prcp-1025-flightpriceprediction

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**PROJECT TEAM'S ID:"PTID-CDS-MAR-24-1859

Project : PRCP-1025-FlightPricePrediction

Introduction:

Flight ticket prices can be something hard to guess, today we might see a price, check out the price of the same flight tomorrow, it will be a different story. We might have often heard travelers saying that flight ticket prices are so unpredictable. That's why we will try to use machine learning to solve this problem. This can help airlines by predicting what prices they can maintain.

In this article, we will be analysing the flight price prediction using machine learning. Then draw some predictions using various factors.

Problem Statement:

Task 1:-Prepare a complete data analysis report on the given data. Task 2:-Create a predictive model which will help the customers to predict future flight prices and plan their journey accordingly.

Dataset: 1. Airline: So this column will have all the types of airlines like Indigo, Jet Airways, Air India, and many more. 2. Date_of_Journey: This column will let us know about the date on which the passenger's journey will start. 3. Source: This column holds the name of the place from where the passenger's journey will start. 4. Destination: This column holds the name of the place to where passengers wanted to travel. 5. Route: Here we can know about what the route is through which passengers have opted to travel from his/her source to their destination. 6. Arrival_Time: Arrival time is when the passenger will reach his/her destination.

7. Duration: Duration is the whole period that a flight will take to complete its journey from source to destination.
8. Total_Stops: This will let us know in how many places flights will stop there for the flight in the whole journey.
9. Additional_Info: In this column, we will get information about food, kind of food, and other amenities.
10. Price: Price of the flight for a complete journey including all the expenses before onboarding.

Importing Libraries

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
```

Importing dataset

[2]:
```
dftr = pd.read_excel('/content/Flight_Fare.xlsx')
```

[3]:
```
dftr
```

[3]:

```
            Airline Date_of_Journey    Source Destination  \
0            IndiGo      24/03/2019  Banglore   New Delhi
1         Air India       1/05/2019   Kolkata    Banglore
2       Jet Airways       9/06/2019     Delhi      Cochin
3            IndiGo      12/05/2019   Kolkata    Banglore
4            IndiGo      01/03/2019  Banglore   New Delhi
…               …             …         …          …
10678     Air Asia       9/04/2019   Kolkata    Banglore
10679    Air India      27/04/2019   Kolkata    Banglore
10680  Jet Airways      27/04/2019  Banglore       Delhi
10681      Vistara      01/03/2019  Banglore   New Delhi
10682    Air India       9/05/2019     Delhi      Cochin

                        Route Dep_Time  Arrival_Time Duration Total_Stops  \
0                   BLR → DEL    22:20  01:10 22 Mar   2h 50m    non-stop
1       CCU → IXR → BBI → BLR    05:50         13:15   7h 25m     2 stops
2       DEL → LKO → BOM → COK    09:25  04:25 10 Jun      19h     2 stops
3             CCU → NAG → BLR    18:05         23:30   5h 25m      1 stop
4             BLR → NAG → DEL    16:50         21:35   4h 45m      1 stop
…                         …        …             …       …         …
10678             CCU → BLR    19:55         22:25   2h 30m    non-stop
10679             CCU → BLR    20:45         23:20   2h 35m    non-stop
10680             BLR → DEL    08:20         11:20       3h    non-stop
10681             BLR → DEL    11:30         14:10   2h 40m    non-stop
10682  DEL → GOI → BOM → COK    10:55         19:15   8h 20m     2 stops

      Additional_Info  Price
0             No info   3897
1             No info   7662
2             No info  13882
3             No info   6218
4             No info  13302
…                ...    …
10678         No info   4107
10679         No info   4145
10680         No info   7229
10681         No info  12648
```

```
10682         No info  11753

[10683 rows x 11 columns]
```

Basic Checks

[4]:
```
dftr.head(10)
```

[4]:
```
             Airline Date_of_Journey    Source Destination  \
0             IndiGo      24/03/2019  Banglore   New Delhi
1          Air India       1/05/2019   Kolkata    Banglore
2        Jet Airways       9/06/2019     Delhi      Cochin
3             IndiGo      12/05/2019   Kolkata    Banglore
4             IndiGo      01/03/2019  Banglore   New Delhi
5           SpiceJet      24/06/2019   Kolkata    Banglore
6        Jet Airways      12/03/2019  Banglore   New Delhi
7        Jet Airways      01/03/2019  Banglore   New Delhi
8        Jet Airways      12/03/2019  Banglore   New Delhi
9  Multiple carriers      27/05/2019     Delhi      Cochin

                  Route Dep_Time  Arrival_Time Duration Total_Stops  \
0             BLR → DEL    22:20  01:10 22 Mar   2h 50m    non-stop
1  CCU → IXR → BBI → BLR    05:50         13:15   7h 25m     2 stops
2  DEL → LKO → BOM → COK    09:25  04:25 10 Jun      19h     2 stops
3        CCU → NAG → BLR    18:05         23:30   5h 25m      1 stop
4        BLR → NAG → DEL    16:50         21:35   4h 45m      1 stop
5             CCU → BLR    09:00         11:25   2h 25m    non-stop
6        BLR → BOM → DEL    18:55  10:25 13 Mar  15h 30m      1 stop
7        BLR → BOM → DEL    08:00  05:05 02 Mar   21h 5m      1 stop
8        BLR → BOM → DEL    08:55  10:25 13 Mar  25h 30m      1 stop
9        DEL → BOM → COK    11:25         19:15   7h 50m      1 stop

               Additional_Info  Price
0                      No info   3897
1                      No info   7662
2                      No info  13882
3                      No info   6218
4                      No info  13302
5                      No info   3873
6  In-flight meal not included  11087
7                      No info  22270
8  In-flight meal not included  11087
9                      No info   8625
```

[5]:
```
dftr.tail()
```

[5]:
```
           Airline Date_of_Journey    Source Destination  \
10678     Air Asia       9/04/2019   Kolkata    Banglore
10679    Air India      27/04/2019   Kolkata    Banglore
10680  Jet Airways      27/04/2019  Banglore       Delhi
10681      Vistara      01/03/2019  Banglore   New Delhi
10682    Air India       9/05/2019     Delhi      Cochin

                      Route Dep_Time Arrival_Time Duration Total_Stops  \
10678              CCU → BLR    19:55        22:25   2h 30m    non-stop
10679              CCU → BLR    20:45        23:20   2h 35m    non-stop
10680              BLR → DEL    08:20        11:20       3h    non-stop
10681              BLR → DEL    11:30        14:10   2h 40m    non-stop
10682  DEL → GOI → BOM → COK    10:55        19:15   8h 20m     2 stops

      Additional_Info  Price
10678         No info   4107
10679         No info   4145
10680         No info   7229
10681         No info  12648
10682         No info  11753
```

[6]:
```
dftr.columns
```

[6]:
```
Index(['Airline', 'Date_of_Journey', 'Source', 'Destination', 'Route',
       'Dep_Time', 'Arrival_Time', 'Duration', 'Total_Stops',
       'Additional_Info', 'Price'],
      dtype='object')
```

[7]:
```
dftr.shape
```

[7]:
```
(10683, 11)
```

[8]:
```
dftr.dtypes
```

[8]:
```
Airline            object
Date_of_Journey    object
Source             object
Destination        object
Route              object
Dep_Time           object
Arrival_Time       object
Duration           object
Total_Stops        object
Additional_Info    object
Price               int64
dtype: object
```

[9]:
```
dftr.Airline.unique()
```

[9]:
```
array(['IndiGo', 'Air India', 'Jet Airways', 'SpiceJet',
       'Multiple carriers', 'GoAir', 'Vistara', 'Air Asia',
       'Vistara Premium economy', 'Jet Airways Business',
       'Multiple carriers Premium economy', 'Trujet'], dtype=object)
```

[10]:
```
dftr.Airline.value_counts()
```

[10]:
```
Airline
Jet Airways                          3849
IndiGo                               2053
Air India                            1752
Multiple carriers                    1196
SpiceJet                              818
Vistara                               479
Air Asia                              319
GoAir                                 194
Multiple carriers Premium economy      13
Jet Airways Business                    6
Vistara Premium economy                 3
Trujet                                  1
Name: count, dtype: int64
```

[11]:
```
dftr.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10683 entries, 0 to 10682
Data columns (total 11 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   Airline          10683 non-null  object
 1   Date_of_Journey  10683 non-null  object
 2   Source           10683 non-null  object
 3   Destination      10683 non-null  object
 4   Route            10682 non-null  object
 5   Dep_Time         10683 non-null  object
 6   Arrival_Time     10683 non-null  object
 7   Duration         10683 non-null  object
 8   Total_Stops      10682 non-null  object
 9   Additional_Info  10683 non-null  object
 10  Price            10683 non-null  int64
dtypes: int64(1), object(10)
memory usage: 918.2+ KB
```

[12]:
```
dftr.dropna(inplace=True)
```

[13]:
```
dftr.isnull().sum()
```

[13]:
```
Airline            0
Date_of_Journey    0
Source             0
Destination        0
Route              0
Dep_Time           0
Arrival_Time       0
Duration           0
Total_Stops        0
Additional_Info    0
Price              0
dtype: int64
```

[14]:
```
dftr.describe()
```

[14]:
```
              Price
count  10682.000000
mean    9087.214567
std     4611.548810
min     1759.000000
25%     5277.000000
50%     8372.000000
75%    12373.000000
max    79512.000000
```

Exploratory Data Analysis (EDA):

[15]:
```
dftr['Date_of_Journey']
```

[15]:
```
0        24/03/2019
1         1/05/2019
2         9/06/2019
3        12/05/2019
4        01/03/2019
             …
10678     9/04/2019
10679    27/04/2019
10680    27/04/2019
10681    01/03/2019
10682     9/05/2019
Name: Date_of_Journey, Length: 10682, dtype: object
```

Extracting Date, Month and Year from the Date of Journey

[16]:
```
from datetime import datetime
dftr['Year'] = pd.to_datetime(dftr['Date_of_Journey']).dt.year
dftr['Month'] = pd.to_datetime(dftr['Date_of_Journey']).dt.month
dftr['Date'] = pd.to_datetime(dftr['Date_of_Journey']).dt.day
```

[17]:
```
dftr.drop(['Date_of_Journey'],axis=1,inplace=True)
```

[18]:
```
# Duration is 5m for a 2 stop flight which is impossible
# Removing this outlier

dftr[dftr['Duration']=='5m']
```

[18]:
```
        Airline  Source Destination                  Route Dep_Time  \
6474  Air India  Mumbai   Hyderabad  BOM → GOI → PNQ → HYD    16:50

     Arrival_Time Duration Total_Stops Additional_Info  Price  Year  Month  \
6474        16:55       5m     2 stops         No info  17327  2019      3

