Capstone Project

Airline Passenger Referral Prediction

By

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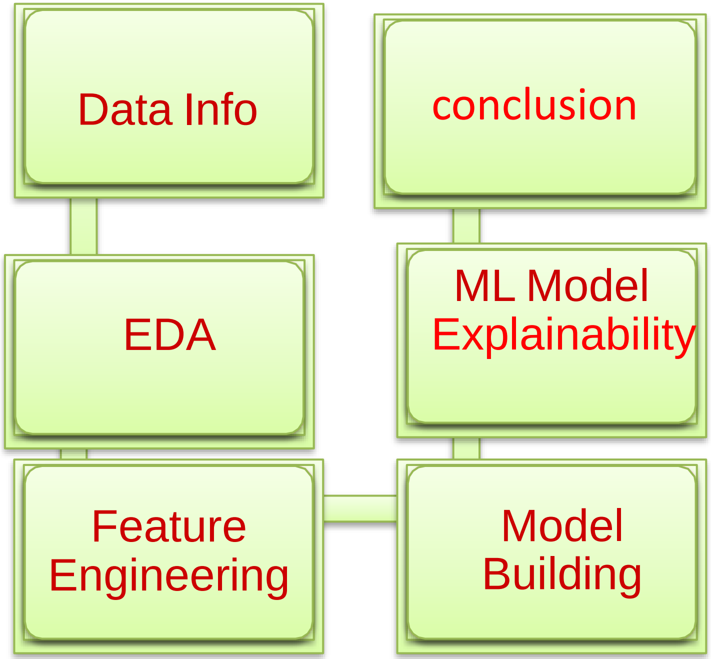
Objective

- The given data includes airline reviews from 2006 to 2019 for popular airlines around the world with multiple choice and free text questions.
- Data is scrapped in Spring 2019. The main objective is to predict whether passengers will refer the airline to their friends.

Methodology

The process from getting the data to drawing the conclusion is as follows:



Data Insights…

- The data set has 17 variables, in which ‘recommended’ is a Dependent variable and the rest are independent variables.
- The size of the data is (131895,17) i.e., we have 131895 rows with 17 columns
- There are lots of null values and duplicates in the data set so we must have to clean the data first.
- Data Set is a mixture of categorical and numerical data so we have to arrange and encode the data before feeding it to the ML model.

```
df.info()
```

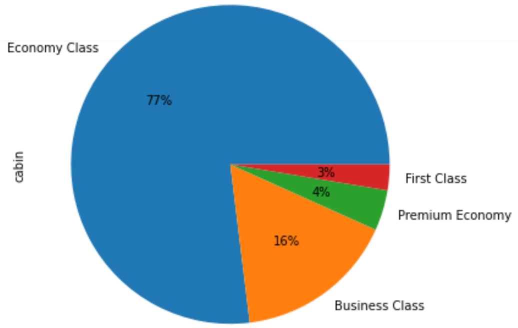
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 131895 entries, 0 to 131894
Data columns (total 17 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   airline          65947 non-null  object
 1   overall          64017 non-null  float64
 2   author           65947 non-null  object
 3   review_date      65947 non-null  object
 4   customer_review  65947 non-null  object
 5   aircraft         19718 non-null  object
 6   traveller_type   39755 non-null  object
 7   cabin            63303 non-null  object
 8   route            39726 non-null  object
 9   date_flown       39633 non-null  object
 10  seat_comfort     60681 non-null  float64
 11  cabin_service    60715 non-null  float64
 12  food_bev         52608 non-null  float64
 13  entertainment    44193 non-null  float64
 14  ground_service   39358 non-null  float64
 15  value_for_money  63975 non-null  float64
 16  recommended      64440 non-null  object
dtypes: float64(7), object(10)
```

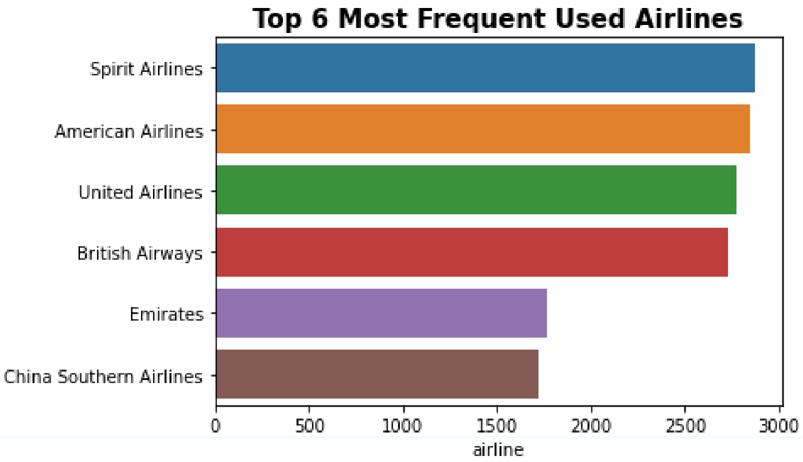
Feature Description:-

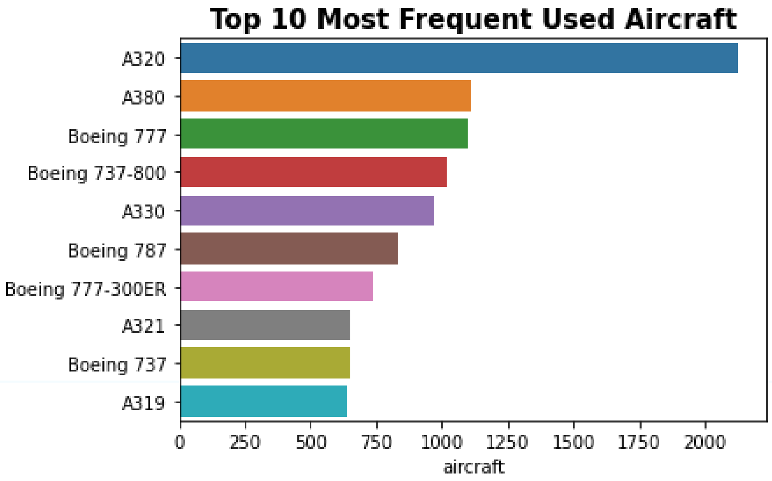
- **airline**: Name of the airline in str format.
- **overall**: Overall point is given to the trip between 1 to 10 in float format.
- **author**: Author of the trip in str format.
- **reviewdate**: Date of the Review customer review: Review of the customers in free text format in str need to be converted into DateTime Format.
- **aircraft**: Type of the aircraft in str format.
- **travellertype**: Type of traveler (e.g. business, leisure) consist of four class in str format.
- **cabin**: Cabin at the flight date flown: Flight date in str format consist of 4 class.
- **seatcomfort**: Rated between 1-5 in float format.
- **cabin service**: Rated between 1-5 float format.
- **foodbev**: Rated between 1-5 entertainment: Rated between 1-5 in float format.
- **groundservice**: Rated between 1-5 in float format.
- **valueformoney**: Rated between 1-5 in float format.

Exploratory Data Analysis

EDA for Cabin, Airlines Company and Aircraft Carrier has been done which showed the following output.

