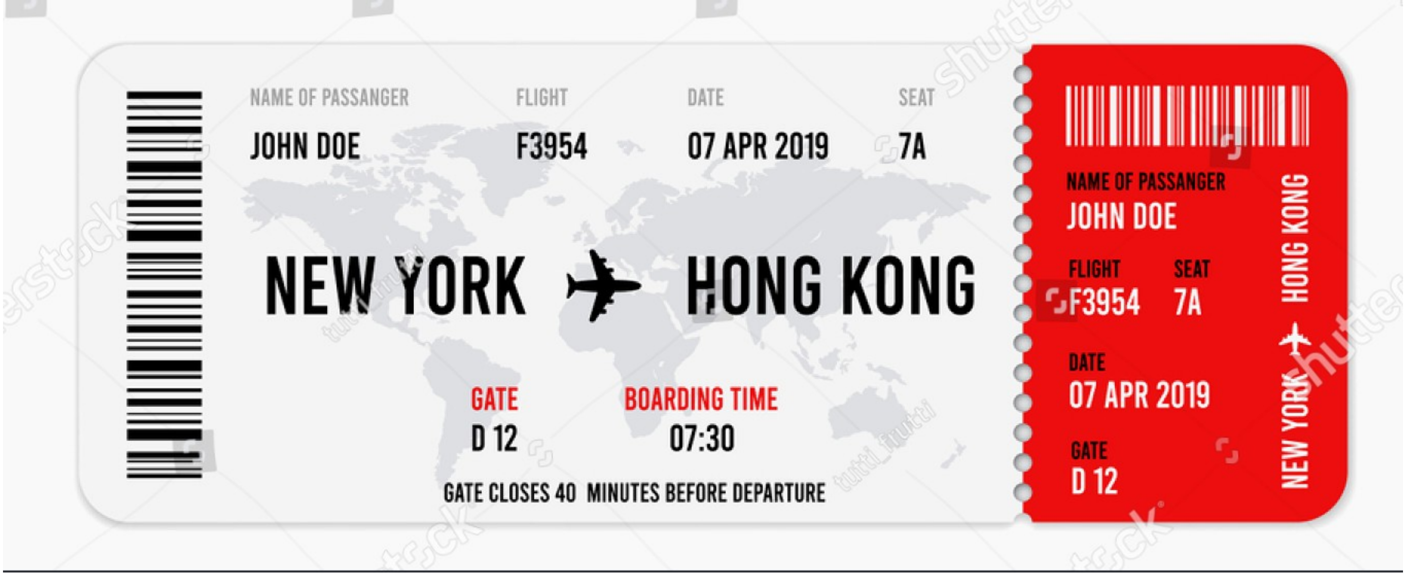
Problem Statement



Travelling through flights has become an integral part of today’s lifestyle as more and more people are opting for faster travelling options. The flight ticket prices increase or decrease every now and then depending on various factors like timing of the flights, destination, and duration of flights various occasions such as vacations or festive season. Therefore, having some basic idea of the flight fares before planning the trip will surely help many people save money and time. The main goal is to predict the fares of the flights based on different factors available in the provided dataset.

import libraries

In [3]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

data ingestion

In [4]:

```
train_df = pd.read_excel('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/archive/Data_Train.xlsx')
```

In [5]:

```
train_df.head()
```

Out[5]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price
0	IndiGo	24/03/2019	Banglore	New Delhi	BLR → DEL	22:20	01:10 22 Mar	2h 50m	non-stop	No info	3897
1	Air India	1/05/2019	Kolkata	Banglore	CCU → IXR → BBI → BLR	05:50	13:15	7h 25m	2 stops	No info	7662
2	Jet Airways	9/06/2019	Delhi	Cochin	DEL → LKO → BOM → COK	09:25	04:25 10 Jun	19h	2 stops	No info	13882
3	IndiGo	12/05/2019	Kolkata	Banglore	CCU → NAG → BLR	18:05	23:30	5h 25m	1 stop	No info	6218
4	IndiGo	01/03/2019	Banglore	New Delhi	BLR → NAG → DEL	16:50	21:35	4h 45m	1 stop	No info	13302

In [6]:

```
train_df.columns
```

Out[6]:

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

Properties and nature of data

In [7]:

```
train_df.shape
```

Out[7]:

```
(10683, 11)
```

In [8]:

```
train_df.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
```

In [9]:

```
train_df.describe().T
```

Out[9]:

	count	mean	std	min	25%	50%	75%	max
Price	10683.0	9087.064121	4611.359167	1759.0	5277.0	8372.0	12373.0	79512.0

