Capstone Project “Falcone Airlines Customer Satisfaction”

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Executive Summary:

- **Problem Statement:**

  "Falcon Airlines" a US airline carrier aims to determine the relative importance of each parameter with regards to their contribution to passenger satisfaction.

  They made a survey to around 90k of their customers and asked them 23 questions, including a question if they are (in overall flight experience) "satisfied" or "neutral or dissatisfied".

  The Answers for 20 questions are based on likert scale (Excellent, good, etc)

  The remaining 3 questions were based on numeric answers.

  However, the dilemma is that they need to know the most significant variables that affect customers' satisfaction and the relationship between the variable and satisfaction i.e, if the airlines manages to increase the satisfaction of one of the variables by 1 point the overall satisfaction result will differ.

- **Brief Description of Methods:**

  First, I explore data and analyze it, fix outliers and structure and missing data, understand each variable and correlations between them.

  Then I start with variable transformation by transforming the variables to only "positive" and "negative.

  I transform "excellent", "good", "acceptable" to "positive''.

  "extremely poor", "poor'', "needs improvement" and "missing values" to "negative".

  After that I make another analysis for the new data and the correlations between them to get new insights.

  After studying all variables and focusing on the most important, I excluded 10 variables based on my intuition and kept only the most significant ones. This led to reduced complication and led to the excluded variables not affecting the overall customer satisfaction.

  Starting with models and after splitting the data to train and test, I make a CART, Random Forest and logistic regression models then evaluate them.

  I make comparisons based on KPIs and the most important variables that fit my logic.

  Finally, I will interpret the models and make final recommendations.

- **Final Insights:**

I focus on the most important 4 variables to minimize the effort and time and maximize the benefit and return on investment.

All three models have Inflight entertainment (all number 1).

Variables Importance:

	CART	FOREST	Logistic Regression
1	Inflight Entertainment	Inflight Entertainment	Inflight Entertainment
2	Ease of Online booking	Food n Drink	Ease of online booking
3	Check in service	Check in service	Online boarding
4	Online boarding	Ease of online booking	Check in service

Forest model had the variable “food n drink” which is more reasonable to satisfy customers than “online boarding”.

Model comparisons:

Metric/Model	CART Train	Forest Train	Logistic Regression Train
Error rate	0.2563	0.2011081	0.2544623
Accuracy	0.7437	0.7988919	0.7455377
Sensitivity	0.7154	0.7984987	0.6989455
Specificity	0.7652	0.7991585	0.7872234
AUC	0.7692007	0.8408412	0.808
KS	0.4842302	0.5907522	
Gini	0.2817875	0.486449	

From Coefficient variance increase percentage of variables

inflight_entertainmentpositive	5.66501491
ease_of_onlinebookingpositive	4.39055963
checkin_servicepositive	2.64212727
online_boardingpositive	1.70330809

- **Recommendations:**

I recommend “Falcon Airline” should concentrate on enhancing the following variables:

1- Inflight Entertainment
2- Food and Drink
3- Ease of online booking
4- Online boarding
5- Check in Service.

The most important 2 variables are “inflight entertainment” and “food and drink”, because “inflight Entertainment” is easy to be enhanced and does not require a lot of time and money and enhancing it is essential to all customers.

As for “Food and Drink” also this is an easy variable to be upgraded with little effort and money, they can satisfy the 50% of the passengers that are dissatisfied from this service.

80% of the passengers are satisfied from the last 3 variables, which means enhancing them will benefit the overall outcome.

Enhancing online booking and online boarding is easy and doesn't require a lot of money and time.

Overall customer satisfaction is good, “Falcon Airflight” is doing good and little effort can increase the overall satisfaction which will positively affect the reputation of “Falcon Airline” and the return on investment**.**

Model Selection:

- **Checking data and preparing it:**

  I checked both datasets (flight data) and (survey data) changed variables to correct format (factors) and left “delays in mins” to integers.

  I merged both datasets into 1 new dataset named it (fli_sur) using the common “ID” variable between. And deleted the ID variable.

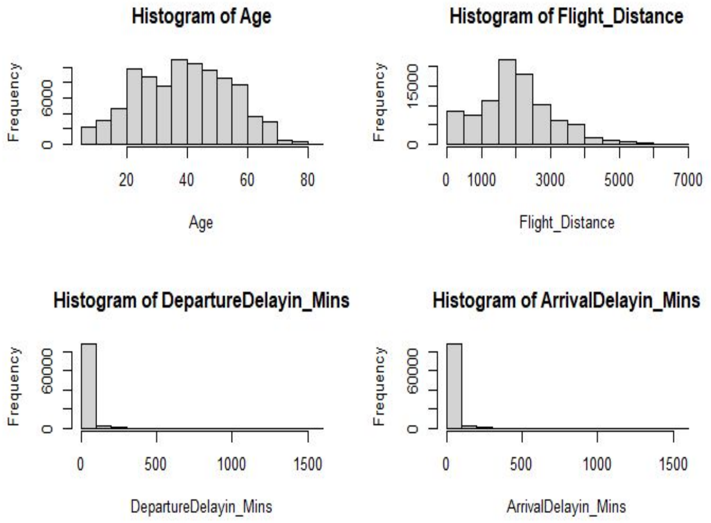
  We have missing values, less than 0.004 from whole data, so i deleted all those observations.

  There are dashes in some of the variables, maybe customers skipped or forgot to fill it. I will replace the dashed into “neutral”

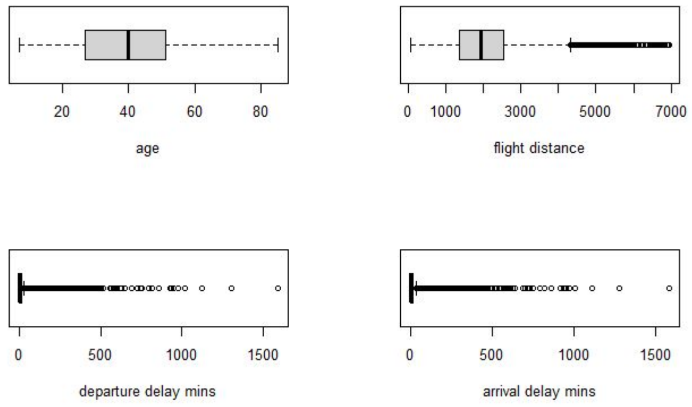
  Now the data is ready to EDA

- **EDA**

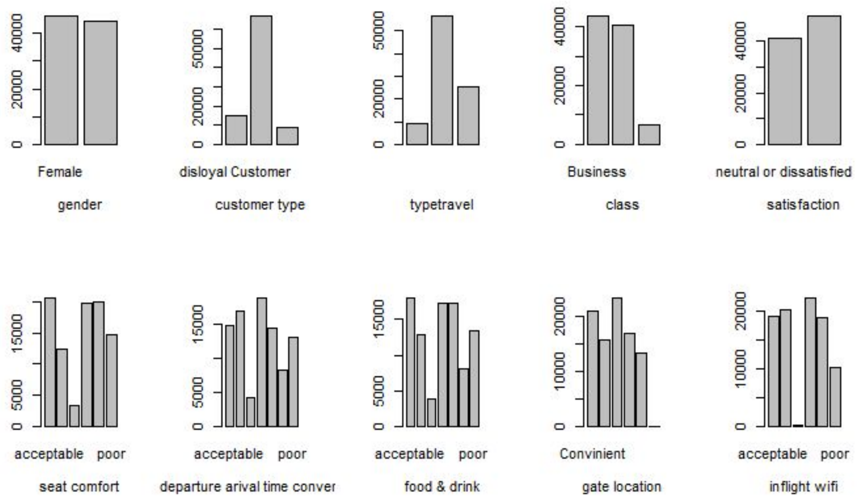
  Univariate:



