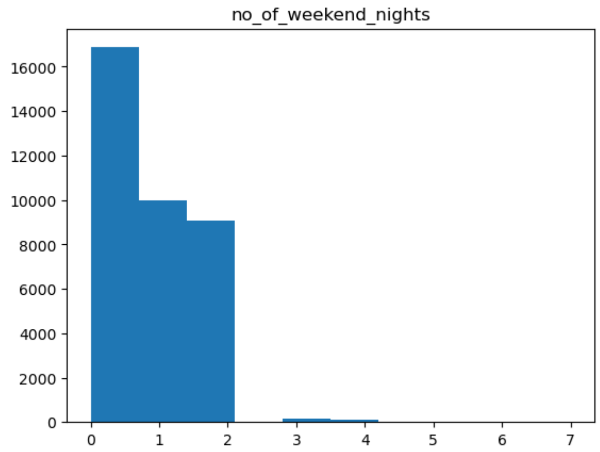
```
d["type_of_meal_plan"].unique()

d["room_type_reserved"].unique()

d["arrival_year"].unique()

d["market_segment_type"].unique()

d = d.drop(columns = ["Booking_ID","type_of_meal_plan"],axis=1) #Booking_ID is removed using drop function specifying axis = 1 which means from columns.

D
```

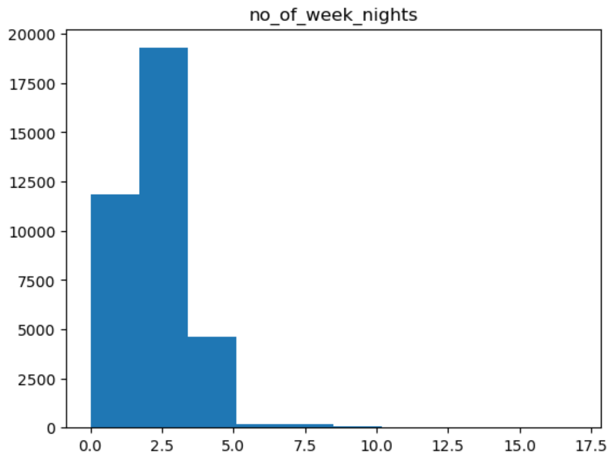
**One-hot encoding**

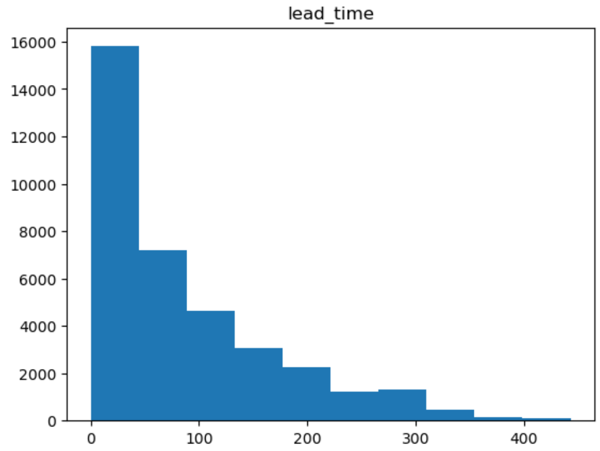
```
data_encoded = pd.get_dummies(d,columns=['room_type_reserved','market_segment_type'])

data_encoded.info()

data_encoded.head()

#poping target column inbetween the columns and  adding it to the last

booking_status_col = data_encoded.pop("booking_status")
data_encoded["booking_status"] = booking_status_col
data_encoded

data_encoded["booking_status"].value_counts()
```

