Final Project

Lauren Walker and Shanaya Piramal

Introduction

Project Motivation and Revelance

The data set we selected for our final project is the "Flights" data set. We got this data set from Kaggle, and it contains 3000153 unique observations, each representing a flight from one of India's 6 metro cities. In order to collect the data, researchers made use of the Octoparse scraping tool to extract data from the website "Ease My Trip". Data was collected in two parts: one for economy class tickets and another for business class tickets. The data was collected over a period of 50 days, from February 11th to March 31st, 2022.

While Covid-19 took a toll on a lot of industries, one of the industries that it took a major toll on was the Airline industry. As a result, flight prices have significantly increased (https://www.nerdwallet.com/article/travel/travel-price-tracker). Both of us have had a passion for travelling and seeing new places. However, as college students, we understand that travelling is a big cost. Hence, exploring how to strategically book tickets, depending on the number of stops, arrival/destination time, and airline is a topic that interested us.

As travel becomes a significant part of our lives again, this project has practical applications for individuals, businesses, and policymakers and can contribute to a better understanding of air travel pricing dynamics.

Data

Our data has 300153 observations and 12 variables. Each row in our dataset represents a particular flight. Each of the variables represent attributes of the flight. The variables are explained below:

Table 1: Variables Explained

Variable	Explanation
Airline	The name of the airline company is stored in the airline column. It is a categorical feature having 6 different airlines.
Flight	Flight stores information regarding the plane's flight code.
Source City	City from which the flight takes off.
Departure Time	This is a derived categorical feature obtained created by grouping time periods into bins. It stores information about the departure time and have 6 unique time labels.
Stops	A categorical feature with 3 distinct values that stores the number of stops between the source and destination cities.
Arrival Time	This is a derived categorical feature created by grouping time intervals into bins. It has six distinct time labels and keeps information about the arrival time.
Dest City	City where the flight will land. It is a categorical feature having 6 unique cities.
Class	A categorical feature that contains information on seat class; it has two distinct values: Business and Economy.
Duration	A continuous feature that displays the overall amount of time it takes to travel between cities in hours.
Days Left	This is a derived characteristic that is calculated by subtracting the trip date by the booking date.
Price	Target variable stores information of the ticket price in INR.

https://www.kaggle.com/datasets/shubhambathwal/flight-price-prediction

Research Question and Hypothesis

After doing some research, we found out that the typical price of a domestic flight in India is ~ 7,000 INR (As per SkyScanner, in May 2023. Keeping in mind our motivation for this project, the main research question that we will explore through our final project,is: "For flights that are departing out of cities, to what extent do the source destination, duration, departure time, and number of days before booking the flight influence the predictive odds of a flight being priced above 7,000 INR?"

Our formal null hypothesis and alternative hypothesis based on this research question are as follows:

Null Hypothesis H_0: None of the aforementioned factors will be predictive of the odds that the flight price is above 7,000 INR.

Alternative Hypothesis H_1: At least one of the aforementioned factors will be predictive of the odds that the flight price is above 7,000 INR.

Data Cleaning

We first checked our data for missing values and duplicates. After looking through our data, we realized that we had none of the aforementioned problems. However, we still felt the need to modify certain variables to make our modelling process smoother and conduct an effective EDA.

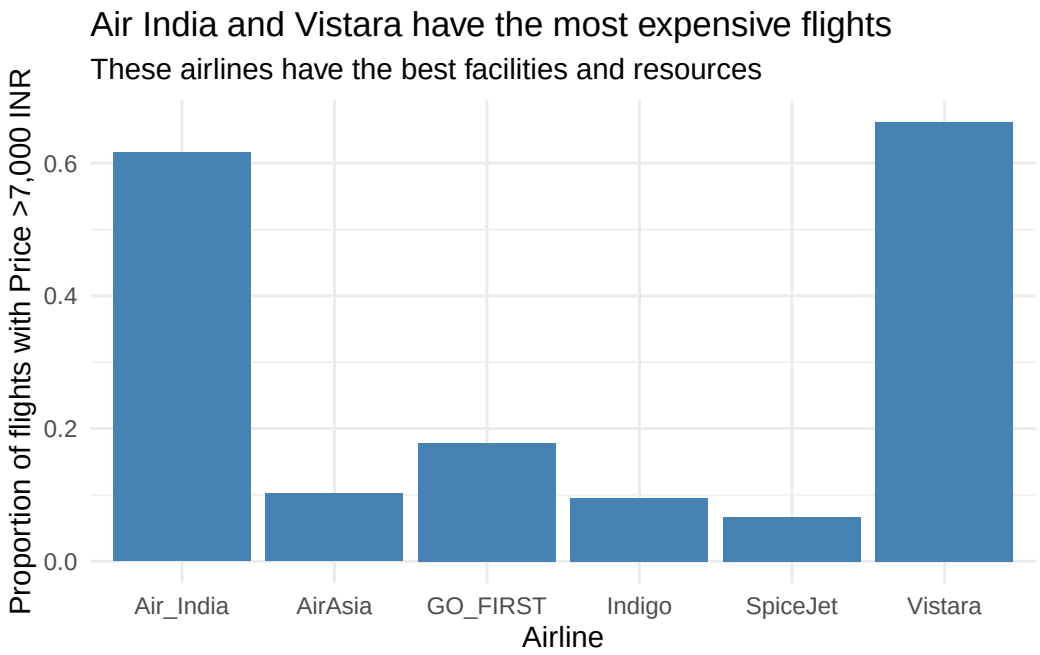
Since Mumbai and Delhi are the two biggest Hubs in India, we decided to focus our research project with these two cities as our primary source and destination.