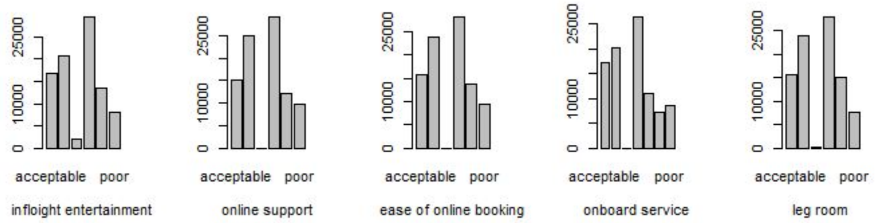
*** Age is normal distribution**
*** Flight distance have outliers**
*** delays are skewed a lot and it makes sense, because of unexpected delay**



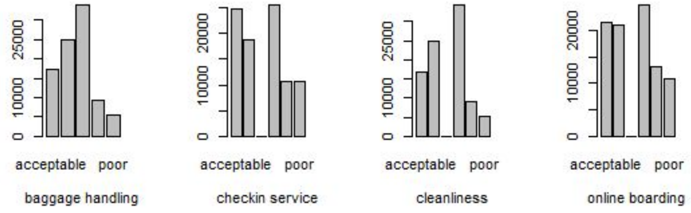
*** Outliers in the delayed must be treated**



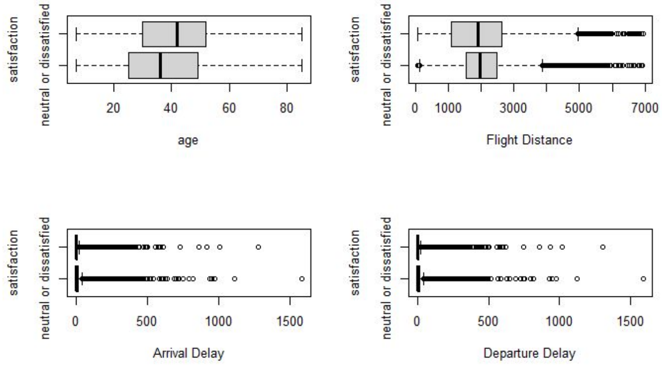
* genders are almost equal
* loyal customer are more than not loyal
* business travel is more
* more satisfied than not satisfied
* more seat comfort positive
* more positive inflight
* inflight wifi



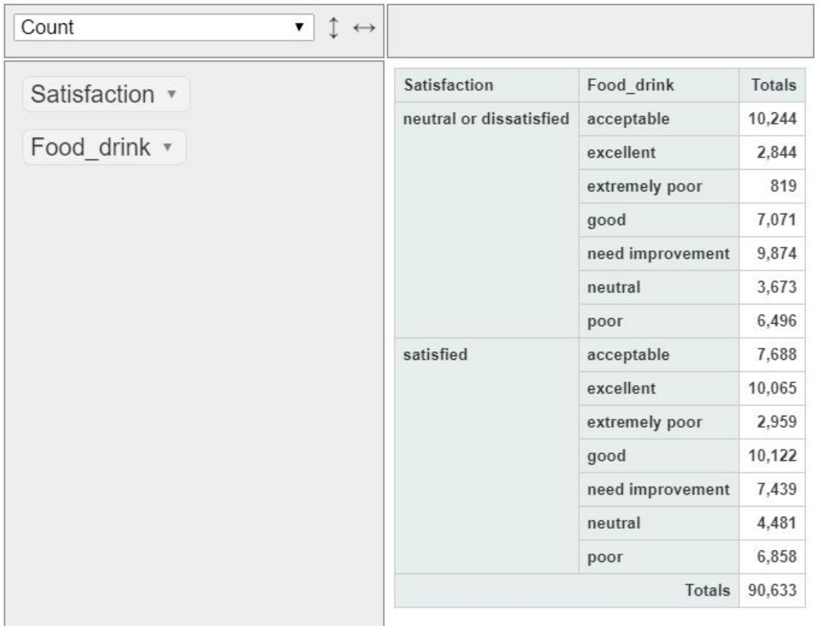
More positive



Bivariate:

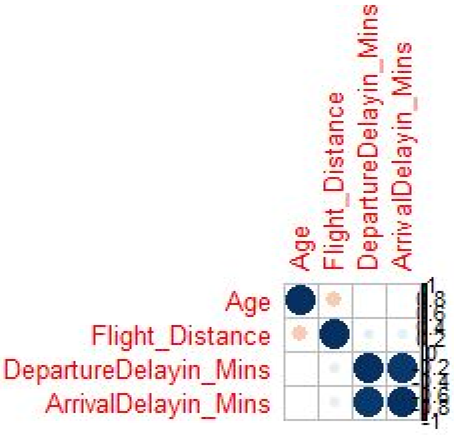


Correlations between Satisfaction and numeric variables



Satisfaction	Food_drink	Totals
neutral or dissatisfied	acceptable	10,244
	excellent	2,844
	extremely poor	819
	good	7,071
	need improvement	9,874
	neutral	3,673
	poor	6,496
satisfied	acceptable	7,688
	excellent	10,065
	extremely poor	2,959
	good	10,122
	need improvement	7,439
	neutral	4,481
	poor	6,858
	Totals	90,633

*** food n drink are almost 50% * around 10 dissatisfied says it needs improvement , so easily to satisfy them**

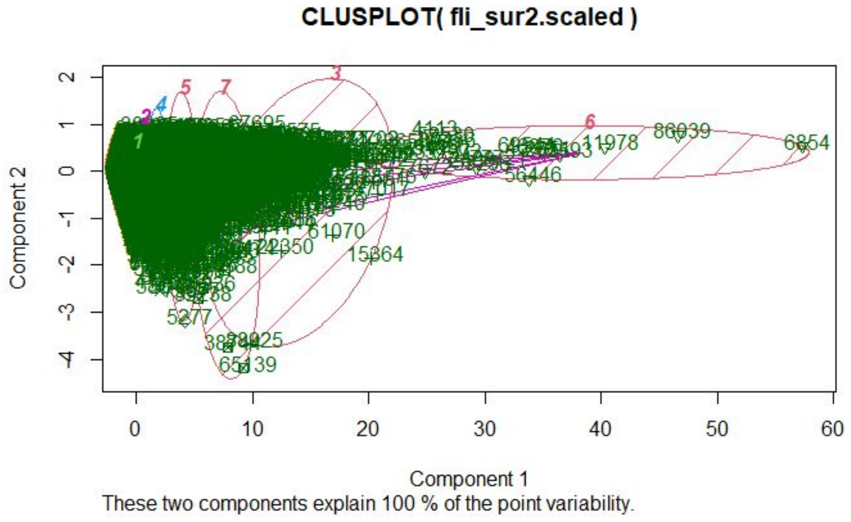


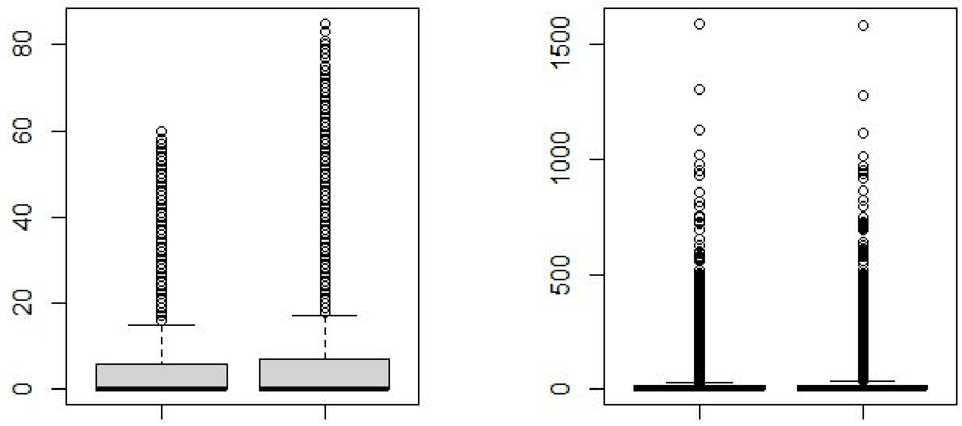
*** negative and small correlations between them.**
*** not show a lot of details**