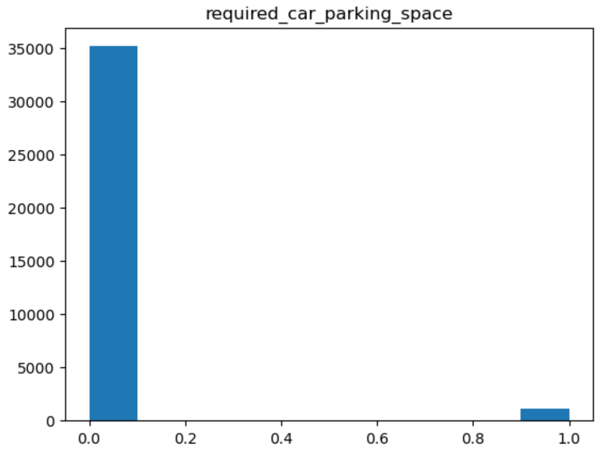
## Data Visualization

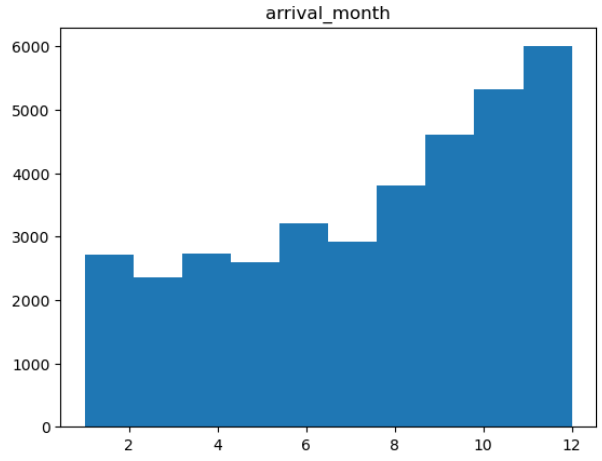
```
# histograms for all columns
for col in data_encoded.columns[:-1]:
    plt.hist(data_encoded[col])
    plt.title(col)
    plt.show()
```

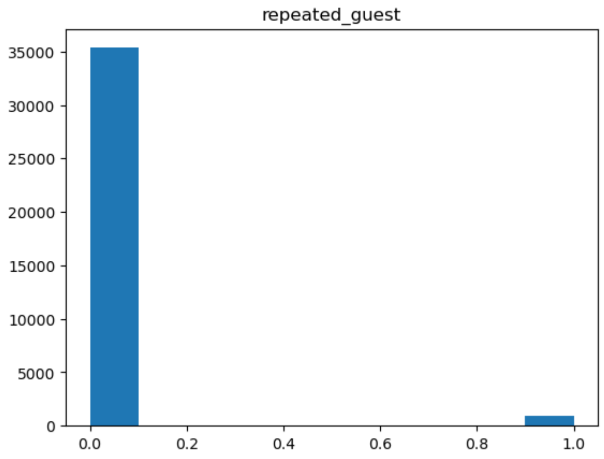


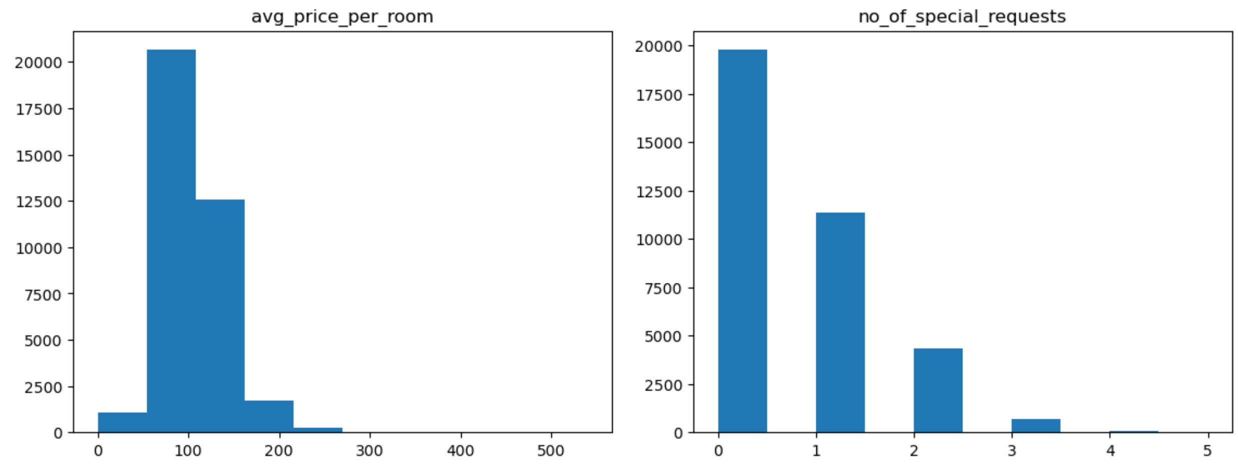




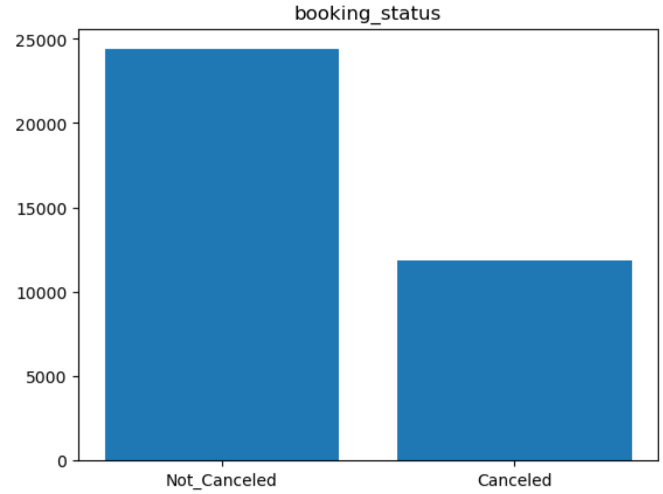








```
#Bar Plot for output Variable
output_counts = data_encoded[data_encoded.columns[-1]].value_counts()
plt.bar(output_counts.index, output_counts.values)
plt.title(data_encoded.columns[-1])
plt.show()
```