This then reduces our number of observations to 30,098 flights.

Our main change was to our main variable of interest. We converted it to a binary variable, 1 for if it was greater than 7,000 INR and 0 if it was less than 7,000 INR.

Exploratory Data Analysis

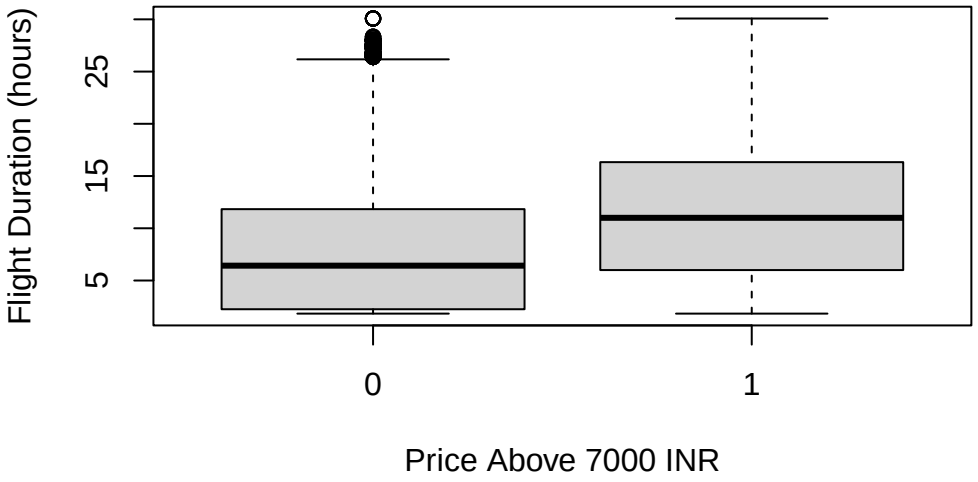
Before we explore our research question, we are going to analyze summary statistics and other relevant relationships between our main response variable of interest, Ticket Price, and other variables in the data set such as duration, airline, class and days left. By understanding the patterns behind these trends, we will be able to effectively explore our research question.



National airlines such as Vistara and Air India have the highest proportion of flights that we are considering expensive. The more commercial airlines have cheaper options. I found this quite interesting, because I would assume the national airlines would be cheaper and more

affordable to all. We also see a great difference between the proportion of expensive flights within the airlines. This suggests that the airline chosen might be predictive of the odds of a flight being overpriced.

```
boxplot(duration~binary, data = flights2, title="Car Milage Data",
   ylab="Flight Duration (hours)", xlab="Price Above 7000 INR")
```



Another important factor to consider is the duration of the flights. Based on the box plot, we observe that the median flight duration as well as the middle 50% of flight durations for flights priced above 7,000 INR is about 5 hours more than the median flight duration and middle 50% of the data for flights priced 7,000 INR or below. Moreover, we notice that the box plot for fights costing 7000 or less INR is more right skewed than the box plot for flights costing more than 7000 INR, suggesting that more flight duration lie on the lower end of flight durations compared to flights costing more than 7000 INT. These findings indicate that flight durations are longer for flights costing more than 7000 INR than that of flights costing 7000 or less INR. These results were not suprising to us because we assumed that flights that lasted longer would cost more.