- **Removal of unwanted variables**

  I removed based on my intuition and my flight experience variables that will not affect customer satisfaction and kept only: 1- departure delays 2- arrival delays 3- satisfaction 4- time conventinet 5- food n drink 6- wifi - inflight entertainment 7- online boarding 8- ease of booking 9- baggages 10 - check in 11- cleanliness 12- online booking 13- check in service

- **Outlier Treatment**





after treatment

before treatment

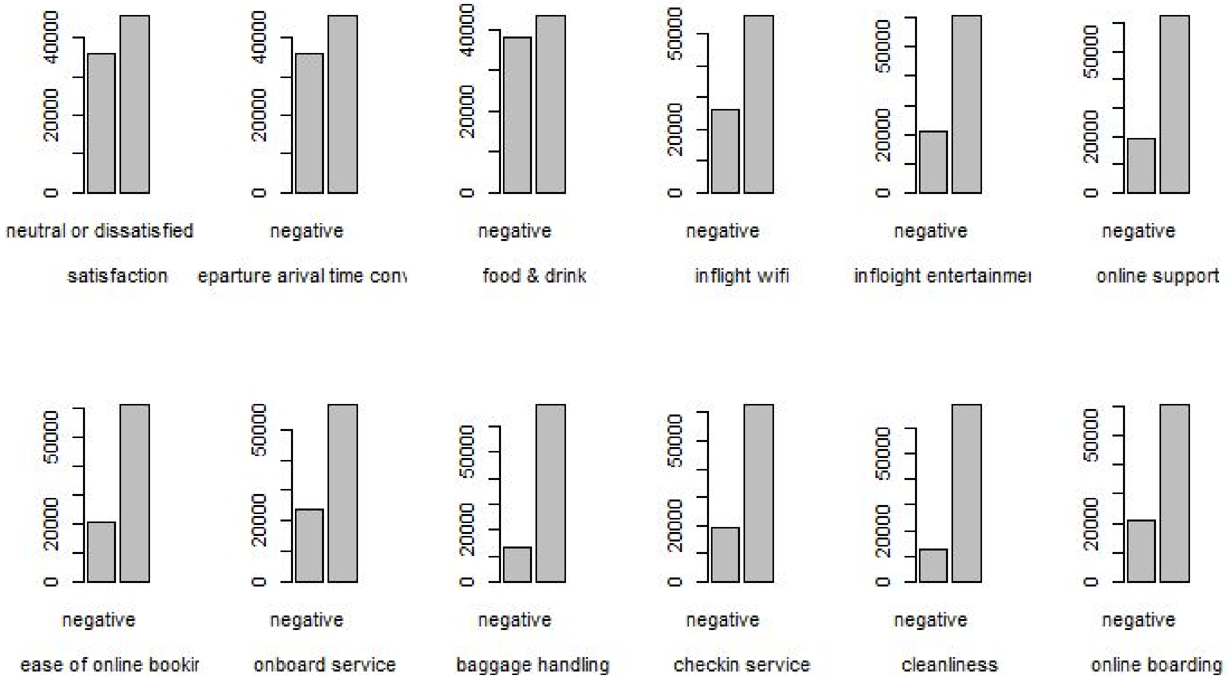
After treating the outliers , this is the best I could do and deleted around 9000 observations!

- **Variable Transformation**

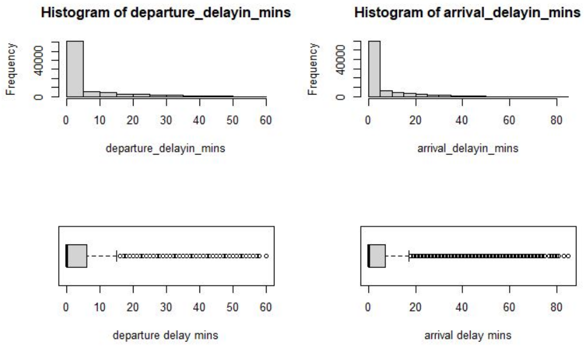
I transformed all factors into 2:

“Positive” = “exellent” , “good” and “acceptable”
“Negative” = “extremelly poor” , “poor” , “need importvment” and “neutral”
So now I have only positive and negative.