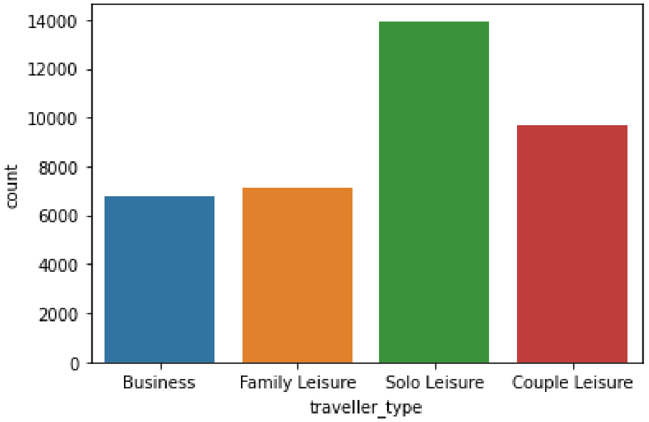


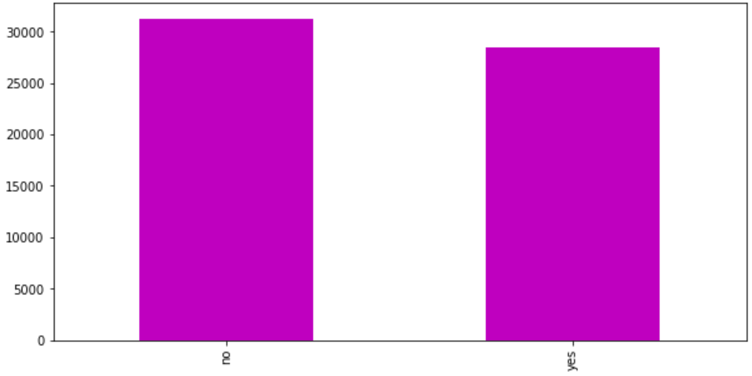




Exploratory Data Analysis

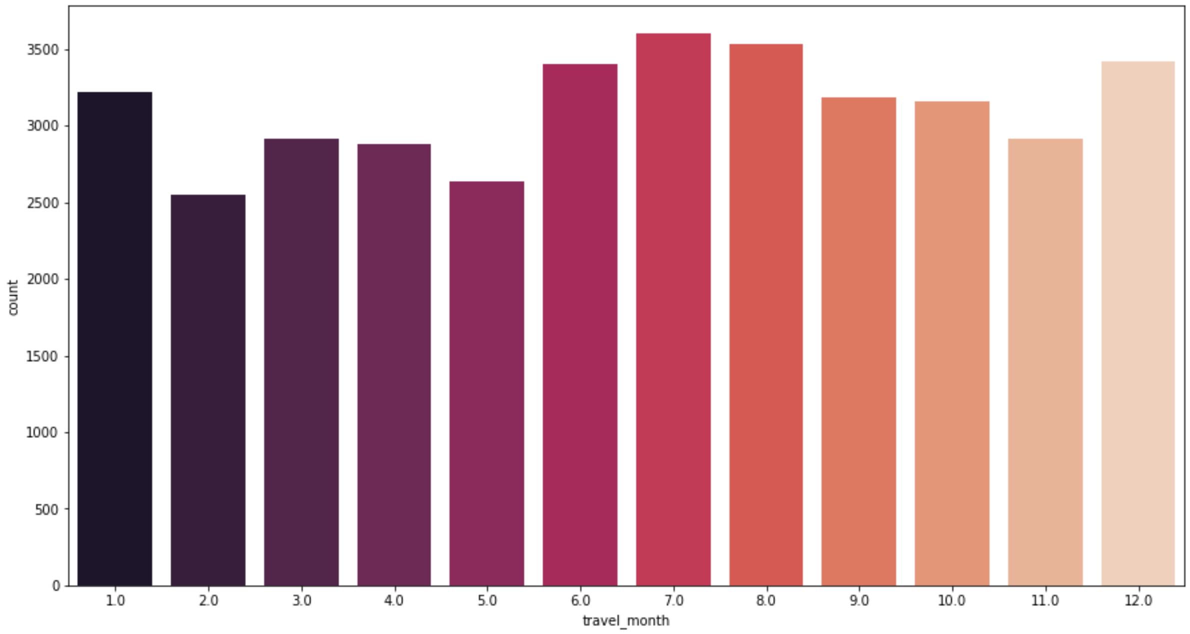
- We can see there are 4 classes present in the Traveler type feature. Also, we can notice that Solo Leisure has the highest value count. From this, we can conclude that most people who travel by airline travel in solo. Followed by College then Family. A very small percentage of people prefer flying for business.
- In recommended plot we can see that the Dependent feature 'recommended' has balanced data in its classes Yes and No.





Exploratory Data Analysis

Here we can see that people have flown most frequently in the month of July and least frequently in the month of February.



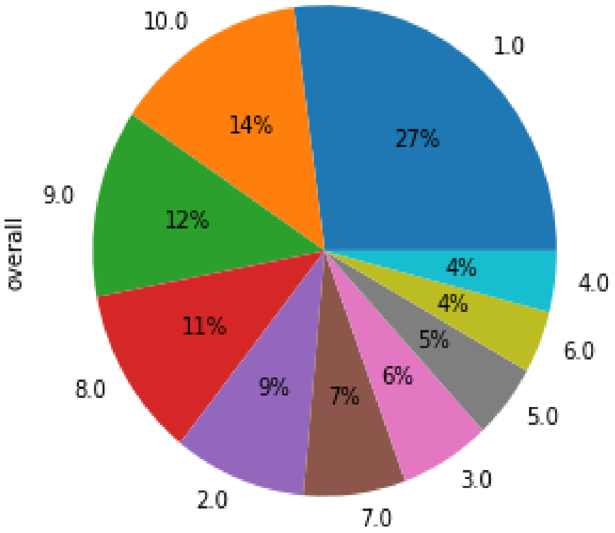
Exploratory Data Analysis

Overall percentage of passenger Rating and preferences

- From the above graphs, we have observed that-

44 % of passengers gave an overall rating of 7 and above on a scale of 10, for the services offered by the airlines.It implies that this section of people think that airlines are giving good services.

- 42% passengers gave an overall rating below 3.0 . So , It suggests that people are not very much satisfied with airline services. There are still need of improvements.

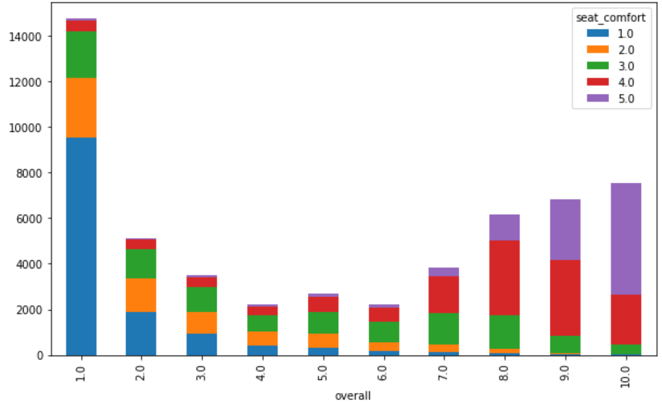


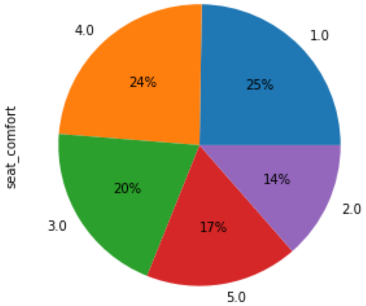
Exploratory Data Analysis

Percentage of Seat-comfort Rating by Passengers

- 25% passenger are not satisfied with seat-comfort as they give 1.0 rating.

- 41% passenger are giving 4.0 and 5.0 rating for seat-comfort. So, we can say people are mostly satisfied with seat-comfort.

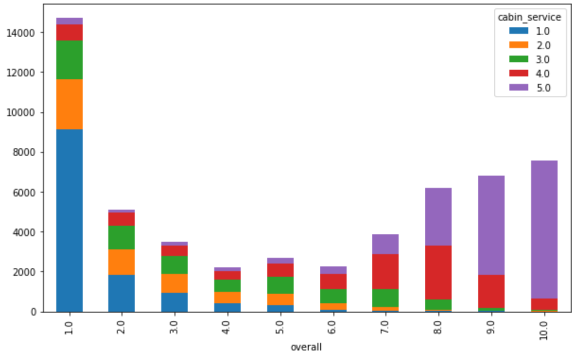


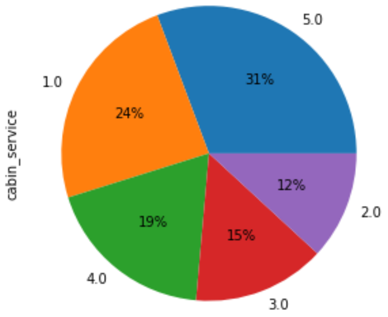


Exploratory Data Analysis

Percentage of Cabin-Service Rating by passengers:

- 24% passenger are not satisfied with cabin-service as they give 1.0 rating.
- 50% passenger are giving 4.0 and 5.0 rating for cabin-service when overall rating of airline is good. So, we can say good cabin-service positively impacts airline businesses.