Results

In order to answer our research question - for flights that are departing out of cities, to what extent do the source destination, duration, departure time, and number of days before booking the flight influence the predictive odds of a flight being priced above 7,000 INR? - we created a logistic regression model.

```
m1 <- glm(binary ~ destination_city + duration + departure_time + days_left,
          data = flights2,
          family = "binomial")
tidy(m1)
```

```
# A tibble: 9 x 5
  term                        estimate std.error statistic  p.value
  <chr>                          <dbl>     <dbl>     <dbl>    <dbl>
1 (Intercept)                   0.238   0.0434       5.48  4.34e- 8
2 destination_cityMumbai        0.0847  0.0250       3.39  6.94e- 4
3 duration                      0.0738  0.00179     41.1   0
4 departure_timeEarly_Morning   0.149   0.0398       3.75  1.79e- 4
5 departure_timeEvening        -0.226   0.0399      -5.68  1.34e- 8
6 departure_timeLate_Night    -15.1    90.5         -0.166 8.68e- 1
7 departure_timeMorning         0.0829  0.0395       2.10  3.57e- 2
8 departure_timeNight          -0.366   0.0464      -7.90  2.84e-15
9 days_left                    -0.0385  0.000934   -41.2   0
```

Our null hypothesis is that there is none of the aforementioned factors will be predictive of the odds that the flight price is above 7,000 INR, holding the other predictors constant. Our alternative hypothesis is that at least one of the aforementioned factors will be predictive of the odds that the flight price is above 7,000 INR, holding the other predictors constant.

For duration, the z-statistic is -41.223, which follows a standard normal distribution under the null hypothesis. Our significance level is 0.05 and because our p-value $<$ 2e-16 $<$ 0.05, we reject the null hypothesis. Holding all other predictors constant, there is evidence to suggest that duration will be predictive of the odds that the flight price is above 7,000 INR. Holding all other predictors constant, for one hour increase in flight duration, the odds of the flight costing more than 7000 INR is predicted to be multiplied by exp(7.375e-02) = 1.001.

For the number days before booking the flight, the z-statistic is 41.129, which follows a standard normal distribution under the null hypothesis. Our significance level is 0.05 and because our p-value $<$ 2e-16 $<$ 0.05, we reject the null hypothesis. Holding all other predictors constant, there is evidence to suggest that the number of days before booking the flight will be predictive of the odds that the flight price is above 7,000 INR. Holding all other predictors constant, for

one hour increase in the number of days before booking the flight, the odds of the flight costing more than 7000 INR is predicted to be multiplied by exp(9.341e-04) = 1.077.

For departure time, compared to afternoon departure which is acting as a the baseline, the z-statistic for flights departing in the early morning, morning, evening, night, and late night are 3.747, 2.101, -5.681, -7.898, and -0.166, respectively, which follows a standard normal distribution under the null hypothesis. Our significance level is 0.05, and p-values of 0.000179, 0.035669, 1.34e-08, and 2.84e-15 for early morning, morning, evening, and night respectively < 0.05. For late night, p-value = 0.867847 > 0.05. This suggests that we reject the null hypothesis for early morning, morning, evening, and night departure times and can conclude there is evidence to suggest that those departure times will be predictive of the odds that the flight price is above 7,000 INR while holding all other predictors constant and comparing to afternoon departure time. This also suggests that we fail reject the null hypothesis for late night departure time and can conlcude that there is not enought evidence to suggest that a late night departure time will be predictive of the odds that the flight price is above 7,000 INR while holding all other predictors constant and comparing to afternoon departure time. Holding all other predictors constant, comparing to an afternoon departure time, the odds of the flight costing more than 7000 INR is predicted to be multiplied by exp(1.493e-01) = 1.161, exp(8.292e-02) = 1.086, exp(-2.265e-01) = 0.797, exp(-3.665e-01) = 0.693, and exp(-1.506e+01) = 2.881 for early morning departure, morning departure, evening departure, night departure, and late night departure, respectivly.

For destination city, compared to Dehli which acts as the baseline, the z-statistic is 3.392, which follows a standard normal distribution under the null hypothesis. Our significance level is 0.05 and because our p-value = 0.000694, we reject the null hypothesis. Holding all other predictors constant, there is evidence to suggest that destination city will be predictive of the odds that the flight price is above 7,000 INR. Holding all other predictors constant, comparing to leaving from Mumbai, the odds of the flight costing more than 7000 INR is predicted to be multiplied by exp(2.498e-02) = 1.025.

Diagnostics

```
exp(9)
```

```
[1] 8103.084
```

Discussion