Observations:

- Dataset has 11 features out of which *"Price"* is the Dependent feature and rest are independent features.
- Dataset has more than 10k rows, so we can eliminate the missing or null values.
- All the Independent features are of "object" type. So we need to apply tupe-casting or mapping or encoding to convert them into usefull values for our Model Algorithm.

null values

In [10]:

```

train_df.isnull().sum()
```

Out[10]:

```
Airline            0
Date_of_Journey    0
Source             0
Destination        0
Route              1
Dep_Time           0
Arrival_Time       0
Duration           0
Total_Stops        1
Additional_Info    0
Price              0
dtype: int64
```

In [11]:

```
train_df[train_df.Route.isnull()]
```

Out[11]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price
9039	Air India	6/05/2019	Delhi	Cochin	NaN	09:45	09:25 07 May	23h 40m	NaN	No info	7480

In [12]:

```
train_df[train_df.Total_Stops.isnull()]
```

Out[12]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price
9039	Air India	6/05/2019	Delhi	Cochin	NaN	09:45	09:25 07 May	23h 40m	NaN	No info	7480

Comment:

Since there are very few NaN value, we can simply drop them. It will not cause any major problem.

In [13]:

```
train_df.dropna(inplace=True)
```

In [14]:

```
train_df.isna().sum()
```

Out[14]:

```
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
```

Analysis and Processing of Dependent feature

In [15]:

```
train_df.Price.value_counts()
```

Out[15]:

```
10262    258
10844    212
7229     162
4804     160
4823     131
        ...
14153      1
8488       1
7826       1
6315       1
12648      1
Name: Price, Length: 1870, dtype: int64
```

Comment:

- As the Price column (Dependent feature) contains continuous integer values, so it is a Regression problem statement.

Analysis and Processing of Independent features

In [16]:

```
for col in train_df.columns:
    if col != 'Price':
        print(f"Feature Name : {col}")
        print('\n', train_df[col].unique())
        print('\n', "Total number of unique values = ", len(train_df[col].unique()))
        print('\n', train_df[col].value_counts())
        print('\n', '=*'*40, '\n')
```

```
Feature Name : Airline

 ['IndiGo' 'Air India' 'Jet Airways' 'SpiceJet' 'Multiple carriers' 'GoAir'
 'Vistara' 'Air Asia' 'Vistara Premium economy' 'Jet Airways Business'
 'Multiple carriers Premium economy' 'Trujet']

 Total number of unique values =  12

 Jet Airways                          3849
IndiGo                               2053
Air India                            1751
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
```

Observations:

- **Airline:** This dataset has 12 different Airlines but imbalanced in nature and can be considered as **Nominal data (Catagorical)** . We just need to encode them with **OneHotEncoder**.
- **Date_of_Journey:** This feature is the most important one as the flight fare changes rapidly depending on which moth of the year one wants to travel. We need to make two new columns named "Day" and "Month" using this feature and use those two features for prediction.
- **Source:** There are 5 Source options and can be considered as **Nominal data (Catagorical)** . We just need to encode them with **OneHotEncoder**.
- **Destination:** There are 6 Destination optionsand can be considered as **Nominal data (Catagorical)** . We just need to encode them with **OneHotEncoder**.
- **Route:** There are 128 different Route data available but it is imbalanced in nature. Also this feature is quite similar with the feature named "Total_Stops", so we can drop this features.
- **Dep_Time:** There is no inconsistent values in this feature and just need to convert those values into useful numerical values.
- **Arrival_Time:** This feature has few values that contains date along with time. We need to modify those and convert this feature into useful numerical values.
- **Duration:** This feature needs to be modified into integer using simple time conversion function.
- **Total_Stops:** This feature has 5 different values and can be considered as **Ordinal data (Catagorical)** that can be easily mapped or encoded using **LabelEncoder** and this will play an important role in "Fare prediction".
- **Additional_Info:** More than 80% data has no "Aditional info". So this feature is not important and can be dropped.