      Date
6474     6
```

[19]:
```
dftr.drop([6474,],axis=0,inplace=True)
```

[20]:
```
# Extracting Dur_hours and Dur_min from the Duration Column

dftr['Dur_hours'] = dftr['Duration'].str.split(' ').str[0]
dftr['Dur_hours'] = dftr['Dur_hours'].str.replace('h','').astype(float)
dftr['Dur_hours'].fillna(0, inplace=True)

dftr['Dur_min'] = dftr['Duration'].str.split(' ').str[1]
dftr['Dur_min'] = dftr['Dur_min'].str.replace('m','').astype(float)
dftr['Dur_min'].fillna(0, inplace=True)
```

[21]:
```
dftr.drop(['Duration'],axis=1,inplace=True)
```

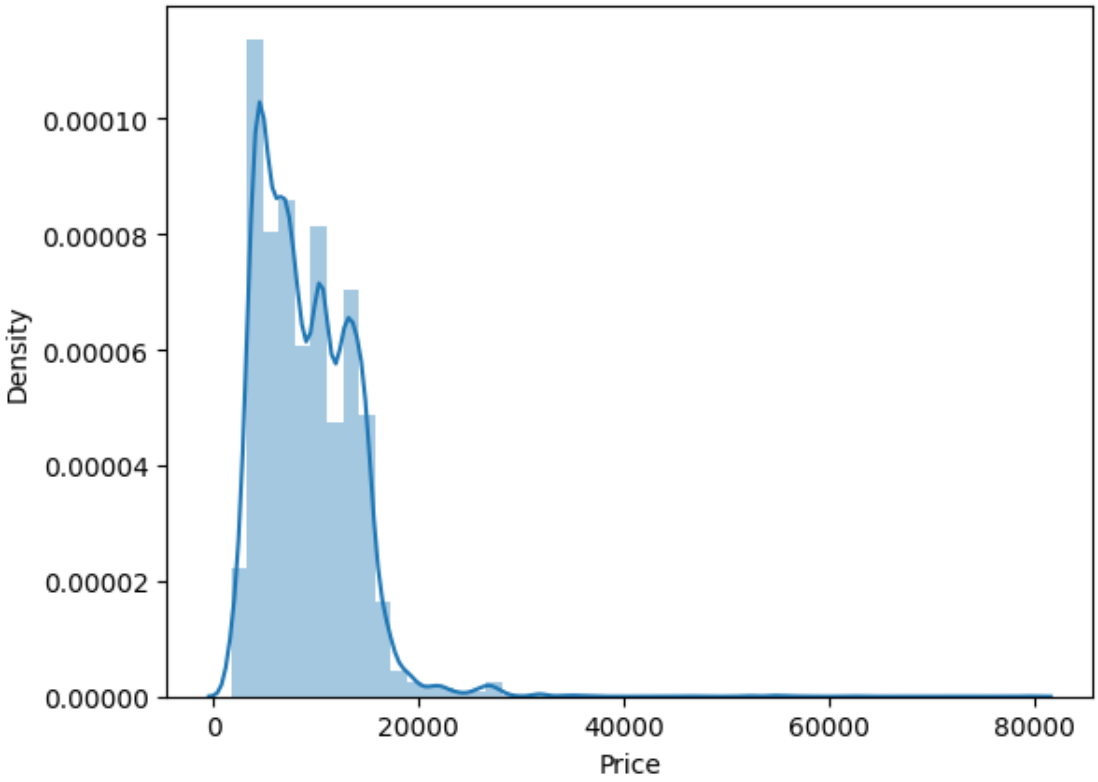
[22]:
```
# There is only one record of Trujet in train dataset and zero record in Test␣
 ↪dataset
# This will create problem in our model building
# Therefore will remove this record

dftr[dftr['Airline'] == 'Trujet']
```

[22]:
```
     Airline  Source Destination           Route Dep_Time Arrival_Time  \
2878  Trujet  Mumbai   Hyderabad  BOM → NDC → HYD    13:05        16:20

     Total_Stops Additional_Info  Price  Year  Month  Date  Dur_hours  Dur_min
2878      1 stop         No info   4140  2019      3     6        3.0     15.0
```

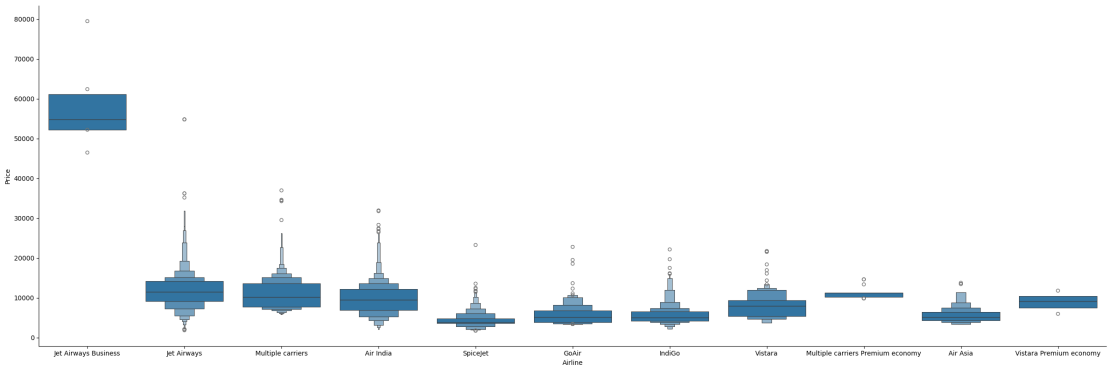
[23]:
```
dftr.drop([2878,],axis=0,inplace=True)
```

[24]:
```
# Our Dependent Variable Price is not normally distributed therefore would have␣
 ↪to apply scaling

sns.distplot(dftr['Price'])
```

[24]:
```
<Axes: xlabel='Price', ylabel='Density'>
```



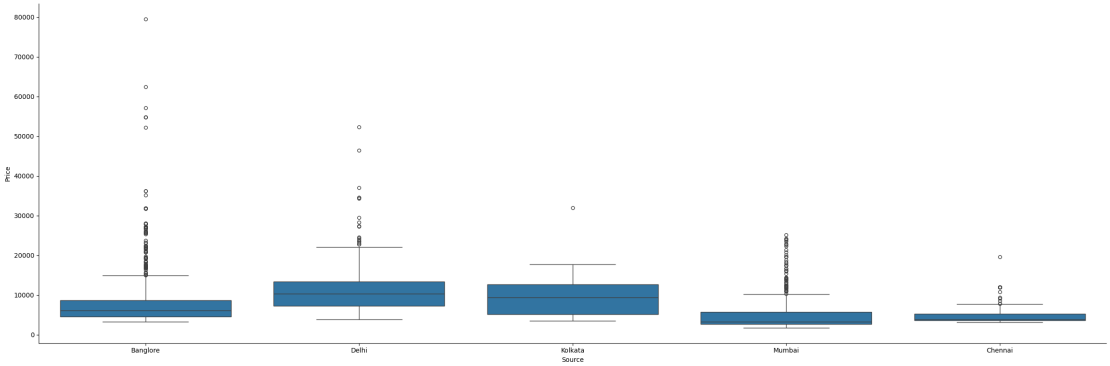
[25]:
```
sns.catplot(y="Price",x="Airline",data=dftr.
 ↪sort_values("Price",ascending=False),kind="boxen",height=8,aspect=3)
plt.show()
```



Insights:

Here with the help of the cat plot we are trying to plot the boxen plot between the price of the flight and the airline and we can conclude that Jet Airways has the most outliers in terms of price. And Vistara Premium economy has the least outliers based on price.

[26]:
```
sns.catplot(y="Price",x="Source",data=dftr.
 ↪sort_values("Price",ascending=False),kind="box",height=8,aspect=3)
plt.show()
```

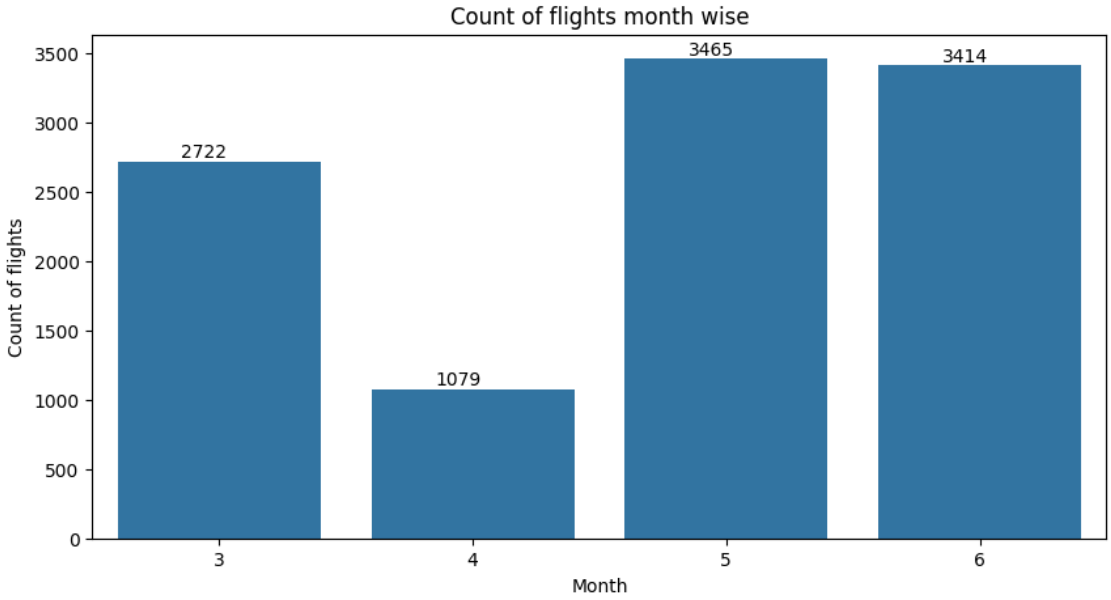


Insights:

with the help of cat plot only we are plotting a box plot between the price of the flight and the source place that is the place from where passengers will travel to the destination and we can see that Banglore is the source location has the most outliers while Chennai has the least.

[27]:
```
plt.figure(figsize = (10, 5))
plt.title('Count of flights month wise')
ax=sns.countplot(x ='Month', data =dftr)
plt.xlabel('Month')
plt.ylabel('Count of flights')
for p in ax.patches:
```

```
    ax.annotate(int(p.get_height()), (p.get_x()+0.25, p.get_height()+1),␣
↪va='bottom',color='black')
```



Insights:

Here in the above graph we have plotted the count plot for journey in a month vs several flights.

And got to see that June has the most number of flights.

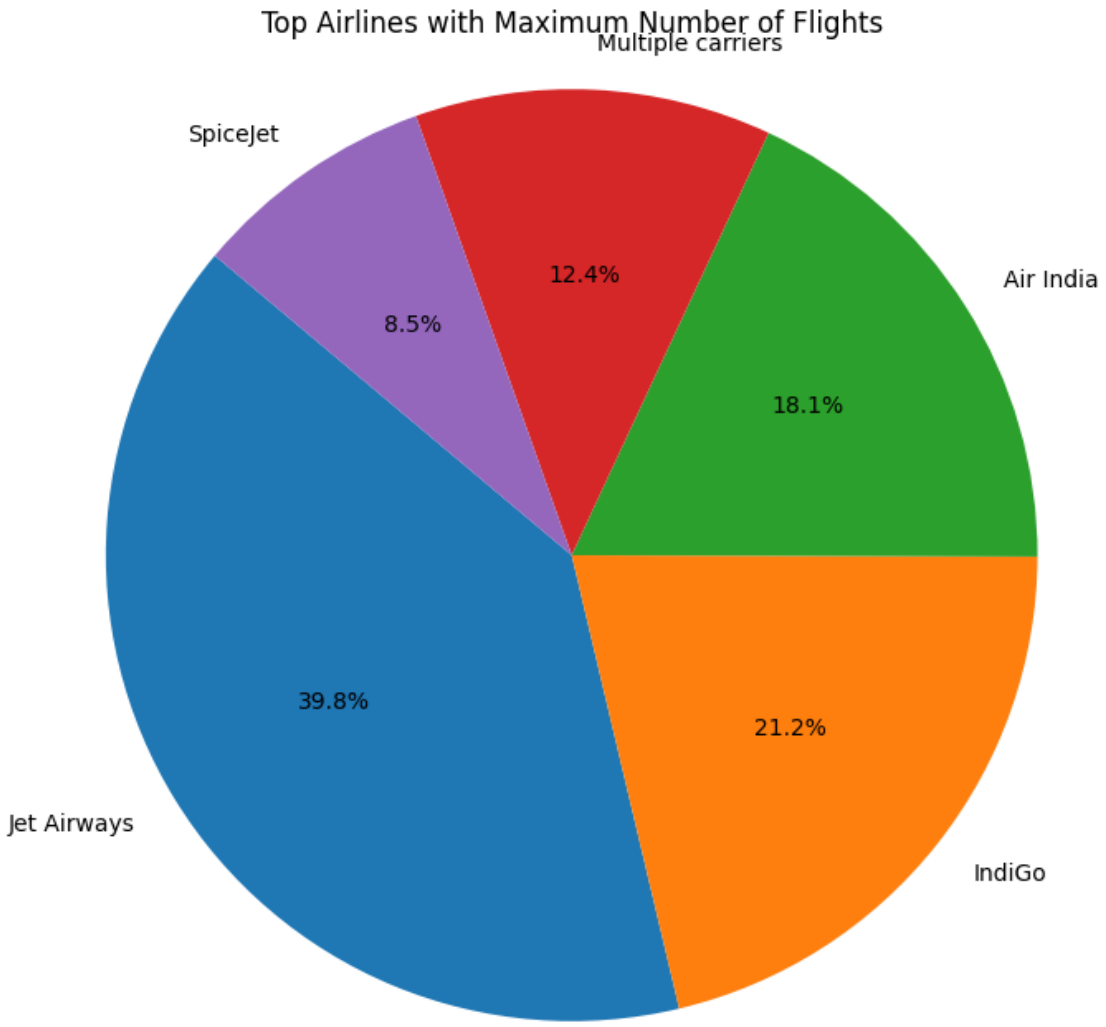
[28]:
```
plt.figure(figsize = (15,4))
plt.title('Price VS Airlines')
plt.scatter(dftr['Airline'],dftr['Price'])
plt.xticks
plt.xlabel('Airline')
plt.ylabel('Price of ticket')
plt.xticks(rotation=90)
```

[28]:
```
([0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
 [Text(0, 0, 'IndiGo'),
  Text(1, 0, 'Air India'),
  Text(2, 0, 'Jet Airways'),
  Text(3, 0, 'SpiceJet'),
  Text(4, 0, 'Multiple carriers'),
  Text(5, 0, 'GoAir'),
  Text(6, 0, 'Vistara'),
  Text(7, 0, 'Air Asia'),
  Text(8, 0, 'Vistara Premium economy'),
  Text(9, 0, 'Jet Airways Business'),
```