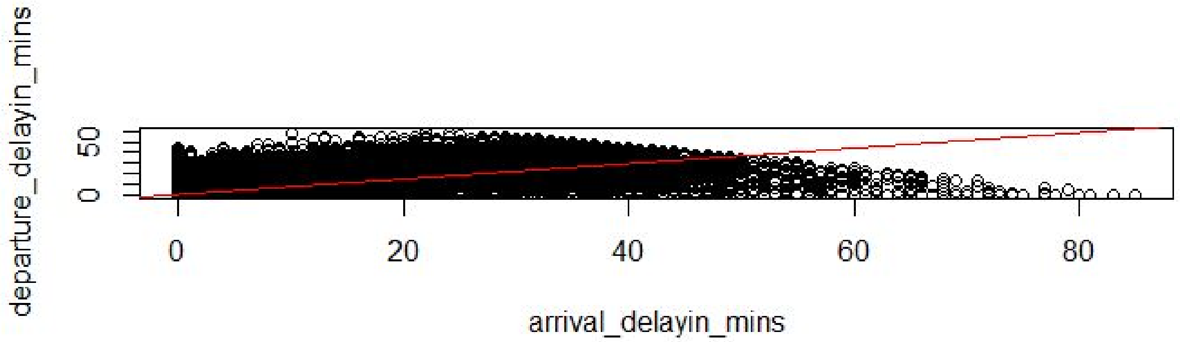
- **EDA**

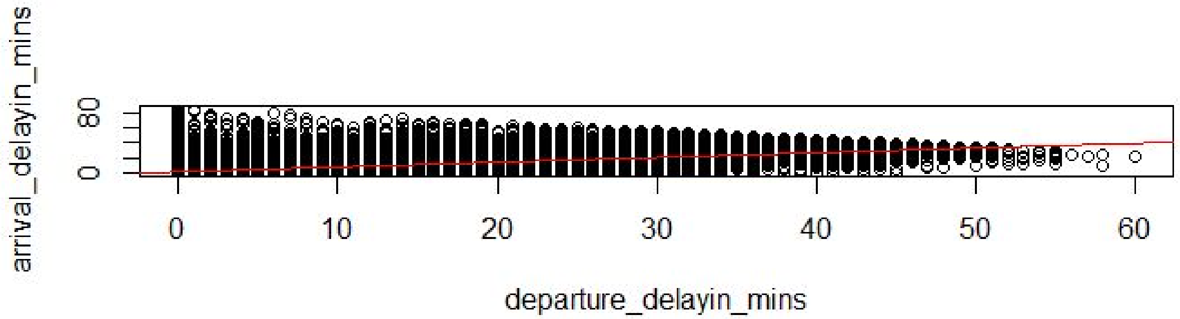


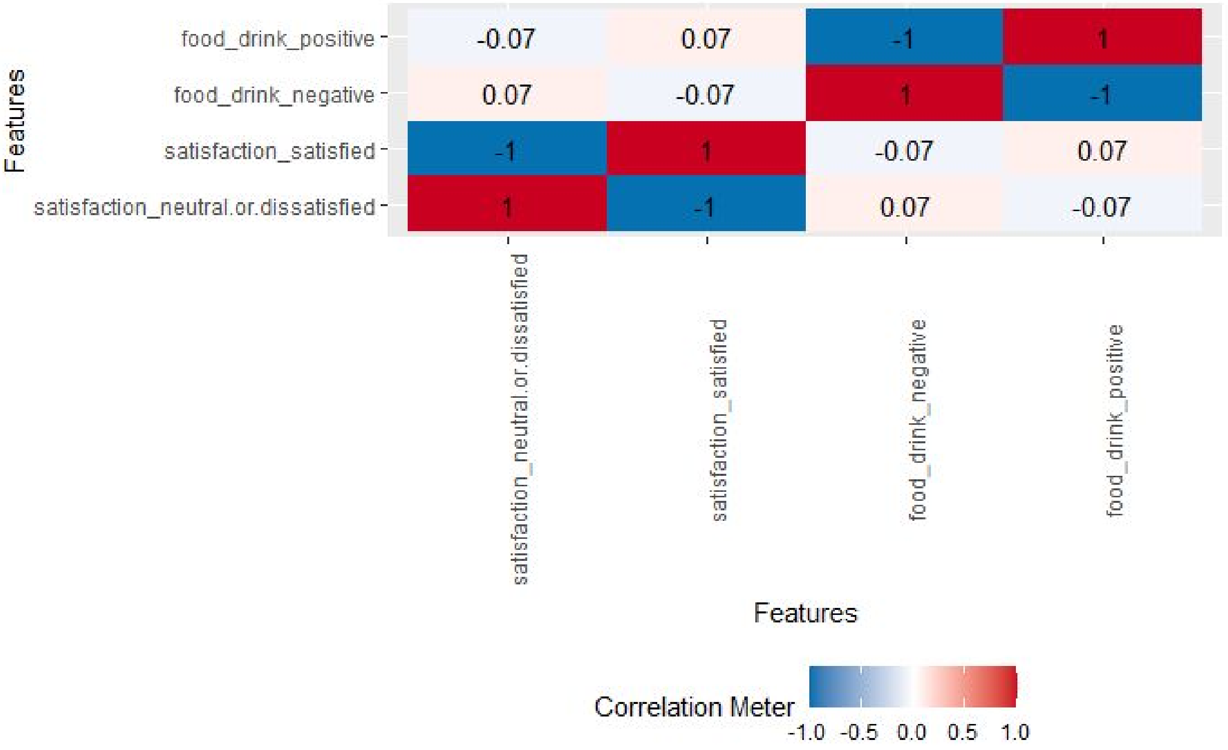
0
20000
40000
50000
neutral or dissatisfied
satisfaction
negative
eparture arival time conv
negative
food & drink
negative
inflight wifi
negative
infloight entertainmer
negative
online support
negative
ease of online bookir
negative
onboard service
negative
baggage handling
negative
checkin service
negative
cleanliness
negative
online boarding



Histogram of departure_delayin_mins
Frequency
0
40000
0 10 20 30 40 50 60
departure_delayin_mins
Histogram of arrival_delayin_mins
Frequency
0
40000
0 20 40 60 80
arrival_delayin_mins
0 10 20 30 40 50 60
departure delay mins
0 20 40 60 80
arrival delay mins


departure_delayin_mins
0
50
0
20
40
60
80
arrival_delayin_mins


arrival_delayin_mins
0
80
0
10
20
30
40
50
60
departure_delayin_mins


Features
food_drink_positive
food_drink_negative
satisfaction_satisfied
satisfaction_neutral.or.dissatisfied
-0.07
0.07
-1
1
0.07
-0.07
1
-1
-1
1
-0.07
0.07
1
-1
0.07
-0.07
satisfaction_neutral.or.dissatisfied
satisfaction_satisfied
food_drink_negative
food_drink_positive
Features
Correlation Meter
-1.0
-0.5
0.0
0.5
1.0

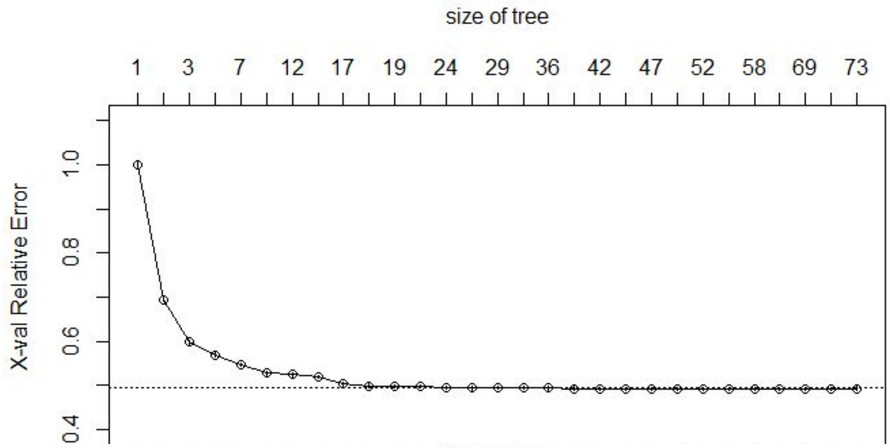
- **Modeling Process**

First I split the data in train and test datasets so I make the model on train and check the validation of the random observations on the test dataset, I will make 3 models - CART - RandomForest - Logistic Regression and we will compare results for all models on train and test using the most important metrics.

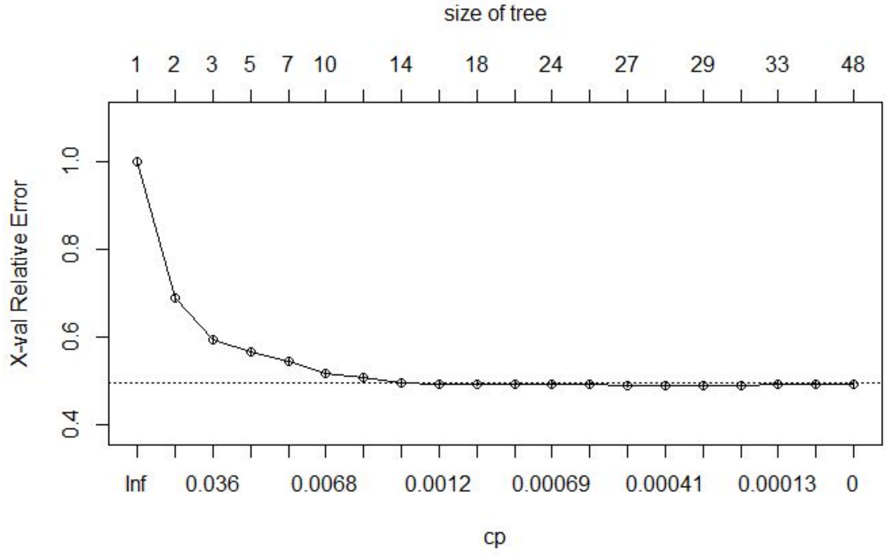
*** All results shown in this report are final results after choosing the correct parameters,**