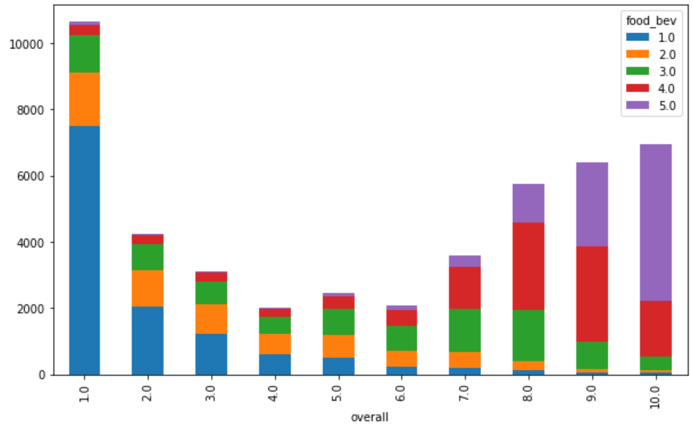


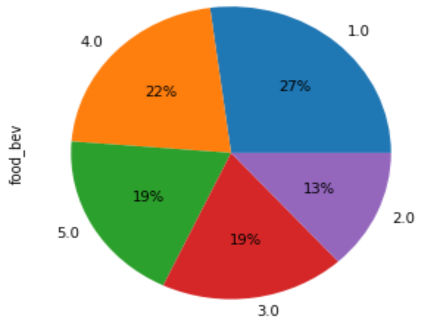
Exploratory Data Analysis

Percentage of Food-Beverage Rating by passengers

- 27% passenger are not satisfied with food-service as they give 1.0 rating.

- 41% passenger are giving 4.0 and 5.0 rating for cabin-service when overall rating of airline is good. So, we can say good food beverage service positively impacts airline businesses.



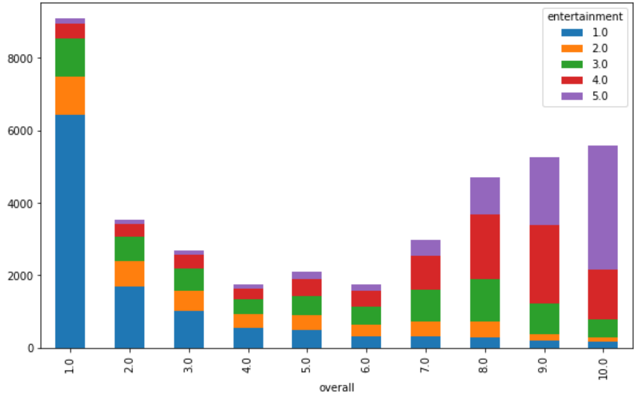


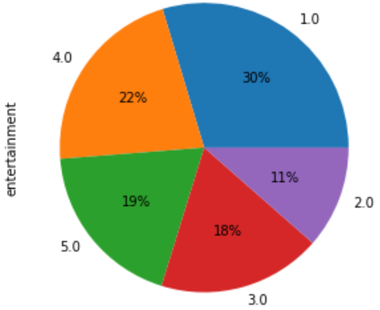
Exploratory Data Analysis

Percentage of Entertainment Rating by passengers

- 30% passenger are not satisfied with entertainment as they give 1.0 rating.

- 41% passenger are giving 4.0 and 5.0 rating for entertainment when overall rating of airline is good. So, we can say people are mostly not satisfied with entertainment service and it negatively impacts airline businesses.



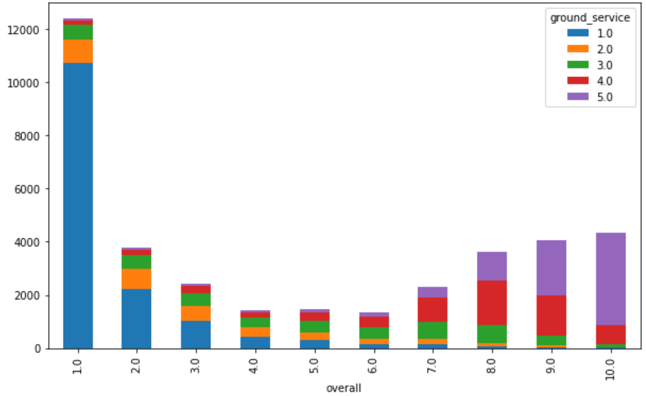


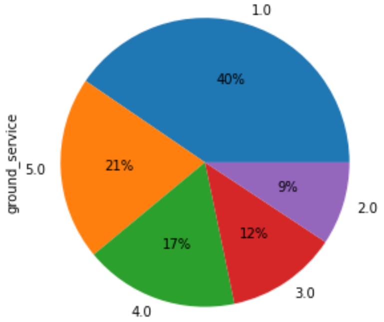
Exploratory Data Analysis

Percentage of Ground Service Rating by passengers

- 40% passenger are not satisfied with ground-service as they give 1.0 rating.

- 38% passenger are giving 4.0 and 5.0 rating for ground-service when overall rating of airline is good. So, we can say people are mostly unsatisfied with ground-service and it negatively impacts airline businesses..



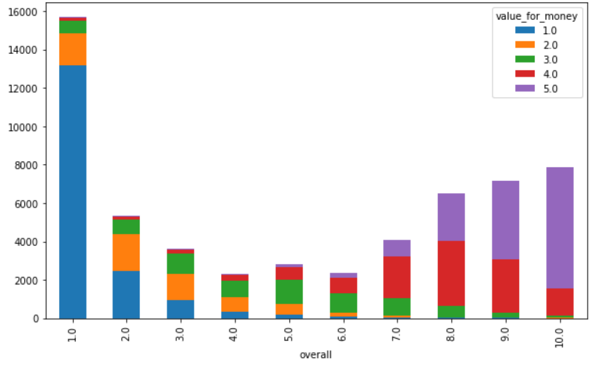


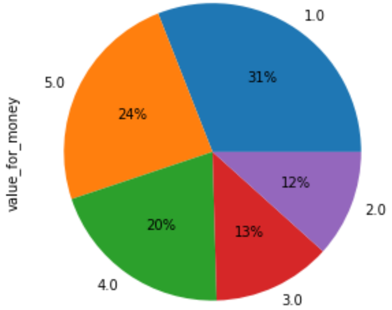
Exploratory Data Analysis

Percentage of Value for Money Rating by passengers
:

- 31% passenger are not satisfied with value for money-service as they give 1.0 rating.

- 44% passenger are giving 4.0 and 5.0 rating for ground-service when overall rating of airline is good. So, we can say good value for money service positively impacts airline businesses.

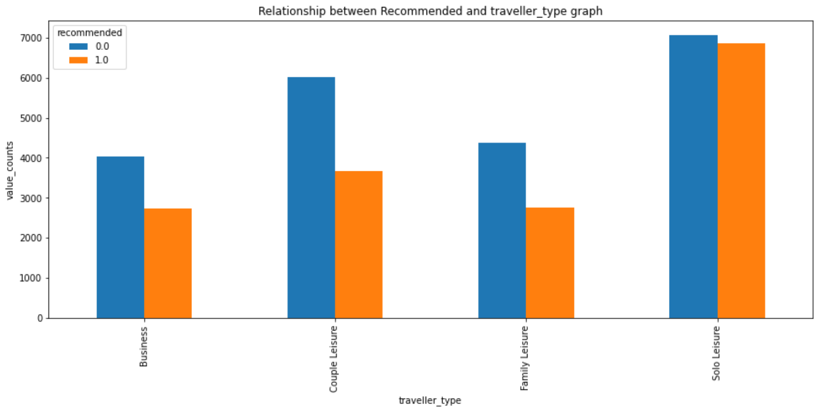




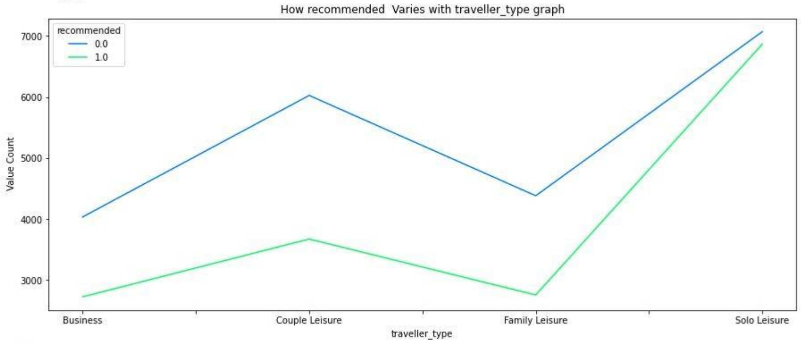
Exploratory Data Analysis

Variation of recommendation feature Traveller type:

- We can see that people have given both 1 or 0 which we will consider from now on as positive and negative recommendation so to interpret it effectively to the solo leisure. This may because of the poor infrastructure or the service received by the people and positive recommendation may be because of low price for solo. But this is approximate analysis based on the data provided.