```
Text(10, 0, 'Multiple carriers Premium economy')])
```

Insights: In the above graph,we have plotted Airline against price of ticket in the scatter plot.Here we can see that when all of the airlines are compared based on prices,Jet Airways Business has the highest price.

[29]:
```
import matplotlib.pyplot as plt

# Count the number of flights for each airline
airline_counts = dftr['Airline'].value_counts()

# Get the top 5 airlines with the maximum number of flights
top_airlines = airline_counts.head(5)

# Plot the pie chart
plt.figure(figsize=(8, 8))
plt.pie(top_airlines, labels=top_airlines.index, autopct='%1.1f%%',␣
 ↪startangle=140)
plt.title('Top Airlines with Maximum Number of Flights')
plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle.
plt.show()
```



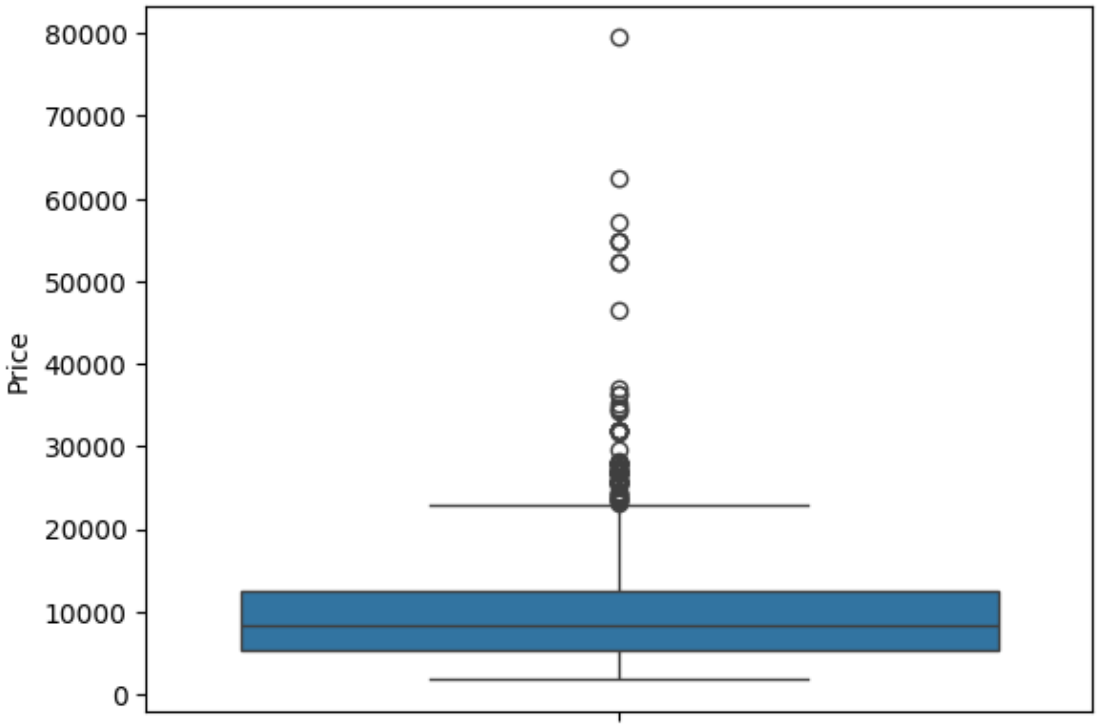
Insights:

We can see maximum number of flights run by Jet Airways while minimum Flights run by Spicejet.

Around 25% of flights of Business Class.

[30]:
```
sns.boxplot(dftr['Price'])
```

[30]:
```
<Axes: ylabel='Price'>
```



[31]:
```
dftr[dftr['Price']>75000]
```

[31]:
```
                    Airline    Source Destination            Route Dep_Time  \
2924  Jet Airways Business  Banglore   New Delhi  BLR → BOM → DEL    05:45

     Arrival_Time Total_Stops Additional_Info  Price  Year  Month  Date  \
2924        11:25      1 stop  Business class  79512  2019      3     1

      Dur_hours  Dur_min
2924        5.0     40.0
```

[32]:
```
dftr[dftr['Airline'] == 'Jet Airways Business']
```

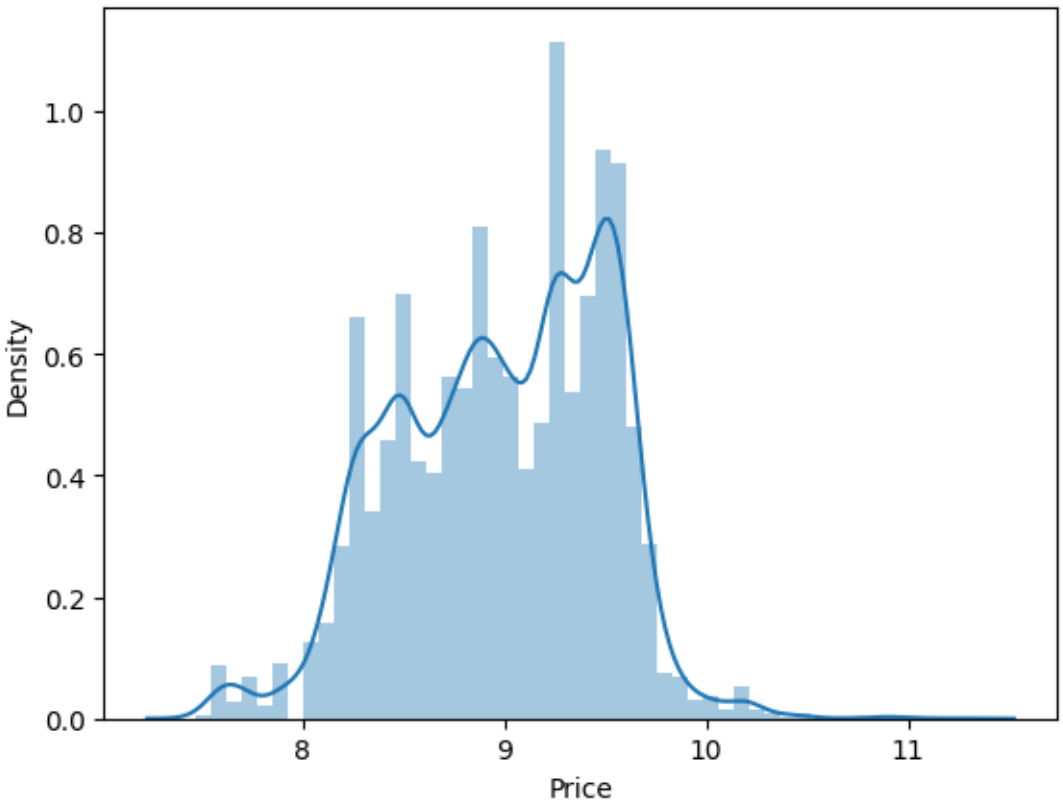
[32]:
```
                    Airline    Source Destination                  Route  \
657    Jet Airways Business  Banglore   New Delhi        BLR → BOM → DEL
2924   Jet Airways Business  Banglore   New Delhi        BLR → BOM → DEL
5372   Jet Airways Business  Banglore   New Delhi        BLR → BOM → DEL
7351   Jet Airways Business     Delhi      Cochin  DEL → ATQ → BOM → COK
9715   Jet Airways Business     Delhi      Cochin  DEL → ATQ → BOM → COK
10364  Jet Airways Business  Banglore   New Delhi        BLR → MAA → DEL

      Dep_Time  Arrival_Time Total_Stops Additional_Info  Price  Year  Month  \
657      05:45         10:45      1 stop         No info  52229  2019      3
```

```
2924     05:45          11:25       1 stop  Business class  79512  2019      3
5372     05:45          12:25       1 stop  Business class  62427  2019      3
7351     20:05  04:25 04 Mar      2 stops         No info  46490  2019      3
9715     20:05  04:25 07 Mar      2 stops         No info  52285  2019      3
10364    09:45          14:25       1 stop  Business class  57209  2019      3

       Date  Dur_hours  Dur_min
657       1        5.0      0.0
2924      1        5.0     40.0
5372      1        6.0     40.0
7351      3        8.0     20.0
9715      6        8.0     20.0
10364     1        4.0     40.0
```

[33]:
```
# Applying log transformation to our Dependent Variable Price to make it␣
 ↪normalize

dftr['Price'] = np.log(dftr['Price'])
```

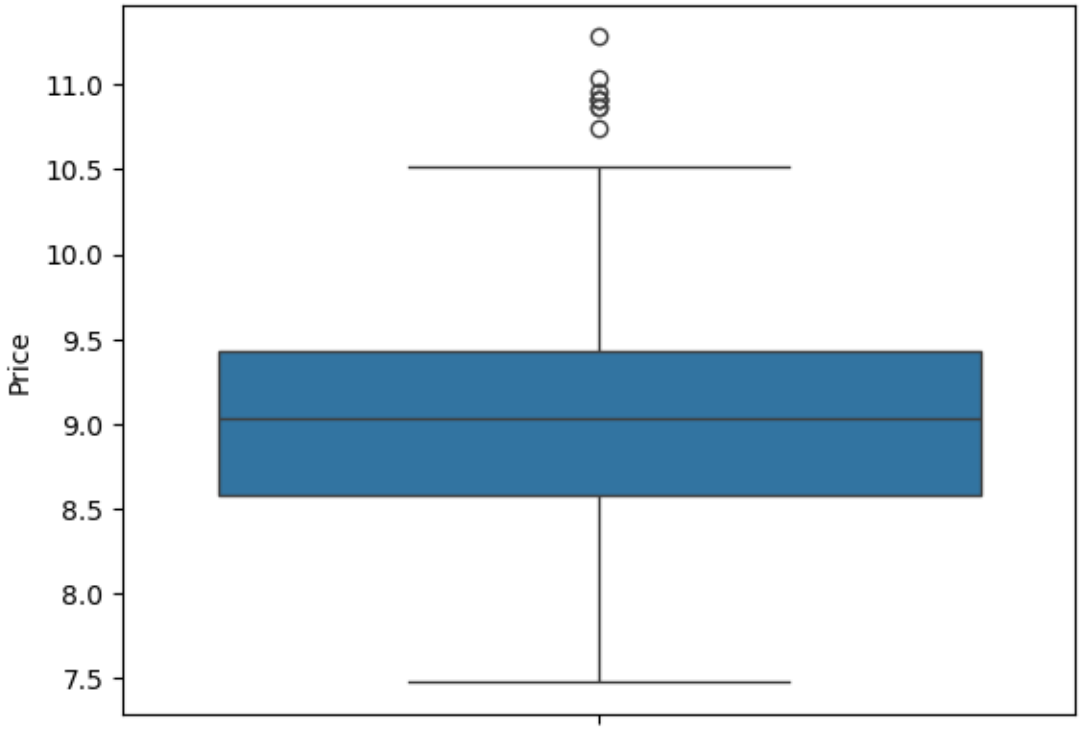
[34]:
```
sns.distplot(dftr['Price'])
```

[34]:
```
<Axes: xlabel='Price', ylabel='Density'>
```



[35]:
```
sns.boxplot(dftr['Price'])
```

[35]:
```
<Axes: ylabel='Price'>
```



[36]:
```
# Adding Dep_hour and Dep_min column to dftr dataframe