*** Check R code for coding process**

- **CART: Comparisons between Train and Test**

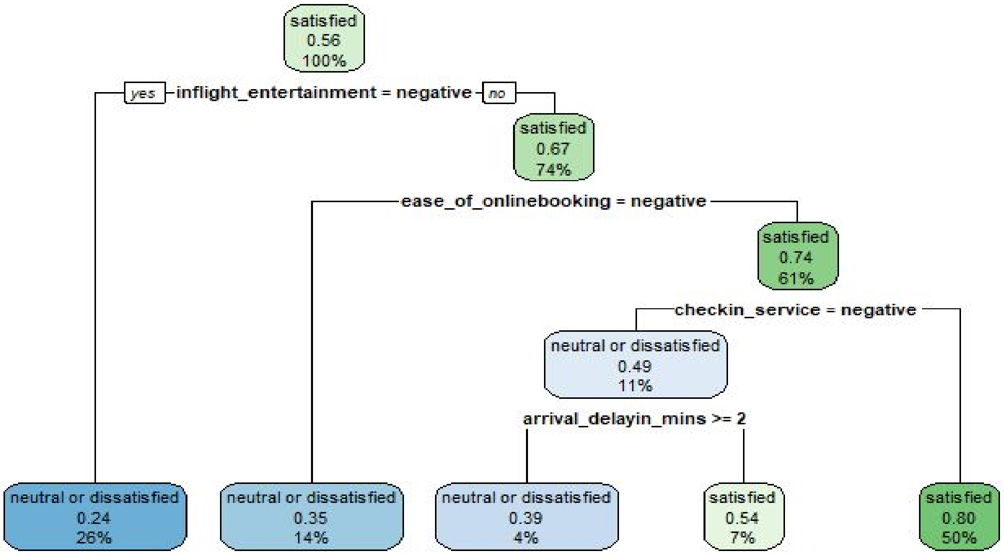


Train data set CP plot
CP = 1.7837e-04



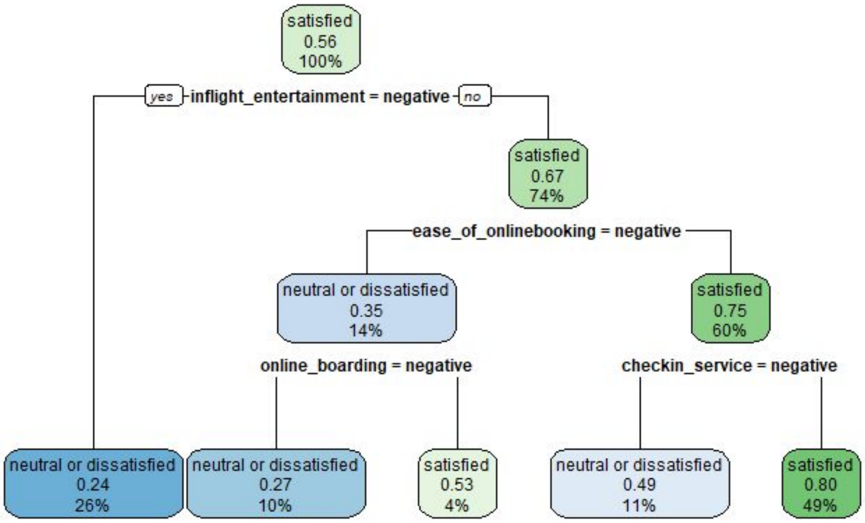
Test data set CP plot
CP = 6.4743e-04

After Pruning and increasing the minbuckets to 2000 the result is:



Train Cart

1- Entertainment is at first split 0.56 satisfied - 2- ease of online booking -
3- checkin service - 4- arrival delays
I increased the buckets to show the first 4 important variables to understand which variables we need to know on how can we enhance customer satisfaction from the right prediction



Test Cart

1- Entertainment 0.56 satisfied - 2- ease of online booking - 3-

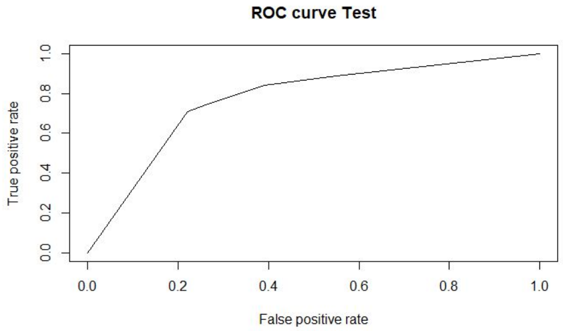
checkin service - 4- online boarding

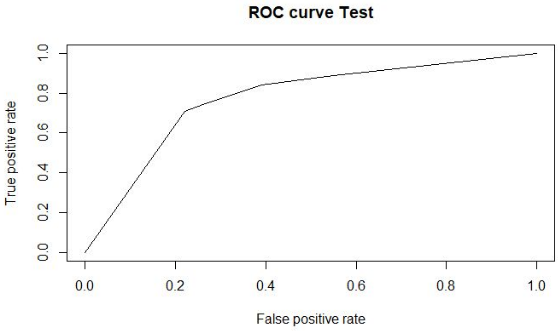
Prediction (Train)	neutral or dissatisfied	satisfied
neutral or dissatisfied	17620	7609
satisfied	7010	24795

:

Prediction (Test)	neutral or dissatisfied	satisfied
neutral or dissatisfied	7930	2882
satisfied	3443	10188

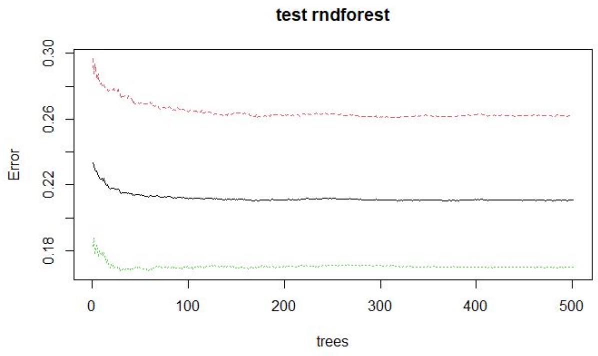
Metric/Model	**CART Train**	**CART Test**
Error rate	0.2563	0.2587
Accuracy	0.7437	0.7413
Sensitivity	0.7154	0.7174
Specificity	0.7652	0.7591
AUC	0.7692007	0.7727487
KS	0.4842302	0.4893509
Gini	0.2817875	0.2819473

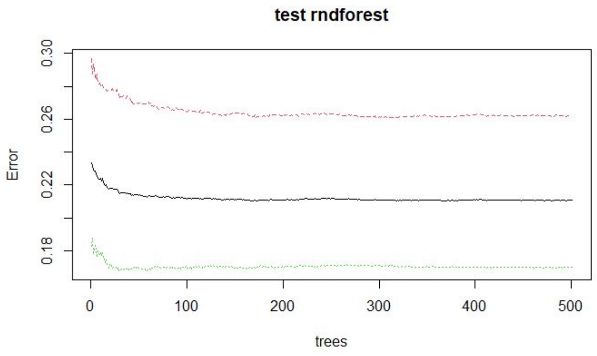




Both models match , not the best error rate.