- In Traveller type we can see that both the recommendation trend as of yes or no increases from business to couple leisure and decreases to family then again increases high in solo leisure. Which indicate people prefer solo leisure higher than any of the other leisures.



traveller_type

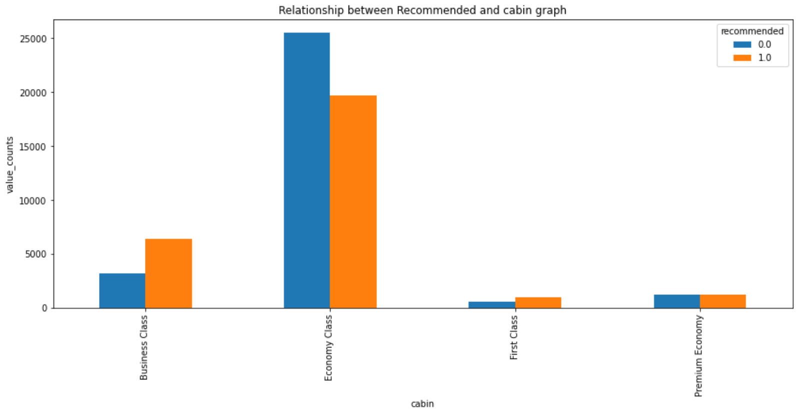


cabin

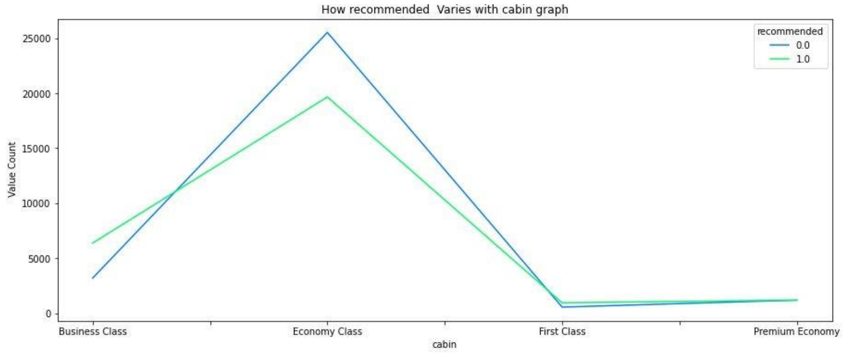
Exploratory Data Analysis

Variation of Recommendation with Cabin Type:

- we can see that people gives the high positive recommendation to economic class in cabin. From this we can conclude that people love to travel in economic class as of low price also in same way we can see people give highest negative recommendation to economy class maybe because less infrastructure or service provided to them. Also we can see people have given higest positive recommendation to Business class it may be because of the quality of service provided to them in Business class and similarly negative recommendation because of high price of business class or less travelling percentage.
- In Cabin type we can see that both the recommendation trend as of yes or no increases from business to Economy class and decreases to First class then again increases slightly in Premium class. Which indicate most people travel on economy class.



cabin

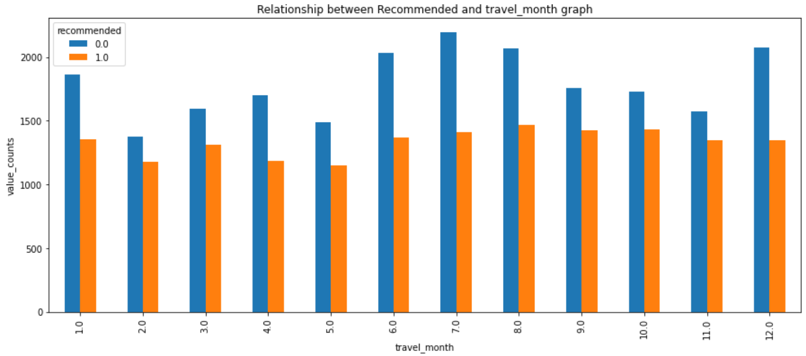


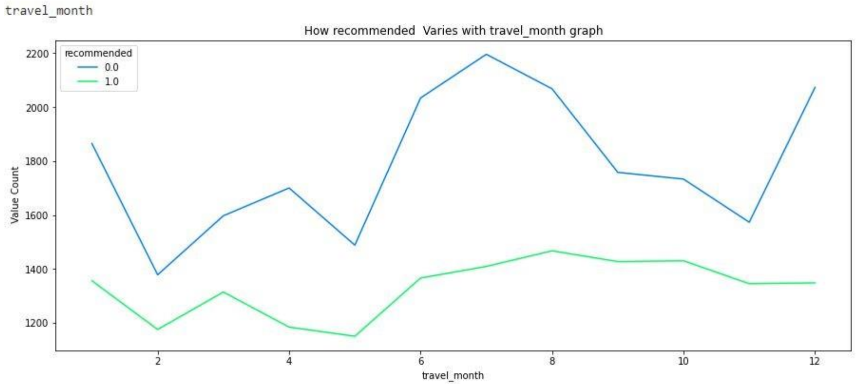
Exploratory Data Analysis

Variation of Recommendation feature with Travel Month:

- From month vs no. of recommendation. We can see that people tents to travel most in the month of July considering the total of positive and negative recommendation combined.

- In month we cannot see any preferable trend but here we can conclude people tent to travel highest during the month of July.



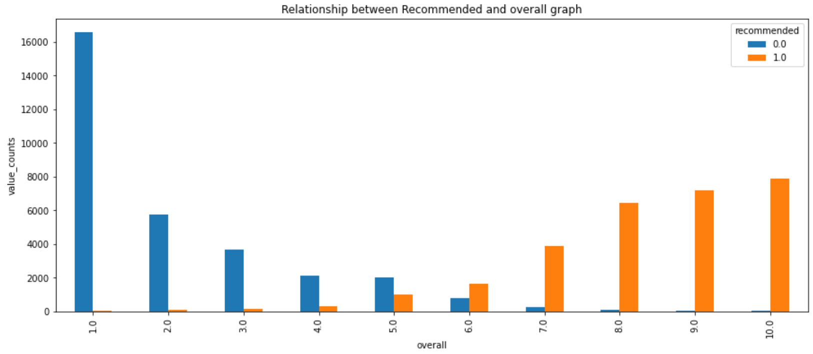


Exploratory Data Analysis

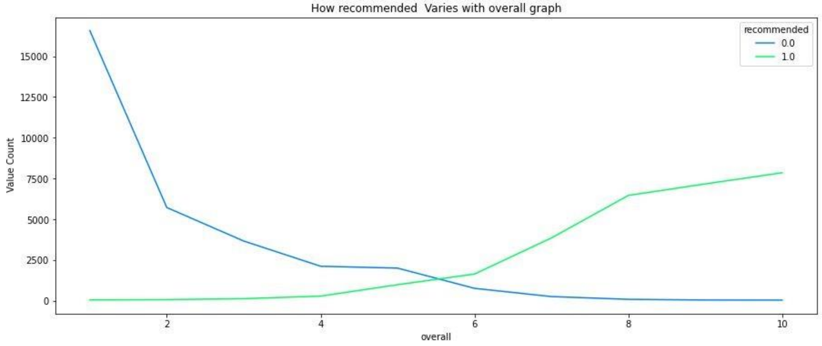
Variation of Recommendation feature with overall rating:

- From overall rating vs recommended graph we can see which is perfectly understandable that negative recommendation has been given to the overall rating of 1.0 and high positive recommendation has been given to the overall rating of 10. But it is very true that highest negative recommendation has been given to overall rating of 1.0 which is really a matter of concern.