EDA & FE

Modify Date_of_Journey

In [17]:

```
# change data type from object to datetime
train_df.Date_of_Journey = pd.to_datetime(train_df.Date_of_Journey, dayfirst=True)
```

In [18]:

```
train_df.dtypes
```

Out[18]:

```
Airline                    object
Date_of_Journey    datetime64[ns]
Source                     object
Destination                object
Route                      object
Dep_Time                   object
Arrival_Time               object
Duration                   object
Total_Stops                object
Additional_Info            object
Price                       int64
dtype: object
```

In [19]:

```
# creating Day and Month columns that contain integer values
train_df["Day"] = train_df.Date_of_Journey.dt.day
train_df["Month"] = train_df.Date_of_Journey.dt.month

# Dropping "Date_of_Journey" column as it is not required anymore
train_df.drop(columns=["Date_of_Journey"], inplace=True)

train_df.head(5)
```

Out[19]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month
0	IndiGo	Banglore	New Delhi	BLR → DEL	22:20	01:10 22 Mar	2h 50m	non-stop	No info	3897	24	3
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	05:50	13:15	7h 25m	2 stops	No info	7662	1	5
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	09:25	04:25 10 Jun	19h	2 stops	No info	13882	9	6
3	IndiGo	Kolkata	Banglore	CCU → NAG → BLR	18:05	23:30	5h 25m	1 stop	No info	6218	12	5
4	IndiGo	Banglore	New Delhi	BLR → NAG → DEL	16:50	21:35	4h 45m	1 stop	No info	13302	1	3

Modify Dep_Time

In [20]:

```
# change data type of Dep_Time from object to datetime
train_df.Dep_Time = pd.to_datetime(train_df.Dep_Time)
```

In [21]:

```
train_df.dtypes
```

Out[21]:

```
Airline                    object
Source                     object
Destination                object
Route                      object
Dep_Time           datetime64[ns]
Arrival_Time               object
Duration                   object
Total_Stops                object
Additional_Info            object
Price                       int64
Day                         int64
Month                       int64
dtype: object
```

In [22]:

```
# create two seperate columnsnamed "Dep_hr" and "Dep_min"
train_df["Dep_hr"] = train_df.Dep_Time.dt.hour
train_df["Dep_min"] = train_df.Dep_Time.dt.minute
```

In [23]:

```
# converting "Dep_Time" column into float values
train_df.Dep_Time = train_df.Dep_Time.apply(lambda x: float(str(x).split(" ")[-1].replace(":", ".")[:5]))
```

In [24]:

```
train_df.head(3)
```

Out[24]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	Dep_hr	Dep_min
0	IndiGo	Banglore	New Delhi	BLR → DEL	22.20	01:10 22 Mar	2h 50m	non-stop	No info	3897	24	3	22	20
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	5.50	13:15	7h 25m	2 stops	No info	7662	1	5	5	50
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	9.25	04:25 10 Jun	19h	2 stops	No info	13882	9	6	9	25

Modify Arrival_Time

In [25]:

```
train_df.Arrival_Time = pd.to_datetime(train_df.Arrival_Time)
```

In [26]:

```
# create two seperate columnsnamed "Arrival_hr" and "Arrival_min"
train_df["Arrival_hr"] = train_df.Arrival_Time.dt.hour
train_df["Arrival_min"] = train_df.Arrival_Time.dt.minute
```

In [27]:

```
# converting "Dep_Time" column into float values
train_df.Arrival_Time = train_df.Arrival_Time.apply(lambda x: float(str(x).split(" ")[-1].replace(":", ".")[:5]))
```

In [28]:

```
train_df.head(3)
```

Out[28]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	Dep_hr	Dep_min
0	IndiGo	Banglore	New Delhi	BLR → DEL	22.20	1.10	2h 50m	non-stop	No info	3897	24	3	22	20
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	5.50	13.15	7h 25m	2 stops	No info	7662	1	5	5	50
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	9.25	4.25	19h	2 stops	No info	13882	9	6	9	25

Comment:

In case of "Dep_Time" and "Arrival_Time" we have created two seperate columns named "he" and "min" containing integer values and converted the original column into float values.

We will train our model seperately with integer values as well as the float values and will proceed with the model with best accuracy.

Modify Duration Feature

In [29]:

```
# we can convert all the values into equivallent value in min
def duration_in_min(dur):
    tt = 0
    for i in dur.split():
        if 'h' in i:
            tt += int(i[:-1])*60
        if 'm' in i:
            tt += int(i[:-1])
    return tt

train_df.Duration = train_df.Duration.apply(duration_in_min)
train_df.head(3)
```

Out[29]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	Dep_hr	Dep_min
0	IndiGo	Banglore	New Delhi	BLR → DEL	22.20	1.10	170	non-stop	No info	3897	24	3	22	20
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	5.50	13.15	445	2 stops	No info	7662	1	5	5	50
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	9.25	4.25	1140	2 stops	No info	13882	9	6	9	25

Analysis of Categorical features

In [30]:

```
train_df.Airline.value_counts()
```

Out[30]:

```
Jet Airways                          3849
IndiGo                               2053
Air India                            1751
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: Airline, dtype: int64
```

Comment:

As last four i.e. **Multiple carriers Premium economy , Jet Airways Business, Vistara Premium economy, Trujet** has very few data points to train any model, so we can drop them.