- **RandomForest: comparison between train and test datasets**

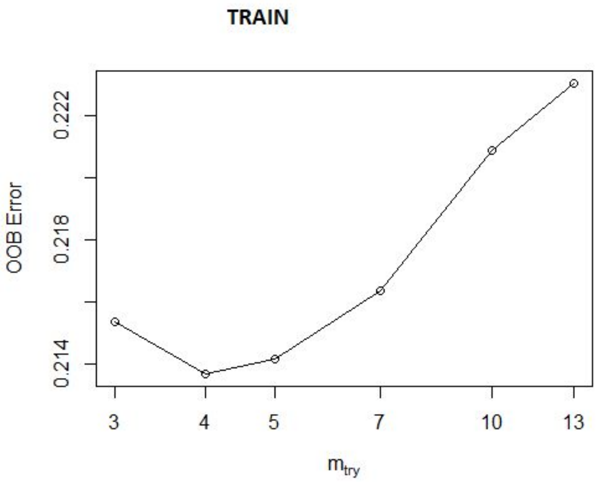


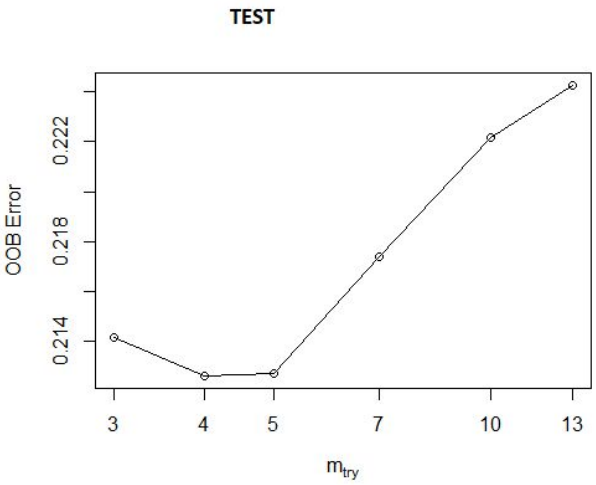


I will use 51 trees.

Prediction (Train) OBB 21.57%	neutral or dissatisfied	satisfied	class.error
neutral or dissatisfied	17956	7273	0.2882794
satisfied	4893	26912	0.1538437

Prediction (Test) OBB 21.09%	neutral or dissatisfied	satisfied	class.error
neutral or dissatisfied	7974	2838	0.2624861
satisfied	2318	11313	0.1700536





I will build a refined tree

Prediction (Train) 21.33%	neutral or dissatisfied	satisfied	class.error
neutral or dissatisfied	18051	7178	0.2845139
satisfied	4951	26854	0.1556673

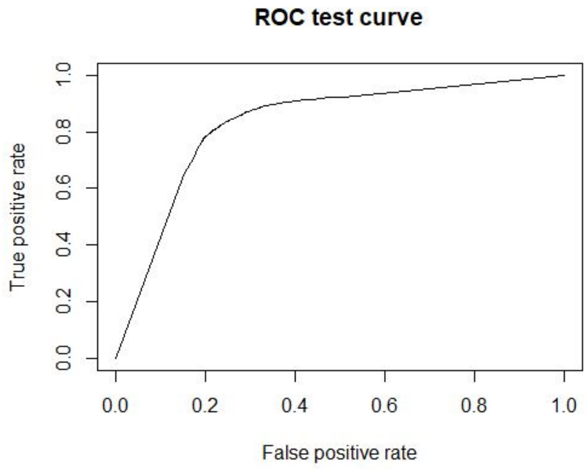
Prediction (Test) 21.19%	neutral or dissatisfied	satisfied	class.error
neutral or dissatisfied	7966	2846	0.2632260
satisfied	2334	11297	0.1712273

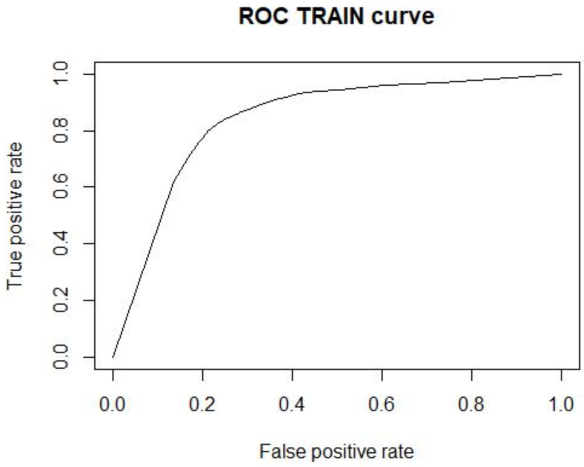
Comparing variables importance between train and test

	importance(train.rndforest)	**importance(test.rndforest)**
1	inflight entertainment	inflight entertainmanet
2	food n drink	ease of online booking
3	checkin servioce	food n drink
4	easeofonlinebooking	check in service

* same variables shown in both datasets , but in different sort except for entertainment

Metric/Model	**Forest Train**	**Forest Test**
Error rate	0.2011081	0.1910567
Accuracy	0.7988919	0.8089433
Sensitivity	0.7984987	0.7983871
Specificity	0.7991585	0.8166207
AUC	0.8408412	0.8287476
KS	0.5907522	0.5894085
Gini	0.486449	0.4924352





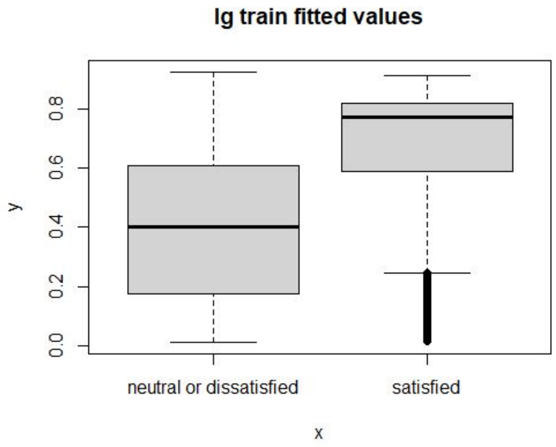
Both models match , and still not the best error rate and AUC but still the importance of variables makes sense and prediction is fair

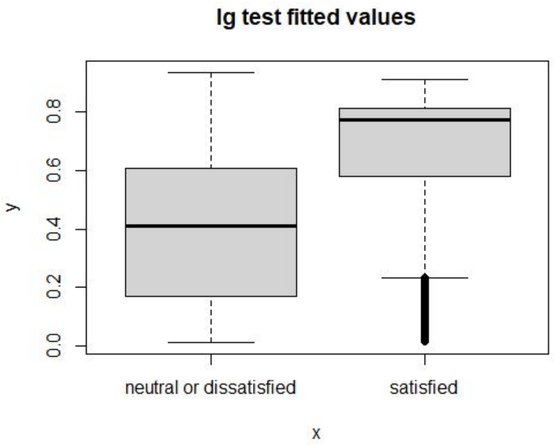
- ***Logistic Regression: comparison between train and test***

Comparing variable importance

	varImp(fit.train)	**varImp(fit.test)**	**Lg.model.train Coefficients**	**Lg.model.test Coefficients**
1	inflight entertainment	inflight entertainment	Entertainment	Entertainment
2	easeofonlinebooking	ease of online booking	easeofonlinebooking	easeofonlinebooking
3	online_boarding	online_boarding	Check in service	Check in service
4	checkin_service	checkin_service	Onboard service	Onboard service