dftr["Dep_hour"] = pd.to_datetime(dftr["Dep_Time"]).dt.hour
dftr["Dep_min"] = pd.to_datetime(dftr["Dep_Time"]).dt.minute
```

[37]:
```
dftr.drop(["Dep_Time"], axis = 1, inplace = True)
```

[38]:
```
dftr.head()
```

[38]:

	Airline	Source	Destination	Route	Arrival_Time	Total_Stops	Additional_Info	Price	Year	Month	Date	Dur_hours
0	IndiGo	Banglore	New Delhi	BLR → DEL	01:10 22 Mar	non-stop	No info	8.267962	2019	3	24	2.0
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	13:15							
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	04:25 10 Jun							
3	IndiGo	Kolkata	Banglore	CCU → NAG → BLR	23:30							
4	IndiGo	Banglore	New Delhi	BLR → NAG → DEL	21:35							

```
1     2 stops         No info  8.944028  2019      5     1        7.0
2     2 stops         No info  9.538348  2019      6     9       19.0
3      1 stop         No info  8.735204  2019      5    12        5.0
4      1 stop         No info  9.495670  2019      3     1        4.0

   Dur_min  Dep_hour  Dep_min
0     50.0        22       20
1     25.0         5       50
2      0.0         9       25
3     25.0        18        5
4     45.0        16       50
```

[39]:
```
# Adding Arrival_hour and Arrival_min column to dftr dataframe

dftr["Arrival_hour"] = pd.to_datetime(dftr["Arrival_Time"]).dt.hour
dftr["Arrival_min"] = pd.to_datetime(dftr["Arrival_Time"]).dt.minute
```

[40]:
```
dftr.drop(["Arrival_Time"], axis = 1, inplace = True)
```

[41]:
```
# Additional_Info contains almost 80% no_info
# Also, the Routes and Total_Stops are related to each other

dftr.drop(["Route", "Additional_Info"], axis = 1, inplace = True)
```

[42]:
```
dftr.head()
```

[42]:
```
       Airline    Source Destination Total_Stops     Price  Year  Month  Date  \
0       IndiGo  Banglore   New Delhi    non-stop  8.267962  2019      3    24
1    Air India   Kolkata    Banglore     2 stops  8.944028  2019      5     1
2  Jet Airways     Delhi      Cochin     2 stops  9.538348  2019      6     9
3       IndiGo   Kolkata    Banglore      1 stop  8.735204  2019      5    12
4       IndiGo  Banglore   New Delhi      1 stop  9.495670  2019      3     1

   Dur_hours  Dur_min  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0        2.0     50.0        22       20             1           10
1        7.0     25.0         5       50            13           15
2       19.0      0.0         9       25             4           25
3        5.0     25.0        18        5            23           30
4        4.0     45.0        16       50            21           35
```

[43]:
```
# The Total_Stops is an Ordinal Categorical type therefore we perform␣
 ↪LabelEncoder

dftr.replace({"non-stop": 0, "1 stop": 1, "2 stops": 2, "3 stops": 3, "4 stops":
 ↪ 4}, inplace = True)
```

[44]:
```
dftr.head()
```

[44]:

	Airline	Source	Destination	Total_Stops	Price	Year	Month	\
0	IndiGo	Banglore	New Delhi	0	8.267962	2019	3	
1	Air India	Kolkata	Banglore	2	8.944028	2019	5	
2	Jet Airways	Delhi	Cochin	2	9.538348	2019	6	
3	IndiGo	Kolkata	Banglore	1	8.735204	2019	5	
4	IndiGo	Banglore	New Delhi	1	9.495670	2019	3	

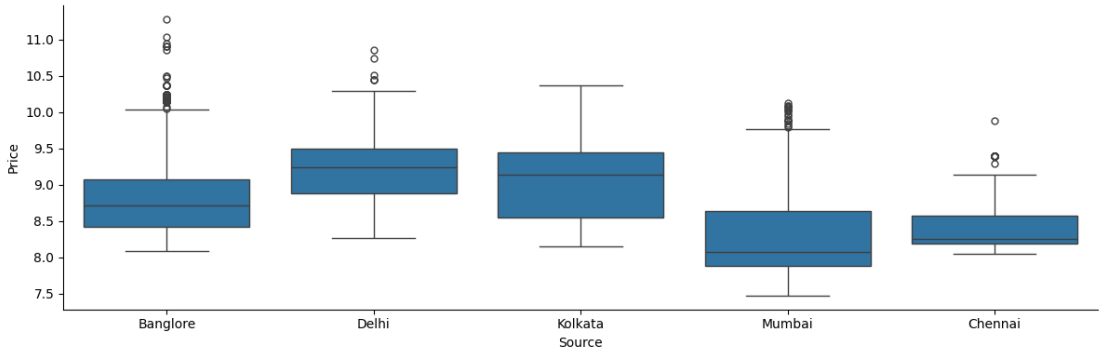
	Date	Dur_hours	Dur_min	Dep_hour	Dep_min	Arrival_hour	Arrival_min
0	24	2.0	50.0	22	20	1	10
1	1	7.0	25.0	5	50	13	15
2	9	19.0	0.0	9	25	4	25
3	12	5.0	25.0	18	5	23	30
4	1	4.0	45.0	16	50	21	35

1 Dealing with Categorical Data

[45]:
```
dftr['Source'].value_counts()
```

[45]:
```
Source
Delhi       4536
Kolkata     2871
Banglore    2197
Mumbai       695
Chennai      381
Name: count, dtype: int64
```

[46]:
```
# Source vs Price

sns.catplot(y = "Price", x = "Source", data = dftr.sort_values("Price",␣
 ↪ascending = False), kind="box", height = 4, aspect = 3)
plt.show()
```



[47]:
```
# As Source is Nominal Categorical data we will perform OneHotEncoding

Source = dftr[["Source"]]

Source = pd.get_dummies(Source, drop_first= True)

Source.head()
```

[47]:

	Source_Chennai	Source_Delhi	Source_Kolkata	Source_Mumbai
0	False	False	False	False
1	False	False	True	False
2	False	True	False	False
3	False	False	True	False
4	False	False	False	False

[48]:
```
dftr['Destination'].value_counts()
```

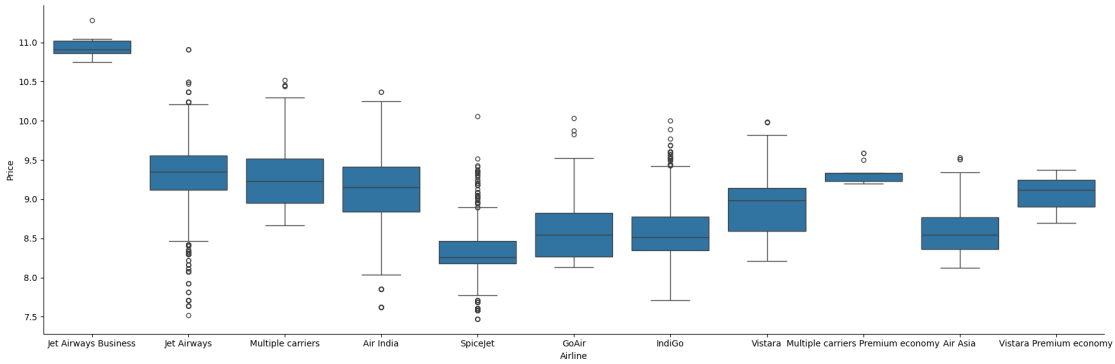
[48]:
```
Destination
Cochin       4536
Banglore     2871
Delhi        1265
New Delhi     932
Hyderabad     695
Kolkata       381
Name: count, dtype: int64
```

[49]:
```
# As Destination is Nominal Categorical data we will perform OneHotEncoding

Destination = dftr[["Destination"]]

Destination = pd.get_dummies(Destination, drop_first= True)

Destination.head()
```

[49]:

	Destination_Cochin	Destination_Delhi	Destination_Hyderabad	Destination_Kolkata	Destination_New Delhi
0	False	False	False	False	True
1	False	False	False	False	False
2	True	False	False	False	False
3	False	False	False	False	False
4	False	False	False	False	True

[50]:
```
#Airline vs Price
sns.catplot(y = "Price", x = "Airline", data = dftr.sort_values("Price",␣
 ↪ascending = False), kind="box", height = 6, aspect = 3)
plt.show()

# From graph, it is clear that Jet Airways Business have the highest Price.
# Apart from that almost all are having similar median
```



[51]:
```
dftr['Airline'].value_counts()
```

[51]:
```
Airline
Jet Airways                          3849
IndiGo                               2053
Air India                            1750
Multiple carriers                    1196
SpiceJet                              818
Vistara                               479
Air Asia                              319
GoAir                                 194
Multiple carriers Premium economy      13
Jet Airways Business                    6
Vistara Premium economy                 3
Name: count, dtype: int64
```

[52]:
```
# As Airline is Nominal Categorical data we will perform OneHotEncoding

Airline = dftr[["Airline"]]

Airline = pd.get_dummies(Airline, drop_first= True)

Airline.head()
```

[52]:
```
   Airline_Air India  Airline_GoAir  Airline_IndiGo  Airline_Jet Airways  \
0              False          False            True                False
```

```
1              True          False           False                False
2             False          False           False                 True
3             False          False            True                False
4             False          False            True                False

   Airline_Jet Airways Business  Airline_Multiple carriers  \
0                         False                      False
1                         False                      False
2                         False                      False
3                         False                      False
4                         False                      False

   Airline_Multiple carriers Premium economy  Airline_SpiceJet  \
0                                      False             False
1                                      False             False
2                                      False             False
3                                      False             False
4                                      False             False

   Airline_Vistara  Airline_Vistara Premium economy
0            False                            False
1            False                            False
2            False                            False
3            False                            False
4            False                            False
```

[53]:
```
dftr.head()
```

[53]:
```
       Airline    Source Destination  Total_Stops     Price  Year  Month  \
0       IndiGo  Banglore   New Delhi            0  8.267962  2019      3
1    Air India   Kolkata    Banglore            2  8.944028  2019      5
2  Jet Airways     Delhi      Cochin            2  9.538348  2019      6
3       IndiGo   Kolkata    Banglore            1  8.735204  2019      5
4       IndiGo  Banglore   New Delhi            1  9.495670  2019      3