- In overall rating we can experience a very good insights which is also regular. We can see as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases.



overall

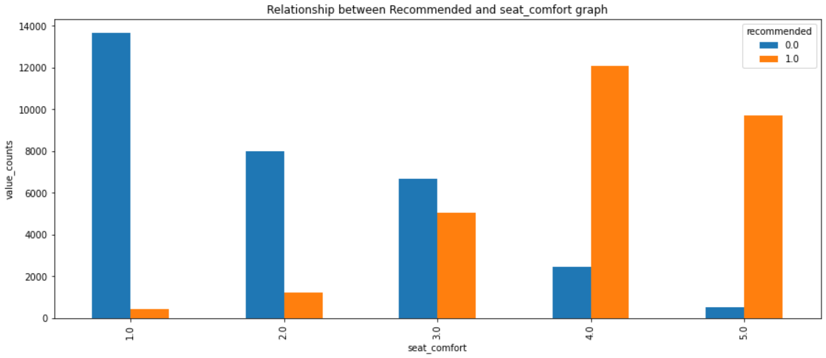


Exploratory Data Analysis

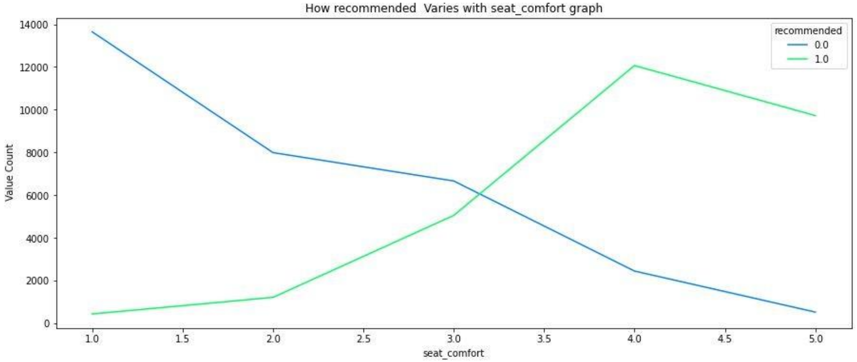
Variation of Recommendation feature with seat comfort :

- In seat comfort people has given highest positive recommended to the seat of class 5 as compared to very low negative recommendation to the same. Also we can see seat of class 1 have been given highest negative recommendation as compare to its positive recommendation. Here we come to a conclusion it must be removed as early as possible.

- In seat comfort we can see as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in seat comfort rating 3.0 where we can see similar positive and negative recommendation.



seat_comfort

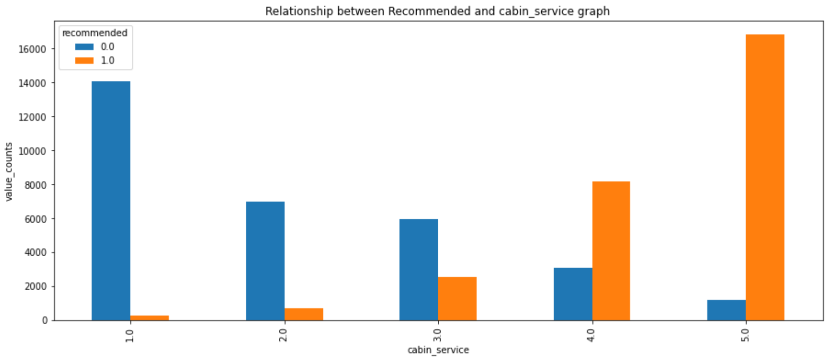


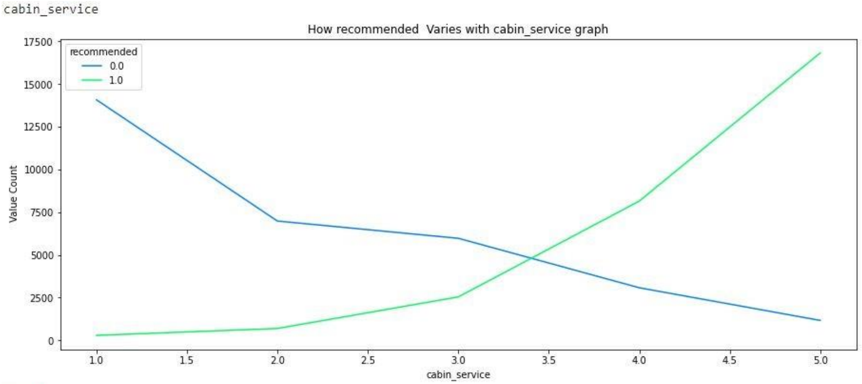
Exploratory Data Analysis

Variation of Recommendation feature with Cabin Service :

- In cabin service rating people has given highest recommendation to rating to cabin service rating 5 as compare to its counterpart. From this we can conclude that cabin service is doing pretty good.

- In cabin service we can see same as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in cabin service rating 3.5 where we can see similar positive and negative recommendation



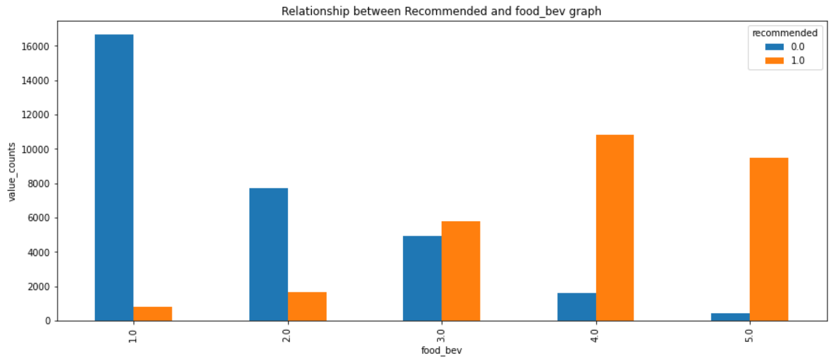


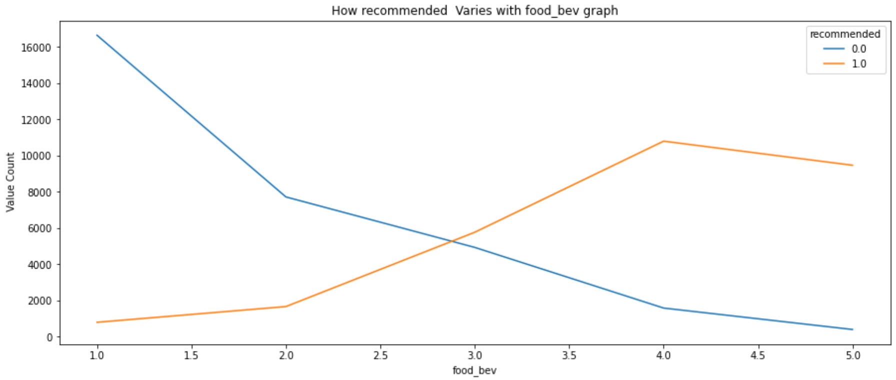
Exploratory Data Analysis

Variation of Recommendation feature with Food Bev :

- In food and beverage rating people have given highest negative recommendation to rating 1.0 from this we can conclude that airline service has to improve their food delivery and quality service.

- In food service we can see same as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in food service rating close to 3.0 where we can see similar positive and negative recommendation.