Both datasets variable inflations are below 5

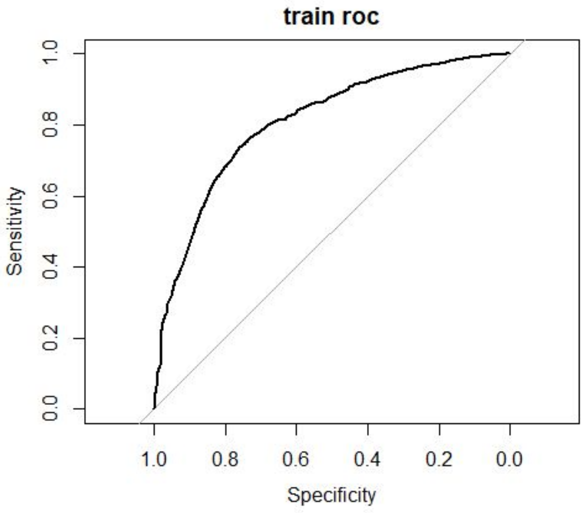


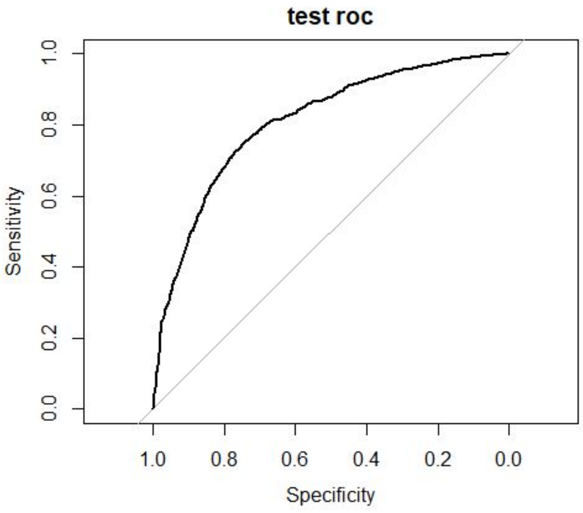


Prediction (Train) **> 0.6**	neutral or dissatisfied	satisfied
neutral or dissatisfied	18824	6405
satisfied	8108	23697

Prediction (Test) **>0.6**	neutral or dissatisfied	satisfied
neutral or dissatisfied	8080	2732
satisfied	3479	10152

Metric/Model	**Logistic Regression Train**	**Logistic Regression Test**
Error rate	0.2544623	0.2541014
Accuracy	0.7455377	0.7458986
Sensitivity	0.6989455	0.6990224
Specificity	0.7872234	0.7879541
AUC	0.808	0.8093





Variable/ Model	**Logistic Regression Train**	**Logistic Regression Test**
inflight_entertainmentpositive	5.66501491	5.39446106
ease_of_onlinebookingpositive	4.39055963	4.74197011
checkin_servicepositive	2.64212727	2.55791667
online_boardingpositive	1.70330809	1.78865377

This shows the increase of satisfaction when increasing those variables

Model comparisons:

Metric/Model	**CART Train**	**Forest Train**	**Logistic Regression Train**
Error rate	0.2563	0.2011081	0.2544623
Accuracy	0.7437	0.7988919	0.7455377
Sensitivity	0.7154	0.7984987	0.6989455
Specificity	0.7652	0.7991585	0.7872234
AUC	0.7692007	0.8408412	0.808
KS	0.4842302	0.5907522	
Gini	0.2817875	0.486449	

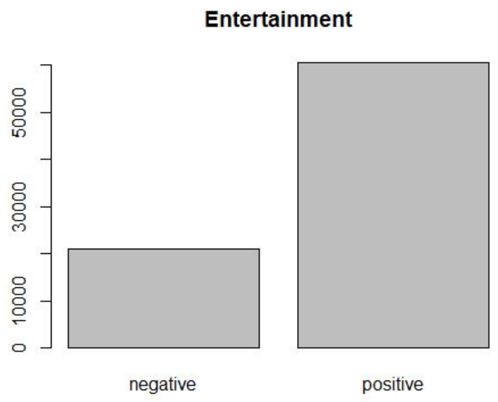
Variables Importance:

	CART	**FOREST**	**Logistic Regression**
1	Inflight Entertainment	Inflight Entertainment	Inflight Entertainment
2	Ease of Online booking	Food n Drink	Ease of online booking
3	Check in service	Check in service	Online boarding
4	Online boarding	Ease of online booking	Check in service

- When reading numbers , randomforest had the best numbers and the most stable model , in regard of train and test
- When comparing the importance of variables and the weight it affects customer satisfaction forest had the most reasonable variables
- this table will give us a good indication on how we can improve the satisfaction of the customers , just by knowing the most 4 important variables will give us the opportunity to enhance them, or maybe the least costly ones and easy to enhance that it would need little time and little money to upgrade it, or maybe the 4 variables that mostly affects dissatisfaction. I,e Whichever approach we chose will definitely enhance the overall satisfaction just by investing in them..
- The 3 models intersect in:
    - Inflight entertainment (all number 1)
    - Ease of online booking
    - Check in service .
- CART and LR models intersect in:
    - Online boarding

  This variable and due to experience , online boarding, is not important that much, we will have to investigate more

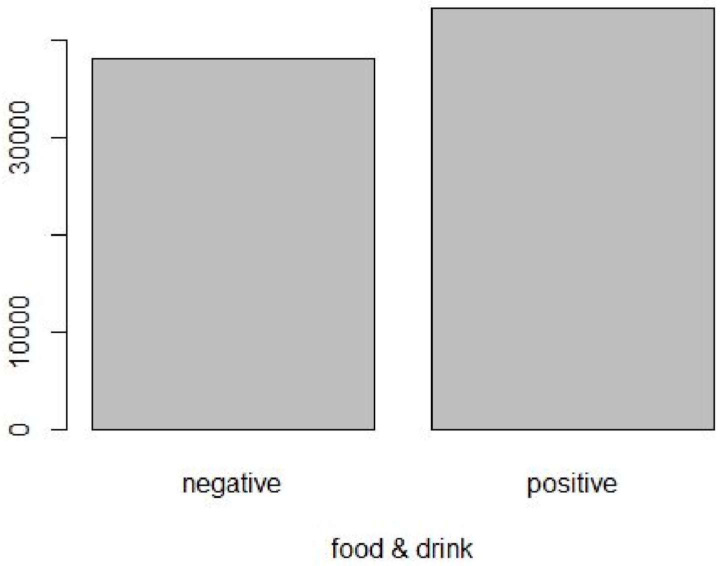
- Forest model had a unique variable, food and drink, which is more reasonable and it fit my experience on inflights satisfaction.
- Having in mind that when i investigated in the correlations between satisfaction and dissatisfaction and entertainment.I went back to submission 2 and found a high correlations between the 2 variables as the below :