   Date  Dur_hours  Dur_min  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0    24        2.0     50.0        22       20             1           10
1     1        7.0     25.0         5       50            13           15
2     9       19.0      0.0         9       25             4           25
3    12        5.0     25.0        18        5            23           30
4     1        4.0     45.0        16       50            21           35
```

[54]:
```
# Concatenating dataframe -> Dftr + Airline + Source + Destination

dftr1 = pd.concat([dftr, Airline, Source, Destination], axis = 1)
```

[55]:
```
dftr1.head()
```

[55]:
```
       Airline    Source Destination  Total_Stops     Price  Year  Month  \
0       IndiGo  Banglore   New Delhi            0  8.267962  2019      3
1    Air India   Kolkata    Banglore            2  8.944028  2019      5
2  Jet Airways     Delhi      Cochin            2  9.538348  2019      6
3       IndiGo   Kolkata    Banglore            1  8.735204  2019      5
4       IndiGo  Banglore   New Delhi            1  9.495670  2019      3

   Date  Dur_hours  Dur_min  …  Airline_Vistara Premium economy  \
0    24        2.0     50.0  …                            False
1     1        7.0     25.0  …                            False
2     9       19.0      0.0  …                            False
3    12        5.0     25.0  …                            False
4     1        4.0     45.0  …                            False

   Source_Chennai  Source_Delhi  Source_Kolkata  Source_Mumbai  \
0           False         False           False          False
1           False         False            True          False
2           False          True           False          False
3           False         False            True          False
4           False         False           False          False

   Destination_Cochin  Destination_Delhi  Destination_Hyderabad  \
0               False              False                  False
1               False              False                  False
2                True              False                  False
3               False              False                  False
4               False              False                  False

   Destination_Kolkata  Destination_New Delhi
0                False                   True
1                False                  False
2                False                  False
3                False                  False
4                False                   True

[5 rows x 33 columns]
```

[56]:
```
dftr1.drop(["Airline", "Source", "Destination"], axis = 1, inplace = True)
```

[57]:
```
dftr1.head()
```

[57]:
```
   Total_Stops     Price  Year  Month  Date  Dur_hours  Dur_min  Dep_hour  \
0            0  8.267962  2019      3    24        2.0     50.0        22
1            2  8.944028  2019      5     1        7.0     25.0         5
2            2  9.538348  2019      6     9       19.0      0.0         9
3            1  8.735204  2019      5    12        5.0     25.0        18
4            1  9.495670  2019      3     1        4.0     45.0        16
```

```
   Dep_min  Arrival_hour  …  Airline_Vistara Premium economy  \
0       20             1  …                            False
1       50            13  …                            False
2       25             4  …                            False
3        5            23  …                            False
4       50            21  …                            False

   Source_Chennai  Source_Delhi  Source_Kolkata  Source_Mumbai  \
0           False         False           False          False
1           False         False            True          False
2           False          True           False          False
3           False         False            True          False
4           False         False           False          False

   Destination_Cochin  Destination_Delhi  Destination_Hyderabad  \
0               False              False                  False
1               False              False                  False
2                True              False                  False
3               False              False                  False
4               False              False                  False

   Destination_Kolkata  Destination_New Delhi
0                False                   True
1                False                  False
2                False                  False
3                False                  False
4                False                   True

[5 rows x 30 columns]
```

[58]:
```
dftr.drop(["Year"], axis=1, inplace=True)
dftr1.drop(["Year"], axis=1, inplace=True)
```

[59]:
```
dftr1.shape
```

[59]: (10680, 29)

2 Test Data

Similar Data Cleaning Process will be followed for the Test Dataset

[60]:
```
dfts = pd.read_excel('/content/Flight_Fare.xlsx')
```

[61]:
```
dfts.head()
```

[61]:
```
        Airline Date_of_Journey    Source Destination                  Route  \
0        IndiGo      24/03/2019  Banglore   New Delhi              BLR → DEL
1    Air India       1/05/2019   Kolkata    Banglore  CCU → IXR → BBI → BLR
2  Jet Airways       9/06/2019     Delhi      Cochin  DEL → LKO → BOM → COK
3        IndiGo      12/05/2019   Kolkata    Banglore        CCU → NAG → BLR
4        IndiGo      01/03/2019  Banglore   New Delhi        BLR → NAG → DEL

  Dep_Time  Arrival_Time Duration Total_Stops Additional_Info  Price
0    22:20  01:10 22 Mar   2h 50m    non-stop         No info   3897
1    05:50         13:15   7h 25m     2 stops         No info   7662
2    09:25  04:25 10 Jun      19h     2 stops         No info  13882
3    18:05         23:30   5h 25m      1 stop         No info   6218
4    16:50         21:35   4h 45m      1 stop         No info  13302
```

[62]:
```
dfts.drop(["Route", "Additional_Info"], axis = 1, inplace = True)
```

[63]:
```
dfts.head()
```

[63]:
```
        Airline Date_of_Journey    Source Destination Dep_Time  Arrival_Time  \
0        IndiGo      24/03/2019  Banglore   New Delhi    22:20  01:10 22 Mar
1    Air India       1/05/2019   Kolkata    Banglore    05:50         13:15
2  Jet Airways       9/06/2019     Delhi      Cochin    09:25  04:25 10 Jun
3        IndiGo      12/05/2019   Kolkata    Banglore    18:05         23:30
4        IndiGo      01/03/2019  Banglore   New Delhi    16:50         21:35

  Duration Total_Stops  Price
0   2h 50m    non-stop   3897
1   7h 25m     2 stops   7662
2      19h     2 stops  13882
3   5h 25m      1 stop   6218
4   4h 45m      1 stop  13302
```

[64]:
```
dfts.replace({"non-stop": 0, "1 stop": 1, "2 stops": 2, "3 stops": 3, "4 stops":
↪ 4}, inplace = True)
```

[65]:
```
dfts.head()
```

[65]:
```
        Airline Date_of_Journey    Source Destination Dep_Time  Arrival_Time  \
0        IndiGo      24/03/2019  Banglore   New Delhi    22:20  01:10 22 Mar
1    Air India       1/05/2019   Kolkata    Banglore    05:50         13:15
2  Jet Airways       9/06/2019     Delhi      Cochin    09:25  04:25 10 Jun
3        IndiGo      12/05/2019   Kolkata    Banglore    18:05         23:30
4        IndiGo      01/03/2019  Banglore   New Delhi    16:50         21:35

  Duration  Total_Stops  Price
0   2h 50m          0.0   3897
1   7h 25m          2.0   7662
```

```
2      19h          2.0  13882
3   5h 25m          1.0   6218
4   4h 45m          1.0  13302
```

[66]:
```
dfts['Year'] = pd.to_datetime(dfts['Date_of_Journey']).dt.year
dfts['Month'] = pd.to_datetime(dfts['Date_of_Journey']).dt.month
dfts['Date'] = pd.to_datetime(dfts['Date_of_Journey']).dt.day
```

[67]:
```
dfts.drop(['Date_of_Journey'], axis=1,inplace=True)
```

[68]:
```
dfts.head()
```

[68]:
```
       Airline    Source Destination Dep_Time  Arrival_Time Duration  \
0       IndiGo  Banglore   New Delhi    22:20  01:10 22 Mar   2h 50m
1    Air India   Kolkata    Banglore    05:50         13:15   7h 25m
2  Jet Airways     Delhi      Cochin    09:25  04:25 10 Jun      19h
3       IndiGo   Kolkata    Banglore    18:05         23:30   5h 25m
4       IndiGo  Banglore   New Delhi    16:50         21:35   4h 45m

   Total_Stops  Price  Year  Month  Date
0          0.0   3897  2019      3    24
1          2.0   7662  2019      5     1
2          2.0  13882  2019      6     9
3          1.0   6218  2019      5    12
4          1.0  13302  2019      3     1
```

[69]:
```
dfts["Dep_hour"] = pd.to_datetime(dfts["Dep_Time"]).dt.hour
dfts["Dep_min"] = pd.to_datetime(dfts["Dep_Time"]).dt.minute
```

[70]:
```
dfts["Arrival_hour"] = pd.to_datetime(dfts["Arrival_Time"]).dt.hour
dfts["Arrival_min"] = pd.to_datetime(dfts["Arrival_Time"]).dt.minute
```

[71]:
```
dfts.drop(['Dep_Time', 'Arrival_Time'], axis=1, inplace=True)
```

[72]:
```
dfts.head()
```

[72]:
```
       Airline    Source Destination Duration  Total_Stops  Price  Year  \
0       IndiGo  Banglore   New Delhi   2h 50m          0.0   3897  2019
1    Air India   Kolkata    Banglore   7h 25m          2.0   7662  2019
2  Jet Airways     Delhi      Cochin      19h          2.0  13882  2019
3       IndiGo   Kolkata    Banglore   5h 25m          1.0   6218  2019
4       IndiGo  Banglore   New Delhi   4h 45m          1.0  13302  2019

   Month  Date  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0      3    24        22       20             1           10
1      5     1         5       50            13           15
2      6     9         9       25             4           25
```

```
3      5    12        18        5            23           30
4      3     1        16       50            21           35
```

[73]:
```
dfts[dfts['Duration']=='5m']
```

[73]:
```
        Airline  Source Destination Duration  Total_Stops  Price  Year  Month  \
6474  Air India  Mumbai   Hyderabad       5m          2.0  17327  2019      3

      Date  Dep_hour  Dep_min  Arrival_hour  Arrival_min
6474     6        16       50            16           55
```

[74]:
```
dfts.drop([2660,],axis=0,inplace=True)
```

[75]:
```
dfts.head()
```

[75]:
```
        Airline    Source Destination Duration  Total_Stops  Price  Year  \
0        IndiGo  Banglore   New Delhi   2h 50m          0.0   3897  2019
1    Air India   Kolkata    Banglore   7h 25m          2.0   7662  2019
2  Jet Airways     Delhi      Cochin       19h          2.0  13882  2019
3       IndiGo   Kolkata    Banglore   5h 25m          1.0   6218  2019
4       IndiGo  Banglore   New Delhi   4h 45m          1.0  13302  2019

   Month  Date  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0      3    24        22       20             1           10
1      5     1         5       50            13           15
2      6     9         9       25             4           25
3      5    12        18        5            23           30
4      3     1        16       50            21           35
```

[76]:
```
dfts['Dur_min'] = dfts['Duration'].str.split(' ').str[1].str[:-1].astype(float)
```

[77]:
```
dfts.drop(['Duration'],axis=1,inplace=True)
```

[78]:
```
dfts.head()
```

[78]:
```
        Airline    Source Destination  Total_Stops  Price  Year  Month  Date  \
0        IndiGo  Banglore   New Delhi          0.0   3897  2019      3    24
1    Air India   Kolkata    Banglore          2.0   7662  2019      5     1
2  Jet Airways     Delhi      Cochin          2.0  13882  2019      6     9
3       IndiGo   Kolkata    Banglore          1.0   6218  2019      5    12
4       IndiGo  Banglore   New Delhi          1.0  13302  2019      3     1

   Dep_hour  Dep_min  Arrival_hour  Arrival_min  Dur_min
0        22       20             1           10     50.0
1         5       50            13           15     25.0
2         9       25             4           25      NaN
3        18        5            23           30     25.0
```

```
4        16       50            21           35     45.0
```

[79]:
```
Source = dfts[["Source"]]

Source = pd.get_dummies(Source, drop_first= True)

Source.head()
```

[79]:
```
   Source_Chennai  Source_Delhi  Source_Kolkata  Source_Mumbai
0           False         False           False          False
1           False         False            True          False
2           False          True           False          False
3           False         False            True          False
4           False         False           False          False
```

[80]:
```
Destination = dfts[["Destination"]]

Destination = pd.get_dummies(Destination, drop_first= True)

Destination.head()
```

[80]:
```
   Destination_Cochin  Destination_Delhi  Destination_Hyderabad  \
0               False              False                  False
1               False              False                  False
2                True              False                  False
3               False              False                  False
4               False              False                  False

   Destination_Kolkata  Destination_New Delhi
0                False                   True
1                False                  False
2                False                  False
3                False                  False
4                False                   True
```

[81]:
```
Airline = dfts[["Airline"]]