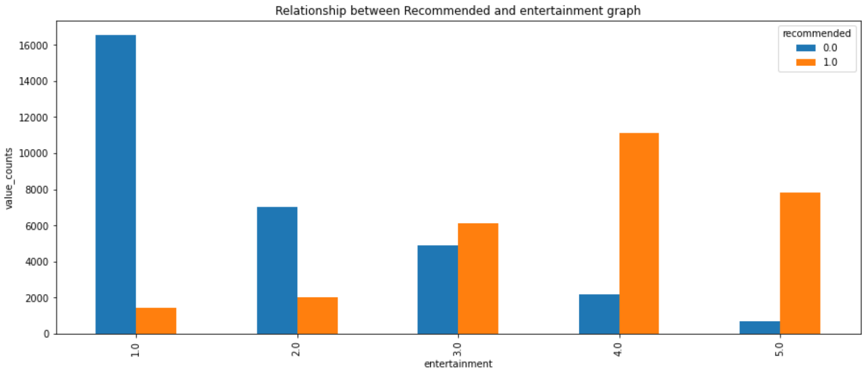


Exploratory Data Analysis

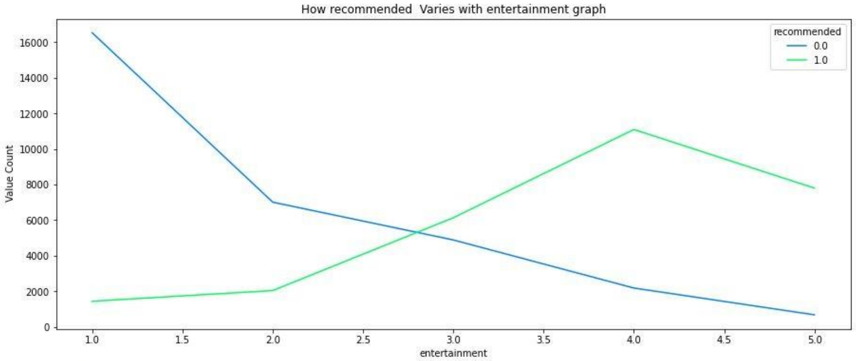
Variation of Recommendation feature with
En tertainment:

- In entertainment also we can see most people has given highest negative recommendation to entertainment rating 1 which shows that airline has to improve their entertainment system as well.

- In Entertainment service too we can see same as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in Entertainment service rating between 2.5 and 3.0 where we can see similar positive and negative recommendation.



entertainment

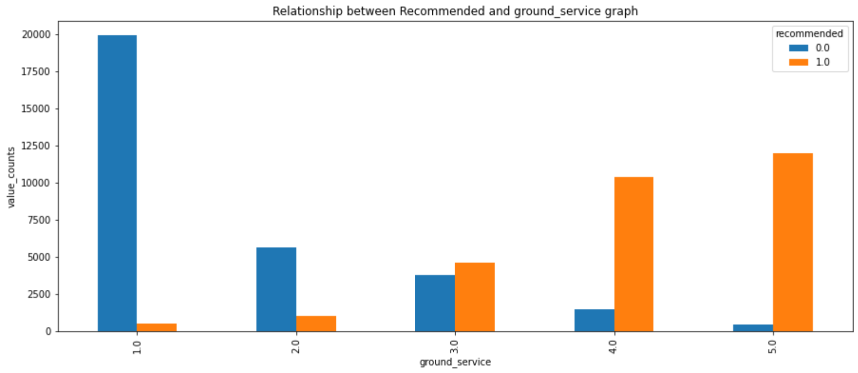


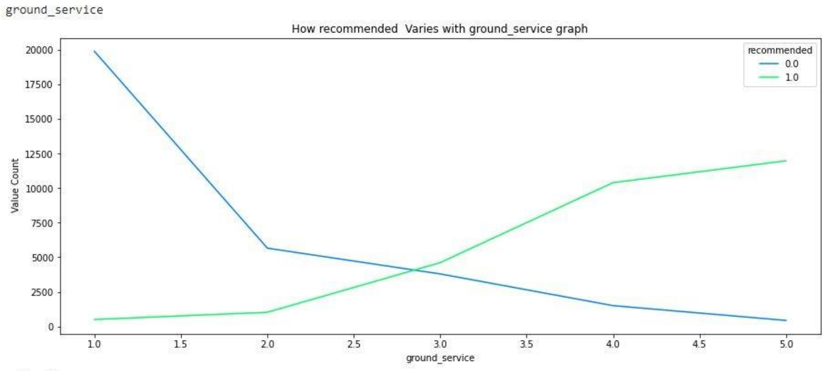
Exploratory Data Analysis

Variation of Recommendation feature with Ground service

- In Ground Service also we can see most people has given highest negative recommendation to entertainment rating 1 which shows that airline has to improve their entertainment system as well.

- In Ground Service too we can see same as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in Entertainment service rating between 2.5 and 3.0 where we can see similar positive and negative recommendation.



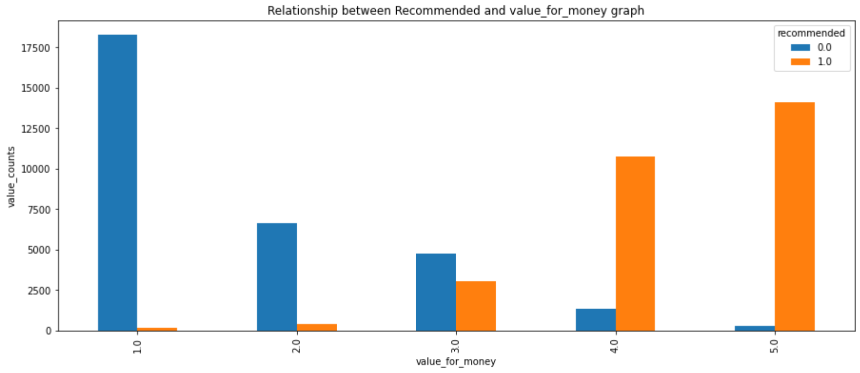


Exploratory Data Analysis

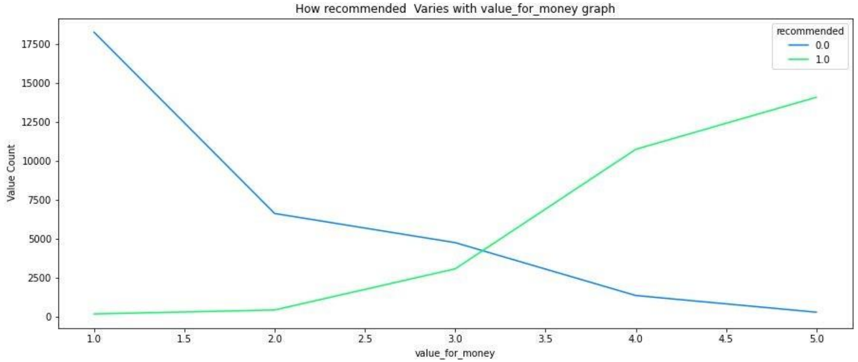
Variation of Recommendation feature with Value for Money.

- In ground service also we can see most people has given highest negative recommendation to ground service rating 1 which shows that airline has to improve their ground service.

- In Ground service also we can see same as the positive recommendation increases with the overall rating and also negative recommendation on the same decreases also we can an intersection in Ground service rating close 3.0 where we can see similar positive and negative recommendation.



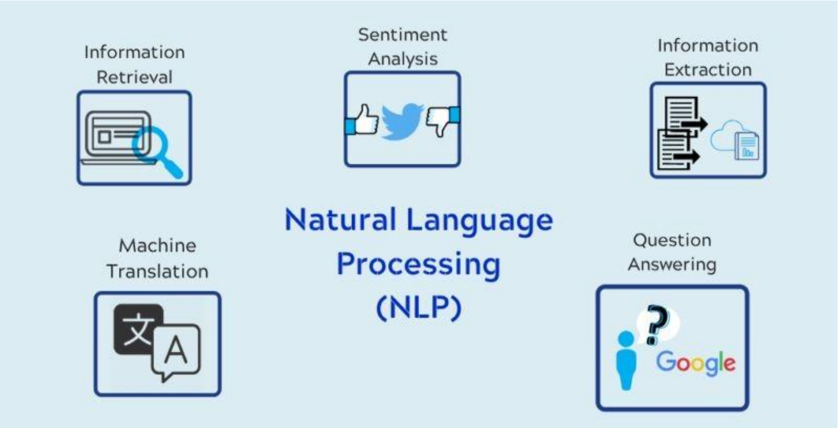
value_for_money



NLP(Natural Language Processing):

- We have used vander sentiment in NLP so to convert sentiments in customer review into score so to have our model prediction.