Positive is 3 times negative

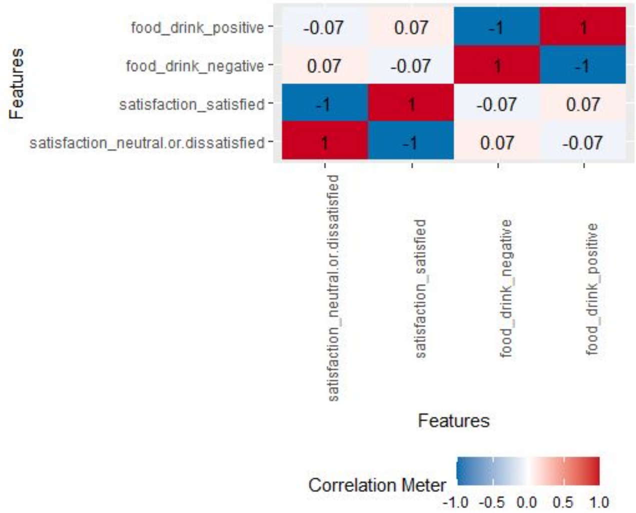
	negative	positive	positive/total satisfied or dissatisfied
neutral or dissatisfied	16012	20029	0.55
satisfied	4952	40484	0.89

- Investigating in food and drink and found the correlation is very low as below:



It is almost 50% 50%.

	negative	positive	positive/total satisfied or dissatisfied
neutral or dissatisfied	18282	17759	0.49
satisfied	19874	25562	0.56



We need to investigate, because if food and drink is significant, upgrading it might be simple

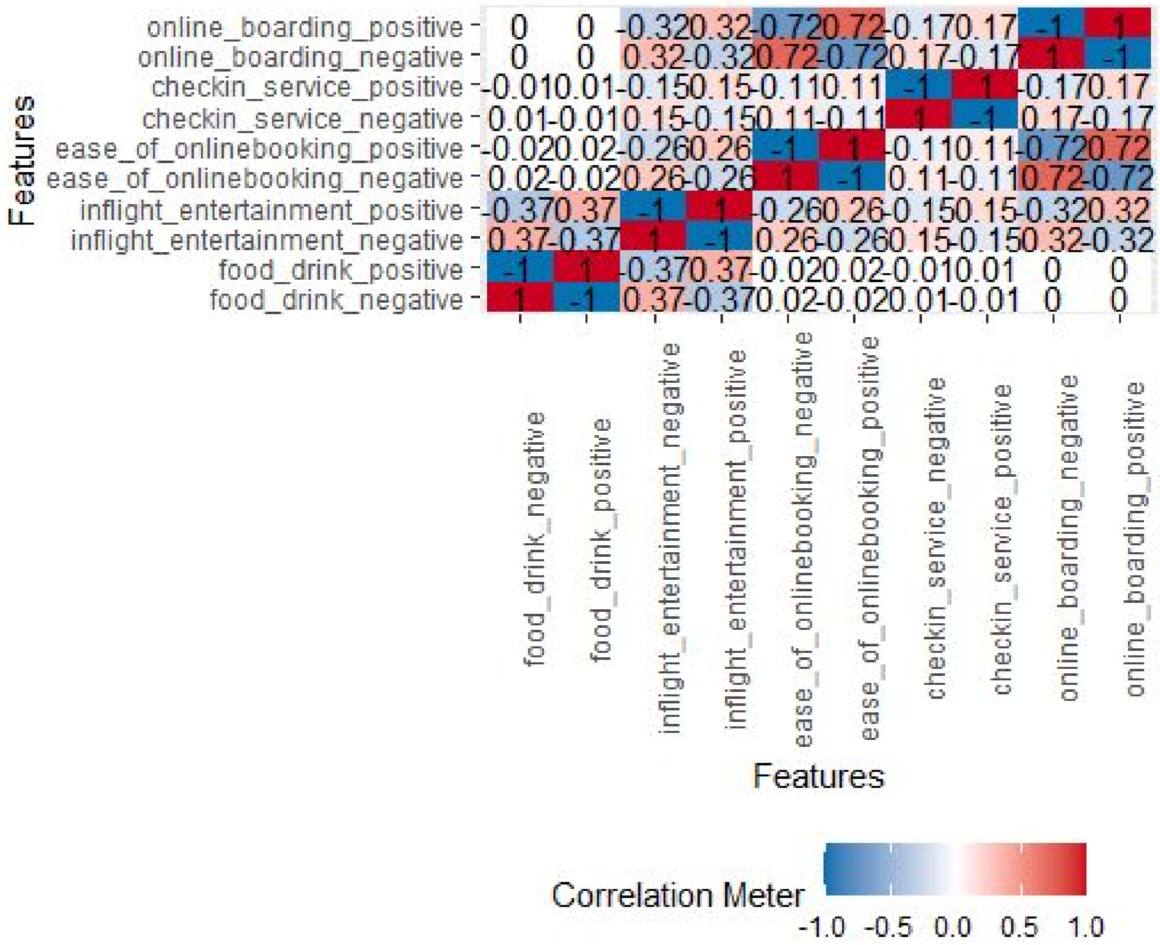
- I will choose the forest model because it has better insights and more reasonable ones.

Model Interpretation:

Random Forest

	importance(train.rndforest)	**importance(test.rndforest)**
1	inflight entertainment	inflight entertainment
2	food n drink	ease of online booking
3	checkin service	food n drink
4	easeofonlinebooking	check in service

- I was concerned here because of the difference of the importance between train and test ,



- * all important variables that need to be investigated .

Conclusions and Recommendations:

Falcon Airlines now can focus on the most important variables in regards to affecting customer satisfaction and in regards to the increase of satisfaction percentage if those variables were enhanced.

They can start with **Inflight Entertainment**:

- it can be upgraded with least time and money if the system they have is upgradable, but if they need new hardware, a new analysis regarding the ROI must be implemented.
- I suggest focusing on targeting people ages between 7-30 (30% of total passengers) They follow trends and stay up to date with new technologies (ex. Adding new games, music and movies or adding network gaming between the passengers will add up to the overall passenger satisfaction.
- Older passengers might care about news, documentaries and movies, which means; other channels of entertainment should be of reach.
- As predicted from the logistic regression model, if we increase the satisfaction for the ''Inflight entertainment'' by 5 points, the customer satisfaction will increase by 66% which proves that it has a good impact. Achieving these results will not be easy.
- Overall satisfaction of the inflight entertainment is good, because 70% of the passengers have positive feedback on this variable.
- Inflight Entertainment took the first position in all models, so this variable is the most important.

Food And Drinks:

- It can be upgraded with minimum time and effort, by adding some treats or making some changes on the served menu.
- It is an important variable, from my experience, even though it was only mentioned in RF model but I gave it second importance after Inflight entertainment
- Around 50% of the customers have positive feedback, which is a good base to start from towards decreasing the number of unsatisfied customers. By making small changes in the served menu or adding extra treats the airlines will be able to to satisfy a larger percentage.

Ease Of online Booking and online boarding

- It is important to update and upgrade those variables, as the online services must always be up to date and must always be easy, effective and user friendly.
- 80% of the customers have positive feedback on those variables, which means that the company has a good online service, but enhancing those services will affect positively to the company.
- As in the logistic regression coefficients, if we increase online booking by 4 points the odds of satisfaction will increase by 39% and online boarding will increase by 1 point the odds will increase by 70%.
- I recommend they hire a reputable consulting online and user experience company and make some A/B testings to finally reach the best and easiest and more convenient online booking and boarding system.
- Both variables are easy and cheap to upgrade and the effect will be positive.

Check in Service

- All models predicted about the importance of this variable even though it is in the grey area, so they need to make another deeper analysis to understand the significance of this variable.

Overall customer satisfaction is good, “Falcon Airflight” is doing good and little effort can increase the overall satisfaction which will positively affect the reputation of “Falcon Airline” and the return on investment**.**

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The End