Airline = pd.get_dummies(Airline, drop_first= True)

Airline.head()
```

[81]:
```
   Airline_Air India  Airline_GoAir  Airline_IndiGo  Airline_Jet Airways  \
0              False          False            True                False
1               True          False           False                False
2              False          False           False                 True
3              False          False            True                False
4              False          False            True                False
```

```
   Airline_Jet Airways Business  Airline_Multiple carriers  \
0                         False                      False
1                         False                      False
2                         False                      False
3                         False                      False
4                         False                      False

   Airline_Multiple carriers Premium economy  Airline_SpiceJet  \
0                                      False             False
1                                      False             False
2                                      False             False
3                                      False             False
4                                      False             False

   Airline_Trujet  Airline_Vistara  Airline_Vistara Premium economy
0           False            False                            False
1           False            False                            False
2           False            False                            False
3           False            False                            False
4           False            False                            False
```

[82]:
```
dfts1 = pd.concat([dfts, Airline, Source, Destination], axis = 1)
```

[83]:
```
dfts1.head()
```

[83]:
```
       Airline    Source Destination  Total_Stops  Price  Year  Month  Date  \
0       IndiGo  Banglore   New Delhi          0.0   3897  2019      3    24
1    Air India   Kolkata    Banglore          2.0   7662  2019      5     1
2  Jet Airways     Delhi      Cochin          2.0  13882  2019      6     9
3       IndiGo   Kolkata    Banglore          1.0   6218  2019      5    12
4       IndiGo  Banglore   New Delhi          1.0  13302  2019      3     1

   Dep_hour  Dep_min  …  Airline_Vistara Premium economy  Source_Chennai  \
0        22       20  …                            False           False
1         5       50  …                            False           False
2         9       25  …                            False           False
3        18        5  …                            False           False
4        16       50  …                            False           False

   Source_Delhi  Source_Kolkata  Source_Mumbai  Destination_Cochin  \
0         False           False          False               False
1         False            True          False               False
2          True           False          False                True
3         False            True          False               False
4         False           False          False               False
```

```
   Destination_Delhi  Destination_Hyderabad  Destination_Kolkata  \
0              False                  False                False
1              False                  False                False
2              False                  False                False
3              False                  False                False
4              False                  False                False

   Destination_New Delhi
0                   True
1                  False
2                  False
3                  False
4                   True

[5 rows x 33 columns]
```

[84]:
```
dfts1.drop(["Airline", "Source", "Destination","Year"], axis = 1, inplace =
↪True)
```

[85]:
```
dfts1.head()
```

[85]:
```
   Total_Stops  Price  Month  Date  Dep_hour  Dep_min  Arrival_hour  \
0          0.0   3897      3    24        22       20             1
1          2.0   7662      5     1         5       50            13
2          2.0  13882      6     9         9       25             4
3          1.0   6218      5    12        18        5            23
4          1.0  13302      3     1        16       50            21

   Arrival_min  Dur_min  Airline_Air India  …  \
0           10     50.0              False  …
1           15     25.0               True  …
2           25      NaN              False  …
3           30     25.0              False  …
4           35     45.0              False  …

   Airline_Vistara Premium economy  Source_Chennai  Source_Delhi  \
0                            False           False         False
1                            False           False         False
2                            False           False          True
3                            False           False         False
4                            False           False         False

   Source_Kolkata  Source_Mumbai  Destination_Cochin  Destination_Delhi  \
0           False          False               False              False
1            True          False               False              False
2           False          False                True              False
3            True          False               False              False
```

```
4           False          False                False               False

   Destination_Hyderabad  Destination_Kolkata  Destination_New Delhi
0                  False                False                   True
1                  False                False                  False
2                  False                False                  False
3                  False                False                  False
4                  False                False                   True

[5 rows x 29 columns]
```

[86]:
```
dfts1.head()
```

[86]:
```
   Total_Stops  Price  Month  Date  Dep_hour  Dep_min  Arrival_hour  \
0          0.0   3897      3    24        22       20             1
1          2.0   7662      5     1         5       50            13
2          2.0  13882      6     9         9       25             4
3          1.0   6218      5    12        18        5            23
4          1.0  13302      3     1        16       50            21

   Arrival_min  Dur_min  Airline_Air India  …  \
0           10     50.0              False  …
1           15     25.0               True  …
2           25      NaN              False  …
3           30     25.0              False  …
4           35     45.0              False  …

   Airline_Vistara Premium economy  Source_Chennai  Source_Delhi  \
0                            False           False         False
1                            False           False         False
2                            False           False          True
3                            False           False         False
4                            False           False         False

   Source_Kolkata  Source_Mumbai  Destination_Cochin  Destination_Delhi  \
0           False          False               False              False
1            True          False               False              False
2           False          False                True              False
3            True          False               False              False
4           False          False               False              False

   Destination_Hyderabad  Destination_Kolkata  Destination_New Delhi
0                  False                False                   True
1                  False                False                  False
2                  False                False                  False
3                  False                False                  False
4                  False                False                   True
```

```
[5 rows x 29 columns]
```

[87]:
```
dftr1.columns
```

[87]:
```
Index(['Total_Stops', 'Price', 'Month', 'Date', 'Dur_hours', 'Dur_min',
       'Dep_hour', 'Dep_min', 'Arrival_hour', 'Arrival_min',
       'Airline_Air India', 'Airline_GoAir', 'Airline_IndiGo',
       'Airline_Jet Airways', 'Airline_Jet Airways Business',
       'Airline_Multiple carriers',
       'Airline_Multiple carriers Premium economy', 'Airline_SpiceJet',
       'Airline_Vistara', 'Airline_Vistara Premium economy', 'Source_Chennai',
       'Source_Delhi', 'Source_Kolkata', 'Source_Mumbai', 'Destination_Cochin',
       'Destination_Delhi', 'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi'],
      dtype='object')
```

[88]:
```
X = dftr1.loc[:, ['Total_Stops', 'Date', 'Month', 'Dep_hour',
       'Dep_min', 'Arrival_hour', 'Arrival_min', 'Dur_hours',
       'Dur_min', 'Airline_Air India', 'Airline_GoAir', 'Airline_IndiGo',
       'Airline_Jet Airways', 'Airline_Jet Airways Business',
       'Airline_Multiple carriers',
       'Airline_Multiple carriers Premium economy', 'Airline_SpiceJet',␣
 ↪'Airline_Vistara', 'Airline_Vistara Premium economy',
       'Source_Chennai', 'Source_Delhi', 'Source_Kolkata', 'Source_Mumbai',
       'Destination_Cochin', 'Destination_Delhi', 'Destination_Hyderabad',
       'Destination_Kolkata', 'Destination_New Delhi']]
X.head()
```

[88]:

	Total_Stops	Date	Month	Dep_hour	Dep_min	Arrival_hour	Arrival_min	\
0	0	24	3	22	20	1	10	
1	2	1	5	5	50	13	15	
2	2	9	6	9	25	4	25	
3	1	12	5	18	5	23	30	
4	1	1	3	16	50	21	35	

	Dur_hours	Dur_min	Airline_Air India	…	\
0	2.0	50.0	False	…	
1	7.0	25.0	True	…	
2	19.0	0.0	False	…	
3	5.0	25.0	False	…	
4	4.0	45.0	False	…	

	Airline_Vistara Premium economy	Source_Chennai	Source_Delhi	\
0	False	False	False	
1	False	False	False	
2	False	False	True	

```
3                           False           False         False
4                           False           False         False

   Source_Kolkata  Source_Mumbai  Destination_Cochin  Destination_Delhi  \
0           False          False               False              False
1            True          False               False              False
2           False          False                True              False
3            True          False               False              False
4           False          False               False              False

   Destination_Hyderabad  Destination_Kolkata  Destination_New Delhi
0                  False                False                   True
1                  False                False                  False
2                  False                False                  False
3                  False                False                  False
4                  False                False                   True

[5 rows x 28 columns]
```

[89]:
```
dftr.Airline.unique()
```

[89]:
```
array(['IndiGo', 'Air India', 'Jet Airways', 'SpiceJet',
       'Multiple carriers', 'GoAir', 'Vistara', 'Air Asia',
       'Vistara Premium economy', 'Jet Airways Business',
       'Multiple carriers Premium economy'], dtype=object)
```

[90]:
```
for i in ['Airline', 'Source', 'Destination']:
  print(i,dftr[i].unique())
```

```
Airline ['IndiGo' 'Air India' 'Jet Airways' 'SpiceJet' 'Multiple carriers'
'GoAir'
 'Vistara' 'Air Asia' 'Vistara Premium economy' 'Jet Airways Business'
 'Multiple carriers Premium economy']
Source ['Banglore' 'Kolkata' 'Delhi' 'Chennai' 'Mumbai']
Destination ['New Delhi' 'Banglore' 'Cochin' 'Kolkata' 'Delhi' 'Hyderabad']
```

[91]:
```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
for i in['Airline','Source','Destination']:
  dftr[i]=le.fit_transform(dftr[i])
dftr.head()
```

[91]:
```
   Airline  Source  Destination  Total_Stops     Price  Month  Date  \
0        3       0            5            0  8.267962      3    24
1        1       3            0            2  8.944028      5     1
2        4       2            1            2  9.538348      6     9
3        3       3            0            1  8.735204      5    12
```

```
4         3       0            5            1  9.495670      3     1

   Dur_hours  Dur_min  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0        2.0     50.0        22       20             1           10
1        7.0     25.0         5       50            13           15
2       19.0      0.0         9       25             4           25
3        5.0     25.0        18        5            23           30
4        4.0     45.0        16       50            21           35
```

[92]:
```
dftr.head()
```

[92]:
```
   Airline  Source  Destination  Total_Stops     Price  Month  Date  \
0        3       0            5            0  8.267962      3    24
1        1       3            0            2  8.944028      5     1
2        4       2            1            2  9.538348      6     9
3        3       3            0            1  8.735204      5    12
4        3       0            5            1  9.495670      3     1