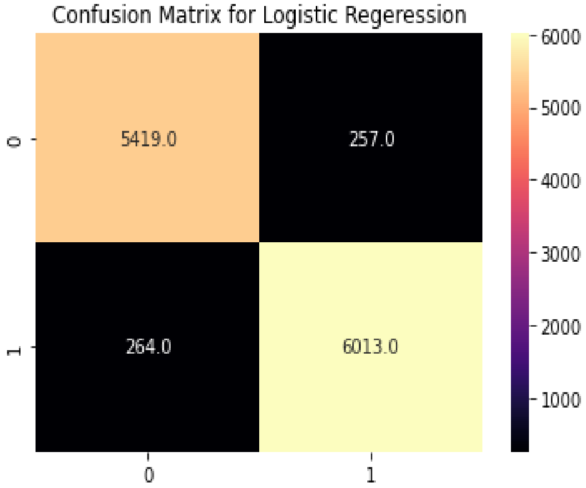
- We have also created new feature numeric review so to store sentiment score we have retrieved using sentiment analysis from customer review feature.



Model Building:

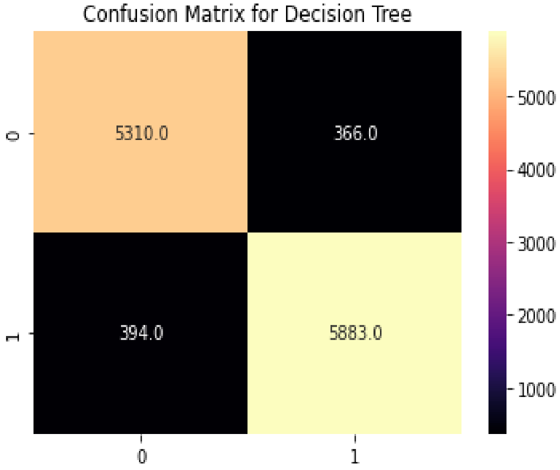
	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.95	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.64%



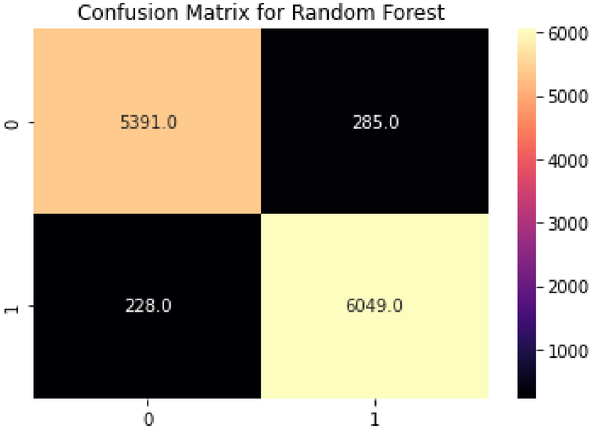
	precision	recall	f1-score	support
0.0	0.94	0.94	0.94	6277
1.0	0.93	0.94	0.93	5676
accuracy			0.94	11953
macro avg	0.94	0.94	0.94	11953
weighted avg	0.94	0.94	0.94	11953

Accuracy score % of the model is 93.63%



	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.96	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.71%



Model Building(Continued….)

	precision	recall	f1-score	support
0.0	0.95	0.96	0.96	6277
1.0	0.96	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.55%

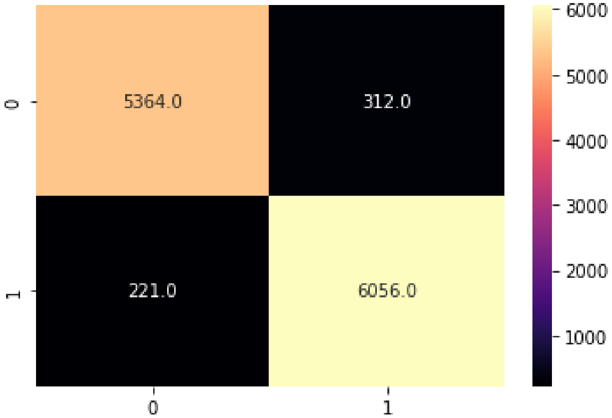
	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.96	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.68%

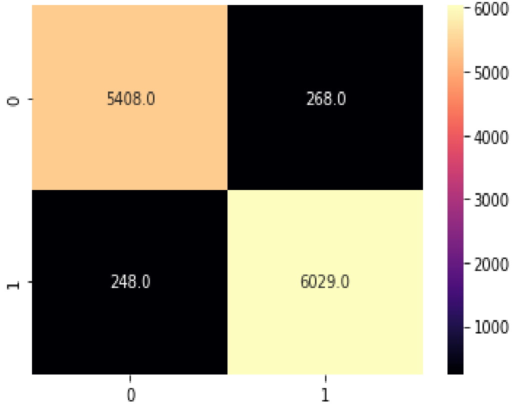
	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.95	0.95	0.95	5676
accuracy			0.95	11953
macro avg	0.95	0.95	0.95	11953
weighted avg	0.95	0.95	0.95	11953

Accuracy score % of the model is 95.38%

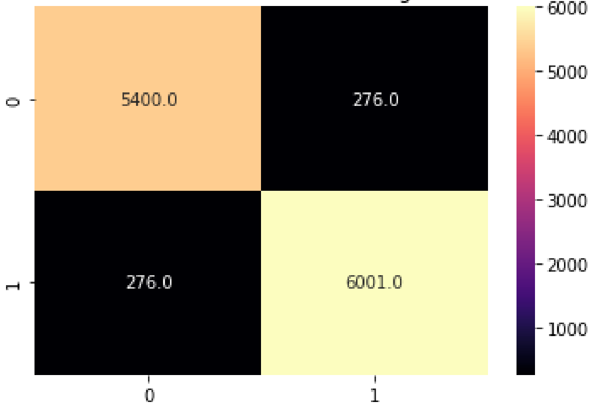
Confusion Matrix for Random Forest with GridSearchCV



Confusion Matrix for SVM



Confusion Matrix for K-nearest-neighbour

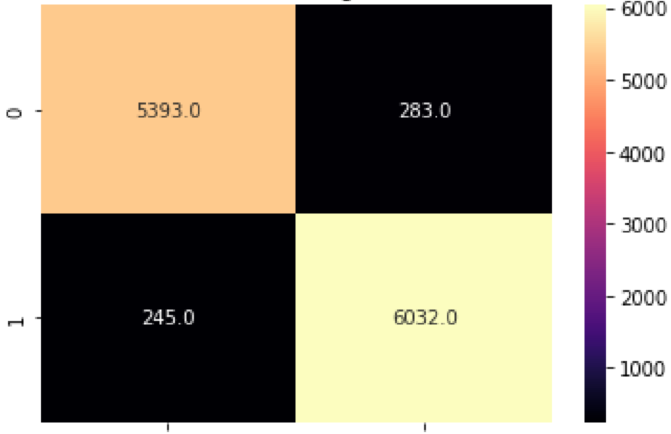


Model Building(Continued….)

	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.96	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.58%

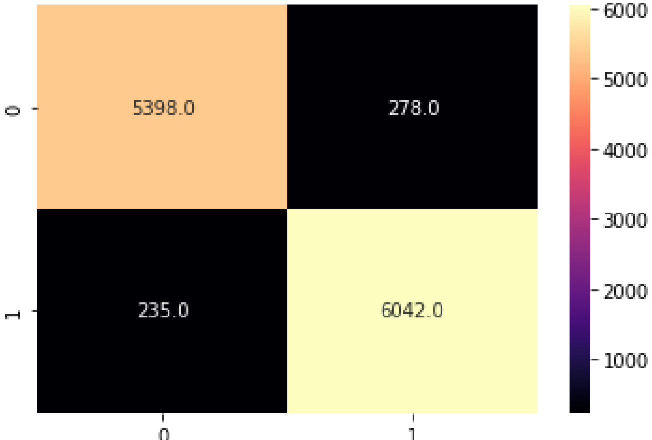
Confusion Matrix for K-nearest-neighbour with GridSearchCV



	precision	recall	f1-score	support
0.0	0.96	0.96	0.96	6277
1.0	0.96	0.95	0.95	5676
accuracy			0.96	11953
macro avg	0.96	0.96	0.96	11953
weighted avg	0.96	0.96	0.96	11953

Accuracy score % of the model is 95.71%

Confusion Matrix for XGBoost



Model Building(Continued….)