**Data Splitting**

```
train_data, test_data, train_target, test_target = train_test_split(
   data_encoded.iloc[:, :-1], data_encoded.iloc[:, -1], test_size=0.3, random_state=42)

unseen_data = data_encoded.iloc[:, :-1].sample(frac=0.1, random_state=42)
```

**Standardization**

```
scaler = StandardScaler()

train_data = scaler.fit_transform(train_data)

test_data = scaler.transform(test_data)

unseen_data = scaler.transform(unseen_data)
```

**Cross Validation using Grid Search for Decision Tree Classifier**

```
dt_params = {

   'criterion': ['gini', 'entropy'],

   'max_depth': [None, 5, 10, 15],

   'min_samples_split': [2, 5, 10],

   'min_samples_leaf': [1, 2, 5]

}

dt_clf = DecisionTreeClassifier(random_state=42)

dt_grid_search = GridSearchCV(dt_clf, dt_params, cv=5, n_jobs=-1, verbose=1)

dt_grid_search.fit(train_data, train_target)

dt_best_params = dt_grid_search.best_params_
```

**dt_best_params**

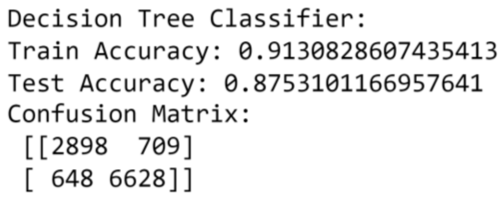
**Output:**

```
{'criterion': 'entropy',
 'max_depth': 15,
 'min_samples_leaf': 1,
 'min_samples_split': 2}
```

```
# Train decision tree classifier with best parameters and measure performance

dt_clf = DecisionTreeClassifier(**dt_best_params, random_state=42)
dt_clf.fit(train_data, train_target)
train_pred = dt_clf.predict(train_data)
test_pred = dt_clf.predict(test_data)
```

```
print('Decision Tree Classifier:')
print('Train Accuracy:', accuracy_score(train_target, train_pred))
print('Test Accuracy:', accuracy_score(test_target, test_pred))
print('Confusion Matrix:\n', confusion_matrix(test_target, test_pred))
```

Output:

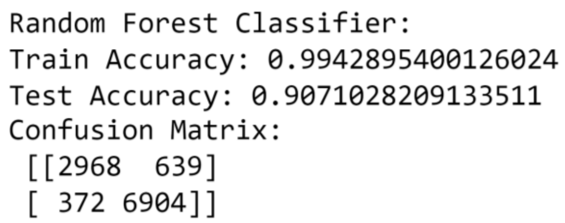


```
Decision Tree Classifier:
Train Accuracy: 0.9130828607435413
Test Accuracy: 0.8753101166957641
Confusion Matrix:
 [[2898  709]
 [ 648 6628]]
```

**Cross Validation using Grid Search for Random Forest Classifier**

```
rf_params = {

   'n_estimators': [100, 200, 500],

   'criterion': ['gini', 'entropy'],

   'max_depth': [None, 5, 10, 15],

   'min_samples_split': [2, 5, 10],

   'min_samples_leaf': [1, 2, 5]

}

rf_clf = RandomForestClassifier(random_state=42)
rf_grid_search = GridSearchCV(rf_clf, rf_params, cv=5, n_jobs=-1, verbose=1)
rf_grid_search.fit(train_data, train_target)
rf_best_params = rf_grid_search.best_params_


# Train random forest classifier with best parameters and measure performance

rf_clf = RandomForestClassifier(**rf_best_params, random_state=42)
rf_clf.fit(train_data, train_target)
train_pred = rf_clf.predict(train_data)
test_pred = rf_clf.predict(test_data)
print('Random Forest Classifier:')
print('Train Accuracy:', accuracy_score(train_target, train_pred))
print('Test Accuracy:', accuracy_score(test_target, test_pred))
print('Confusion Matrix:\n', confusion_matrix(test_target, test_pred))
```