   Dur_hours  Dur_min  Dep_hour  Dep_min  Arrival_hour  Arrival_min
0        2.0     50.0        22       20             1           10
1        7.0     25.0         5       50            13           15
2       19.0      0.0         9       25             4           25
3        5.0     25.0        18        5            23           30
4        4.0     45.0        16       50            21           35
```

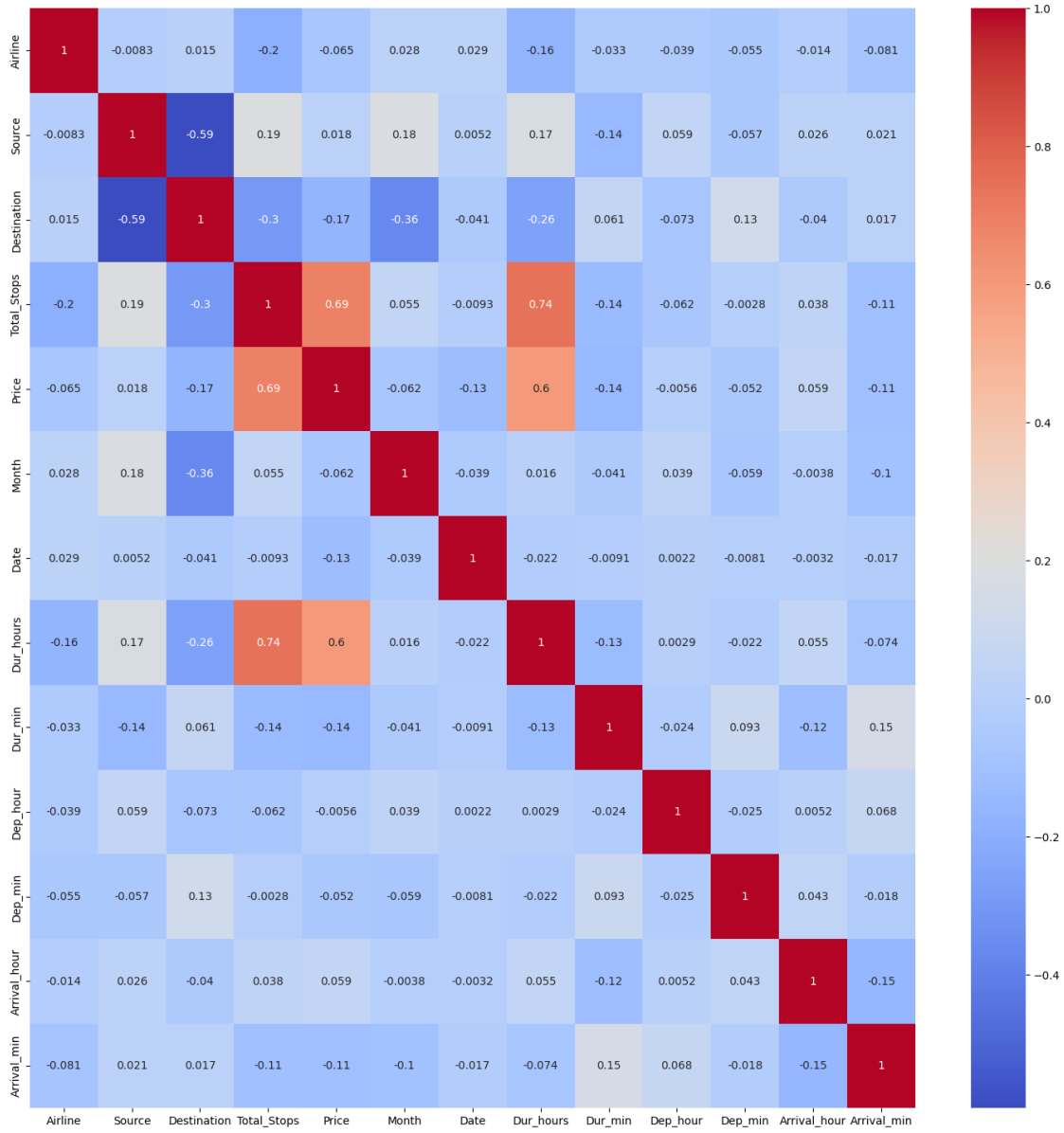
[93]:
```
y = dftr1.iloc[:, 1]
y.head()
```

[93]:
```
0    8.267962
1    8.944028
2    9.538348
3    8.735204
4    9.495670
Name: Price, dtype: float64
```

[94]:
```
dftr.columns
```

[94]:
```
Index(['Airline', 'Source', 'Destination', 'Total_Stops', 'Price', 'Month',
       'Date', 'Dur_hours', 'Dur_min', 'Dep_hour', 'Dep_min', 'Arrival_hour',
       'Arrival_min'],
      dtype='object')
```

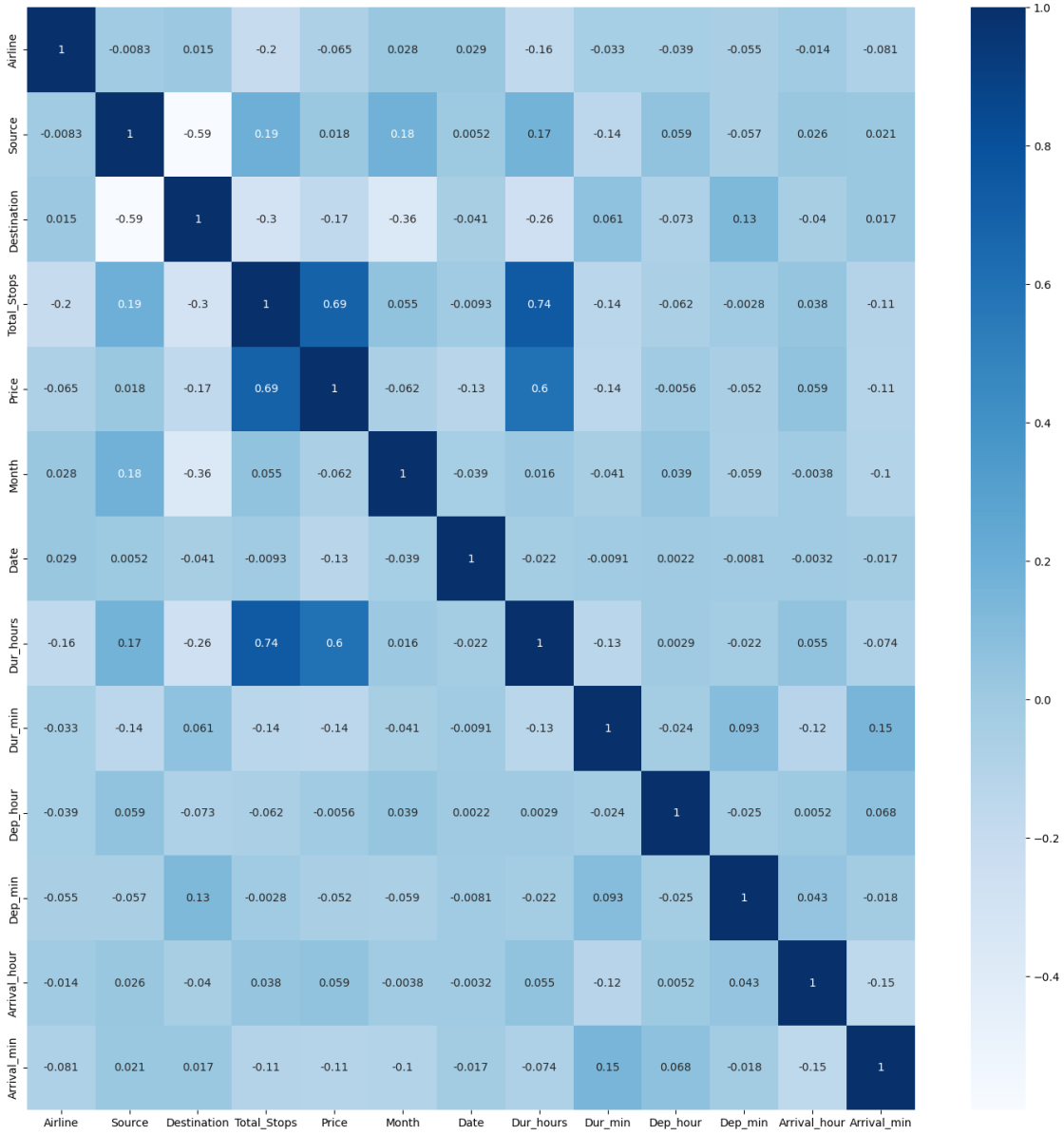
[95]:
```
plt.figure(figsize = (18,18))

sns.heatmap(dftr.corr(),annot= True, cmap = "coolwarm")

plt.show()
```



[96]:
```
dftr.info()
dftr = dftr[dftr['Airline'] != 'IndiGo']
dftr['Airline'] = dftr['Airline'].astype('category').cat.codes
plt.figure(figsize = (18,18))
sns.heatmap(dftr.corr(), annot = True, cmap = "Blues")

plt.show()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 10680 entries, 0 to 10682
Data columns (total 13 columns):
```

```
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Airline       10680 non-null  int64
 1   Source        10680 non-null  int64
 2   Destination   10680 non-null  int64
 3   Total_Stops   10680 non-null  int64
 4   Price         10680 non-null  float64
 5   Month         10680 non-null  int32
 6   Date          10680 non-null  int32
 7   Dur_hours     10680 non-null  float64
 8   Dur_min       10680 non-null  float64
 9   Dep_hour      10680 non-null  int32
 10  Dep_min       10680 non-null  int32
 11  Arrival_hour  10680 non-null  int32
 12  Arrival_min   10680 non-null  int32
dtypes: float64(3), int32(6), int64(4)
memory usage: 1.1 MB
```



Model Creation:

Linear Regression

[97]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y,test_size=0.2,␣
 ↪random_state=0)
```

[98]:
```
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

[98]:
```
LinearRegression()
```

[99]:
```
y_pred = regressor.predict(X_test)
```

[100]:
```
y_pred
```

[100]:
```
array([9.36278421, 9.28045081, 8.10136228, …, 8.46350225, 8.1840636 ,
       9.29190344])
```

[101]:
```
y_pred = np.exp(y_pred)
y_pred
```

[101]:
```
array([11646.77044181, 10726.26638232,  3298.95911344, …,
        4738.62482883,  3583.38657625, 10849.8164224 ])
```

[102]:
```
y_test = np.exp(y_test)
y_test
```

[102]:
```
5880     10262.0
6137     11399.0
7700      3597.0
1437     16757.0
8480      4409.0
           …
9454     12954.0
6391      3943.0
9273      4804.0
5381      2754.0
10037     9663.0
Name: Price, Length: 2136, dtype: float64
```

[103]:
```
df1 = pd.DataFrame({'Actual': y_test, 'Predicted': y_pred})
```

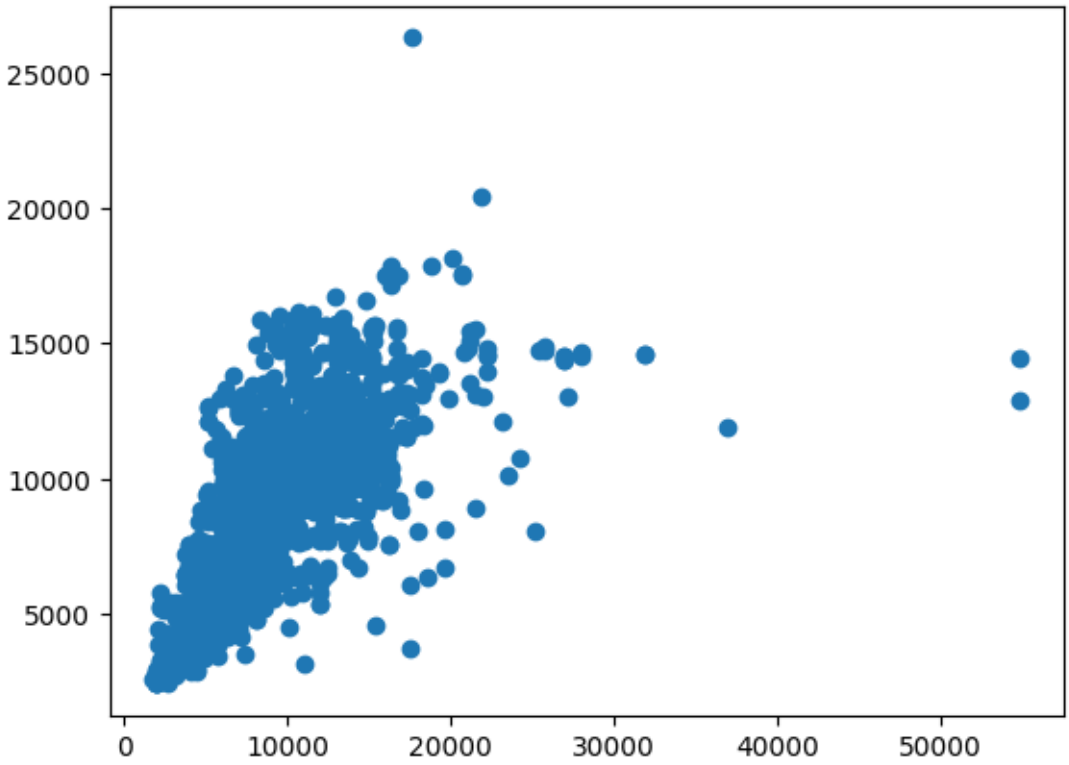
[104]:
```
df1.head()
```

[104]:

	Actual	Predicted
5880	10262.0	11646.770442
6137	11399.0	10726.266382
7700	3597.0	3298.959113
1437	16757.0	13832.067160
8480	4409.0	4950.836863

[105]:
```
plt.scatter(df1['Actual'], df1['Predicted'])
```

[105]:
```
<matplotlib.collections.PathCollection at 0x7b8b182baa70>
```



Model Evaluation:

[106]:
```
# Evaluate the performance of the model
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import r2_score

mse = mean_squared_error(y_test, y_pred)
print("Mean Squared Error:", mse)
```

```
Mean Squared Error: 9879715.208469111
```

[107]:
```
mae = mean_absolute_error(y_test, y_pred)
print("Mean Absolute Error:", mae)
```