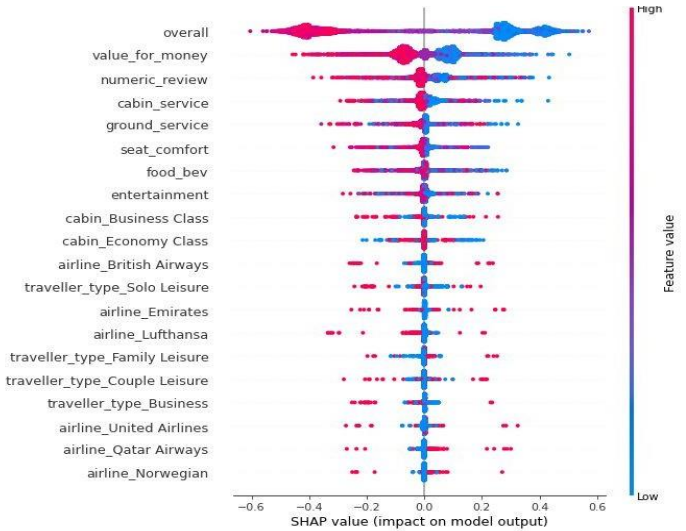
1. In model Selection we can see that Random Forest and XGBoost Model is having the same high Model Accuracy with a score 0.957082 but we can also see that recall, precision, f1-score and roc_auc_score of XGBoost model combined is giving higher score than Random Forest from which we have chosen XGBoost Model for further prediction.

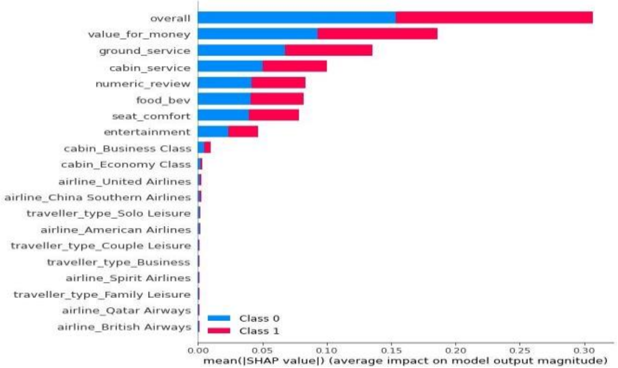
	Model	Accuracy	Recall	Precision	f1-score	roc_auc_score
0	Logistic Regression	0.956413	0.954722	0.953546	0.954133	0.956332
1	Decision Tree	0.936334	0.935518	0.930762	0.933134	0.936295
2	Random Forest	0.957082	0.950493	0.958770	0.954614	0.956766
3	Random Forest with GridSearchCV	0.955492	0.945384	0.960272	0.952770	0.955008
4	SVM	0.956831	0.952784	0.956153	0.954465	0.956637
5	K-nearest-neighbour	0.953819	0.951374	0.951374	0.951374	0.953702
6	K-nearest-neighbour	0.955827	0.950141	0.956545	0.953332	0.955555
7	XGBoost	0.957082	0.951022	0.958282	0.954638	0.956792
8	K-nearest-neighbour with GridSearchCV	0.955827	0.950141	0.956545	0.953332	0.955555

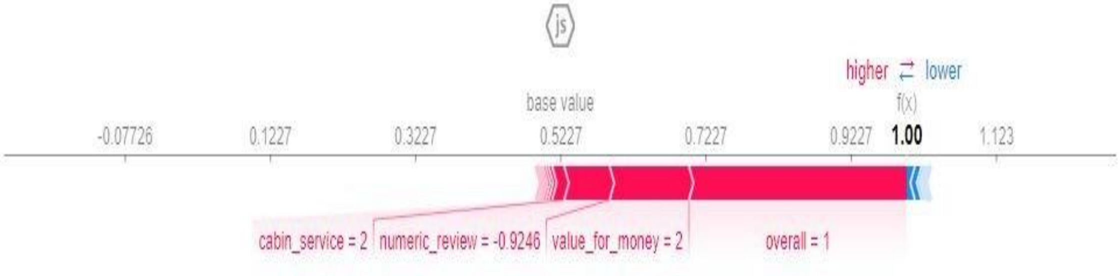
Model Explainability:

SHAP:

- In Shap JS summary we can see positive features overall, value for money,numeric_review combined red color block pushes the prediction toward right over base value and causing positive model prediction and it is common for all model.
- In Shap summary scatter plot we can see in scatter plot high overall,value for money,numeric_review,cabin service,ground_service positive features and low airline_British_airways is increasing positive prediction and it is common for all models. Also we can see that overall,value for money,numeric_review,cabin service,ground_service has high shap feature value.







Conclusion:

- Spirit Airways is the most frequently used airlines with a total count of around 2800 according to the dataset given aircraft A320 has travelled most frequently and also been used by most of the people.

- we can notice that Solo Leisure has highest value count. From this we can conclude that most of people who travel through airline travels in solo. Followed by College then Family. 77% of passengers chose to fly in economy class.most of the people prefers cost-effective economy class air travel and high income peoples are generally prefer business class as it is 2nd most popular cabin type

- We can also conclude that people tends to air travel more after june and from february to may they are not prefering air travel. july has the most air travel count

- We can see that people have given both 1 or 0 which we will consider from now on as positive and negative recomendation so to interpret it effectively to the solo leisure. This may because of the poor infrastructure or the service recieved by the people and positive recommedation may be because of low price for solo. But this is approximate analysis based on the data provided.
- review features ratings positiviley impacts overall rating of airlines and obviously it massively impacts airline businesses.when 'seat_comfort','cabin_service','food_bev','entertainment', 'ground_service', 'value_for_money' these features rating are high then overall rating of airlines are also high.

Conclusion:

- 44 % of passengers gave an overall rating of 7 and above on a scale of 10, for the services offered by the airlines.It implies that this section of people think that airlines are giving good services. people extremely dislikes ground-service(40%),food-beverage service(27%),value for money(30%),entertainment(30%) services of airlines. we can conclude that airlines have to work hard to improve their services otherwise it can negatively impacts airline business very soon.
- Also we can see that people gives the high positive recommendation to economic class in cabin. From this we can conclude that people love to travel in economic class as of low price also in same way we can see people give highest negative recommendation to economy class maybe because less infrastructure or service provided to them. Also we can see people have given highest positive recommendation to Business class it may be because of the quality of service provided to them in Business class and similarly negative recommendation because of high price of business class or less travelling percentage.
- From month vs no. of recommendation. We can see that people tends to travel most in the month of July considering the total of positive and negative recommendation combined.
- From overall vs recommended graph we can see which is perfectly understandable that negative recommendation has been given to the overall rating of 1.0 and high positive recommendation has been given to the overall rating of 10. But it is very true that highest negative recommendation has been given to overall rating of 1.0 which is really a matter of concern.
- In seat comfort people has given highest positive recommended to the seat of class 5 as compared to very low negative recommendation to the same. Also we can see seat of class 1 have been given highest negative recommendation as compare to its positive recommendation. Here we come to a conclusion it must be removed as early as possible.

Conclusion

- In cabin service rating people has given highest recommendation to rating to cabin service rating 5 as compare to its counterpart. From this we can conclude that cabin service is doing pretty good.
- In food and beverage rating people have given highest negative recommendation to rating 1.0 from this we can conclude that airline service has to improve their food delivery and quality service.
- In entertainment also we can see most people has given highest negative recommendation to entertaiment rating 1 which shows that airline has to improve their entertainment system as well.
- In ground service also we can see most people has given highest negative recommendation to ground service rating 1 which shows that airline has to improve their ground service.
- In value for money also we can see most people has given highest negative recommendation to value for money rating 1 which shows that airline has to make their flight service more cost effective.
- In model Selection we can see that Random Forest and XGBoost Model is having the same high Model Accuracy with a score 0.957082 but we can also see that recall, precision, f1-score and roc_auc_score of XGBoost model combined is giving higher score than Random Forest from which we have chosen XGBoost Model for further prediction.
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Thank you