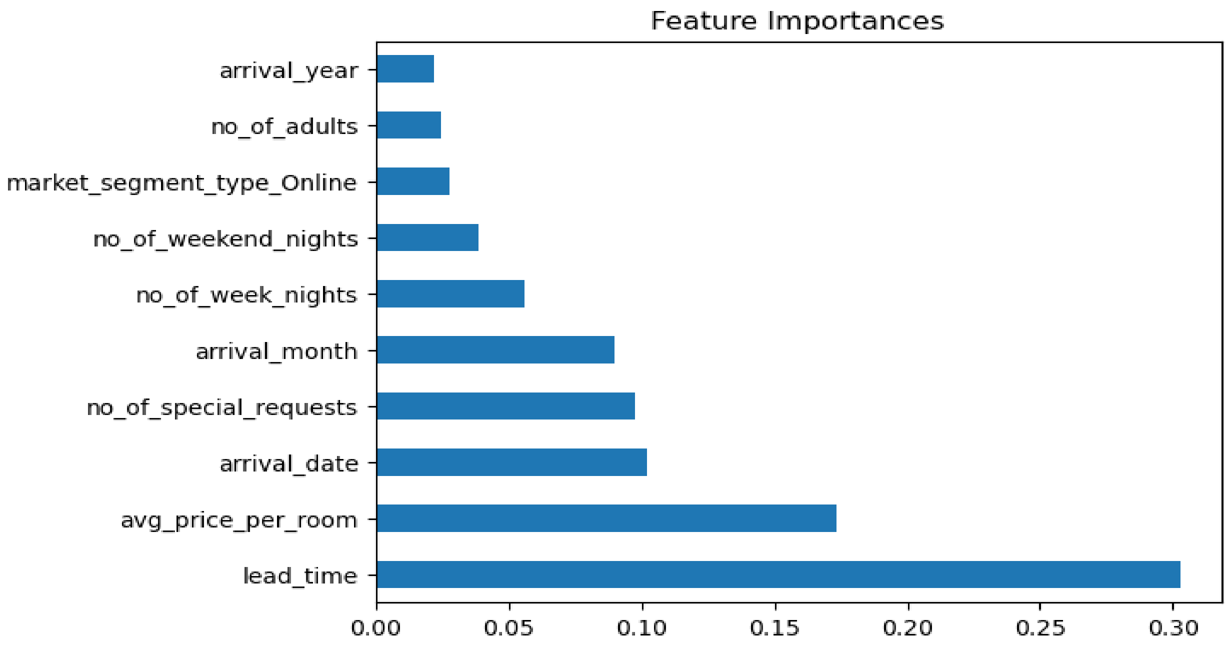
Output:



```
Random Forest Classifier:
Train Accuracy: 0.9942895400126024
Test Accuracy: 0.9071028209133511
Confusion Matrix:
 [[2968  639]
 [ 372 6904]]
```

```
# Use the trained model to make predictions on the unseen data

unseen_pred = rf_clf.predict(unseen_data)
print('Unseen Data Accuracy:', accuracy_score(data_encoded.iloc[:, -1].sample(frac=0.1, random_state=42), unseen_pred))

# Plot feature importances for the random forest classifier
feat_importances = pd.Series(rf_clf.feature_importances_, index=data_encoded.columns[:-1])
feat_importances.nlargest(10).plot(kind='barh')
plt.title('Feature Importances')
plt.show()
```

Output:



# As per the hypothesis, Lead time and Average price per room are the most important features and are responsible for reservation cancellation.

# REFERENCES

[1] www.kaggle.com. (2023). *Hotel Reservations Dataset*. [online] Available at: https://www.kaggle.com/datasets/ahsan81/hotel-reservations-classification-dataset.

[2] R. Prabha, Senthil, G.A., Nisha, S Snega, L Keerthana and S Sharmitha (2022). Comparison of Machine Learning Algorithms for Hotel Booking Cancellation in Automated Method. *2022 International Conference on Computer, Power and Communications (ICCPC)*. doi:https://doi.org/10.1109/iccpc55978.2022.10072135.

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[6] Brownlee, J. (2020). *Train-Test Split for Evaluating Machine Learning Algorithms*. [online] Machine Learning Mastery. Available at: https://machinelearningmastery.com/train-test-split-for-evaluating-machine-learning-algorithms/.

[7] Scikit-learn.org. (2019). *sklearn.model_selection.GridSearchCV — scikit-learn 0.22 documentation*. [online] Available at: https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.GridSearchCV.html.