```
Mean Absolute Error: 1993.2667968498329
```

[108]:
```
r2 = r2_score(y_test, y_pred)
print("R-squared Score:", r2)
```

```
R-squared Score: 0.5528063106264729
```

[109]:
```
# Calculating RMSE
rmse = np.sqrt(mse)
print("Root Mean Squared Error:", rmse)
```

```
Root Mean Squared Error: 3143.2014266459464
```

Model Creation:

Random Forest

[110]:
```
from sklearn.ensemble import RandomForestRegressor
reg_rf = RandomForestRegressor()
reg_rf.fit(X_train, y_train)
```

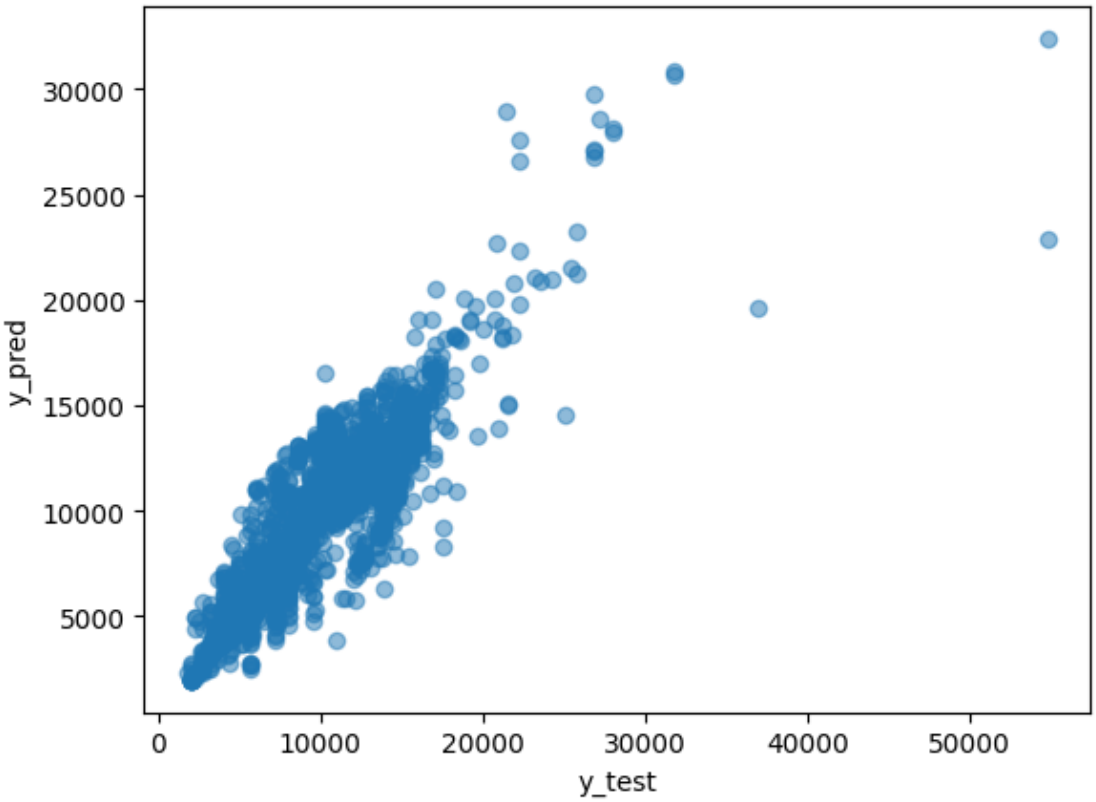
[110]:
```
RandomForestRegressor()
```

[111]:
```
y_pred = reg_rf.predict(X_test)
```

[112]:
```
y_pred = np.exp(y_pred)
y_pred
```

[112]:
```
array([14259.63158131, 14851.98647425,  3582.05041981, …,
        5084.73055081,  3014.80344113, 11201.93365155])
```

[113]:
```
plt.scatter(y_test, y_pred, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



[114]:
```
df1 = pd.DataFrame({'Actual': y_test, 'Predicted': y_pred})
df1.head()
```

[114]:

	Actual	Predicted
5880	10262.0	14259.631581
6137	11399.0	14851.986474
7700	3597.0	3582.050420
1437	16757.0	14213.690373
8480	4409.0	4489.170226

Model Evaluation:

[115]:
```
# Evaluate the performance of the model
mse = mean_squared_error(y_test, y_pred)
print("Mean Squared Error:", mse)

# Calculate mean absolute error (MAE)
mae = mean_absolute_error(y_test, y_pred)
print("Mean Absolute Error:", mae)

# Calculate R² score
r2 = r2_score(y_test, y_pred)
```

```
print("R² Score:", r2)
```

```
Mean Squared Error: 4233749.687419016
Mean Absolute Error: 1219.8635759286187
R² Score: 0.8083642997140299
```

[116]:
```
# Calculating RMSE
rmse = mean_squared_error(y_test, y_pred, squared=False)

print("Root Mean Squared Error:", rmse)
```

```
Root Mean Squared Error: 2057.6077583978476
```

Model Creation:

K Means

[117]:
```
from sklearn.cluster import KMeans
from sklearn.metrics import mean_absolute_error, mean_squared_error

# Assuming you only need numerical features for clustering
X = dftr.select_dtypes(include=np.number)

# Fit KMeans to cluster the data
kmeans = KMeans(n_clusters=5, random_state=42)
kmeans.fit(X)
```

[117]:
```
KMeans(n_clusters=5, random_state=42)
```

[118]:
```
# Assign cluster labels to the original dataset
dftr['cluster'] = kmeans.labels_
```

[119]:
```
# Compute average fare for each cluster
cluster_avg_fare = dftr.groupby('cluster')['Price'].mean()
```

[120]:
```
# Predict fares based on cluster assignment
dftr['predicted_fare'] = dftr['cluster'].map(cluster_avg_fare)
```

Model Evaluation

[121]:
```
# Calculate Mean Absolute Error (MAE)
mae = mean_absolute_error(dftr['Price'], dftr['predicted_fare'])

# Calculate Mean Squared Error (MSE)
mse = mean_squared_error(dftr['Price'], dftr['predicted_fare'])

# Calculate R-squared (R2) score
r2 = r2_score(dftr['Price'], dftr['predicted_fare'])
```

```
# Calculate Root Mean Squared Error (RMSE)
rmse = np.sqrt(mean_squared_error(dftr['Price'], dftr['predicted_fare']))

print("Mean Absolute Error (MAE):", mae)
print("Mean Squared Error (MSE):", mse)
print("R-squared (R2) Score:", r2)
print("Root Mean Squared Error (RMSE):", rmse)
```

```
Mean Absolute Error (MAE): 0.4232609897492923
Mean Squared Error (MSE): 0.2562962115684503
R-squared (R2) Score: 0.028250365427443414
Root Mean Squared Error (RMSE): 0.5062570607591071
```

Gradient Boosting Regressor

Model Creation:

[122]:
```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score

# Splitting the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Creating and training the Gradient Boosting model
gb_model = GradientBoostingRegressor()
gb_model.fit(X_train, y_train)

# Predicting on the test set
y_pred = gb_model.predict(X_test)
```

Model Evaluation

[123]:
```
# Evaluating the model
mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
rmse=np.sqrt(mse)

print("Mean Absolute Error (MAE):", mae)
print("Mean Squared Error (MSE):", mse)
print("R-squared (R2) Score:", r2)
print("Root Mean Squared Error (RMSE) Score:", rmse)
```

```
Mean Absolute Error (MAE): 0.002364953040986227
Mean Squared Error (MSE): 2.104361573044475e-05
R-squared (R2) Score: 0.9999215714417855
Root Mean Squared Error (RMSE) Score: 0.004587332092888496
```

Decision Tree:

Model Creation:

[124]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor
from sklearn.metrics import mean_squared_error

# Create and train the decision tree model
model = DecisionTreeRegressor(random_state=42)
model.fit(X_train, y_train)

# Make predictions on the testing set
predictions = model.predict(X_test)
```

Model Evaluation

[125]:
```
# Evaluate the performance of the model
mse = mean_squared_error(y_test, predictions)
print("Mean Squared Error:", mse)

# Calculate mean absolute error (MAE)
mae = mean_absolute_error(y_test,predictions)
print("Mean Absolute Error:", mae)

# Calculate R² score
r2 = r2_score(y_test, predictions)
print("R² Score:", r2)

# Calculating RMSE
rmse = mean_squared_error(y_test, predictions, squared=False)
print("Root Mean Squared Error:", rmse)
```

```
Mean Squared Error: 8.077573492174111e-05
Mean Absolute Error: 0.0004561596792808597
R² Score: 0.999698952665275
Root Mean Squared Error: 0.008987532193085103
```

XG Boost model

[126]:
```
# Importing necessary libraries
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
import xgboost as xgb
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score

# Splitting the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

```
# Training the XGBoost model
model = xgb.XGBRegressor()
model.fit(X_train, y_train)

# Making predictions
y_pred = model.predict(X_test)
```

Model Evaluation

[127]:
```
# Evaluating the model
mse = mean_squared_error(y_test, y_pred)
mae = mean_absolute_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
rmse = np.sqrt(mse)

print("Mean Squared Error:", mse)
print("Mean Absolute Error:", mae)
print("R-squared Score:", r2)
print("Root Mean Squared Error:", rmse)
```

```
Mean Squared Error: 0.0001987740161409871
Mean Absolute Error: 0.0031204844081673885
R-squared Score: 0.9992591786651053
Root Mean Squared Error: 0.01409872391888667
```

Hyperparameter tuning

[ ]:
```
from sklearn.model_selection import GridSearchCV

# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Define the model
model = RandomForestRegressor()

# Define the hyperparameters grid
param_grid = {
    'n_estimators': [50, 100, 150],
    'max_depth': [None, 10, 20],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]
}

# Perform GridSearchCV
grid_search = GridSearchCV(estimator=model, param_grid=param_grid, cv=5,␣
 ↪scoring='neg_mean_squared_error', n_jobs=-1)
```

```
grid_search.fit(X_train, y_train)

# Print the best hyperparameters
print("Best hyperparameters:", grid_search.best_params_)

# Get the best model
best_model = grid_search.best_estimator_

# Make predictions
y_pred = best_model.predict(X_test)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
print("Mean Squared Error:", mse)
```

[ ]:
```
final_model = best_model
final_model.fit(X, y)
```

[ ]:
```
# Saving the final model for future use
import joblib
joblib.dump(final_model, 'final_flight_fare_prediction_model.pkl')
```

[ ]:
```
# Loading the saved model
model = joblib.load("final_flight_fare_prediction_model.pkl")

# Prediction
prediction = model.predict(X_test)
prediction
```

[ ]:
```
pd.DataFrame([model.predict(X_test)[:], y_test[:]], index = ['Predicted',␣
↪'Actual'])
```

Conclusion:

With this, we come to an end of our article – flight price prediction using machine learning. Our regression models have successfully forecasted airline ticket prices with notable accuracy. Through rigorous feature engineering and optimization, particularly in decision tree regression, we've gained valuable insights into market dynamics.

In summary, our study demonstrates the effectiveness of machine learning in forecasting airfare prices. Continued advancements in deep learning techniques will likely lead to even more precise predictions, benefiting travelers and industry stakeholders alike.

By Comparing the r2 score of every model we can conclude that Gradient boosting and Decision tree are the best model followed by XG Boost, Random Forest and Linear Regression