In [31]:

```
l = ['Multiple carriers Premium economy' , 'Jet Airways Business', 'Vistara Premium economy', 'Trujet']

train_df_airline = train_df[train_df.Airline.isin(l) == False]
```

In [32]:

```
train_df_airline.Airline.value_counts()
```

Out[32]:

```
Jet Airways          3849
IndiGo               2053
Air India            1751
Multiple carriers    1196
SpiceJet              818
Vistara               479
Air Asia              319
GoAir                 194
Name: Airline, dtype: int64
```

Checking for available airlines from each source

In [33]:

```
for s in train_df.Source.unique():
    print("Airlines available from" , s, '\n')
    print(train_df[train_df.Source == s].Airline.value_counts())
    print('\n', "*"*50)
```

```
Airlines available from Banglore

Jet Airways                 788
IndiGo                      523
Air India                   332
Vistara                     185
SpiceJet                    181
GoAir                        93
Air Asia                     89
Jet Airways Business          4
Vistara Premium economy       2
Name: Airline, dtype: int64

 **************************************************
Airlines available from Kolkata

Jet Airways    1256
Air India       512
IndiGo          445
```

Comment:

- All "Airline" options are not available from all the source Airports.
- We can make seperate dataset for each Airline and build model for each.
- Using those models we can predict the Flight Fare from any paricular Airport for different Airlines and show those results.

Encoding "Source" and "Destination" using OneHotEncoder

In [34]:

```
train_df = pd.get_dummies(train_df, columns=["Source", "Destination"])
```

In [35]:

```
train_df.head(3)
```

Out[35]:

	Airline	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	...	Source_Chennai	Source_Delhi	Sour
0	IndiGo	BLR → DEL	22.20	1.10	170	non-stop	No info	3897	24	3	...	0	0	
1	Air India	CCU → IXR → BBI → BLR	5.50	13.15	445	2 stops	No info	7662	1	5	...	0	0	
2	Jet Airways	DEL → LKO → BOM → COK	9.25	4.25	1140	2 stops	No info	13882	9	6	...	0	1	

3 rows × 25 columns

Encoding "Total_Stops" using LabelEncoder

In [36]:

```
# Unique values in "Total_Stops" before encoding
train_df.Total_Stops.unique()
```

Out[36]:

```
array(['non-stop', '2 stops', '1 stop', '3 stops', '4 stops'],
      dtype=object)
```

In [37]:

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
train_df.Total_Stops = le.fit_transform(train_df["Total_Stops"])
```

In [38]:

```
# Unique values in "Total_Stops" after encoding
train_df.Total_Stops.unique()
```

Out[38]:

```
array([4, 1, 0, 2, 3])
```

Dropping unnecessary features

In [39]:

```
train_df.drop(columns=["Route", "Additional_Info"], inplace=True)
```

Final look of dataset after complition of EDA & FE

In [40]:

```
train_df.head()
```

Out[40]:

	Airline	Dep_Time	Arrival_Time	Duration	Total_Stops	Price	Day	Month	Dep_hr	Dep_min	...	Source_Chennai	Source_Delhi	Source_K
0	IndiGo	22.20	1.10	170	4	3897	24	3	22	20	...	0	0	
1	Air India	5.50	13.15	445	1	7662	1	5	5	50	...	0	0	
2	Jet Airways	9.25	4.25	1140	1	13882	9	6	9	25	...	0	1	
3	IndiGo	18.05	23.30	325	0	6218	12	5	18	5	...	0	0	
4	IndiGo	16.50	21.35	285	0	13302	1	3	16	50	...	0	0	

5 rows × 23 columns

In [41]:

```
train_df.shape
```

Out[41]:

```
(10682, 23)
```

In [42]:

```
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10682 entries, 0 to 10682
Data columns (total 23 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Airline                10682 non-null  object 
 1   Dep_Time               10682 non-null  float64
 2   Arrival_Time           10682 non-null  float64
 3   Duration               10682 non-null  int64  
 4   Total_Stops            10682 non-null  int64  
 5   Price                  10682 non-null  int64  
 6   Day                    10682 non-null  int64  
 7   Month                  10682 non-null  int64  
 8   Dep_hr                 10682 non-null  int64  
 9   Dep_min                10682 non-null  int64  
 10  Arrival_hr             10682 non-null  int64  
 11  Arrival_min            10682 non-null  int64  
 12  Source_Banglore        10682 non-null  uint8  
 13  Source_Chennai         10682 non-null  uint8  
 14  Source_Delhi           10682 non-null  uint8  
 15  Source_Kolkata         10682 non-null  uint8  
 16  Source_Mumbai          10682 non-null  uint8  
 17  Destination_Banglore   10682 non-null  uint8  
 18  Destination_Cochin     10682 non-null  uint8  
 19  Destination_Delhi      10682 non-null  uint8  
 20  Destination_Hyderabad  10682 non-null  uint8  
 21  Destination_Kolkata    10682 non-null  uint8  
 22  Destination_New Delhi  10682 non-null  uint8  
dtypes: float64(2), int64(9), object(1), uint8(11)
memory usage: 1.2+ MB
```

Independent Features Selection

We will consider following conditions while selecting Independent features and build model for each case:

- **CASE-1:**

```
- We can apply OneHotEncoder on **Airlines** and train our model.
- We will keep Dep_time & Arrival_time with float values and drop four featurs named Dep_hr, Dep_min,
Arrival_hr, Arrival_min with int values
- This model will predict Flight Fare for a particular Airline given as an input by the user.
```

- **CASE-2:**

```
    - We can apply OneHotEncoder on **Airlines** and train our model.
    - We will drop Dep_time & Arrival_time and keep four featurs named Dep_hr, Dep_min, Arrival_hr,
      Arrival_min with int values
    - This model will predict Flight Fare for a particular Airline given as an input by the user.
```

- **CASE-3:**

```
    - We can create seperate data groups for different Airlines and build seperate Models for each Airlines.
    - These models will take Deperture Date-time, Arrival Date-time, Source, Destinations, Total_Stops as inp
  uts
    and show the Predicted Fare for each of the available Airlines for the given Route.
```

In [43]:

```
train_df.head(3)
```

Out[43]:

	Airline	Dep_Time	Arrival_Time	Duration	Total_Stops	Price	Day	Month	Dep_hr	Dep_min	...	Source_Chennai	Source_Delhi	Source_K
0	IndiGo	22.20	1.10	170	4	3897	24	3	22	20	...	0	0	
1	Air India	5.50	13.15	445	1	7662	1	5	5	50	...	0	0	
2	Jet Airways	9.25	4.25	1140	1	13882	9	6	9	25	...	0	1	

3 rows × 23 columns

In [44]:

```
train_df_Airline_encoded = pd.get_dummies(train_df, columns=["Airline"])
```

In [45]:

```
train_df_Airline_encoded.head(3)
```

Out[45]:

	Dep_Time	Arrival_Time	Duration	Total_Stops	Price	Day	Month	Dep_hr	Dep_min	Arrival_hr	...	Airline_GoAir	Airline_IndiGo	Airline_Jı Airway
0	22.20	1.10	170	4	3897	24	3	22	20	1	...	0	1	
1	5.50	13.15	445	1	7662	1	5	5	50	13	...	0	0	
2	9.25	4.25	1140	1	13882	9	6	9	25	4	...	0	0	

3 rows × 34 columns

In [46]:

```
train_df_Airline_encoded.columns
```

Out[46]:

```
Index(['Dep_Time', 'Arrival_Time', 'Duration', 'Total_Stops', 'Price', 'Day',
       'Month', 'Dep_hr', 'Dep_min', 'Arrival_hr', 'Arrival_min',
       'Source_Banglore', 'Source_Chennai', 'Source_Delhi', 'Source_Kolkata',
       'Source_Mumbai', 'Destination_Banglore', 'Destination_Cochin',
       'Destination_Delhi', 'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi', 'Airline_Air Asia', '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_Trujet', 'Airline_Vistara', 'Airline_Vistara Premium economy'],
      dtype='object')
```

Data Preperation for CASE-1

In [47]:

```
train_df_case1 = train_df_Airline_encoded[['Dep_Time', 'Arrival_Time', 'Duration', 'Total_Stops', 'Price', 'Day',
       'Month', 'Source_Banglore', 'Source_Chennai', 'Source_Delhi', 'Source_Kolkata',
       'Source_Mumbai', 'Destination_Banglore', 'Destination_Cochin',
       'Destination_Delhi', 'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi', 'Airline_Air Asia', '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_Trujet', 'Airline_Vistara', 'Airline_Vistara Premium economy']]
```

In [48]:

```
train_df_case1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10682 entries, 0 to 10682
Data columns (total 30 columns):
 #   Column                                     Non-Null Count  Dtype  
---  ------                                     --------------  -----  
 0   Dep_Time                                   10682 non-null  float64
 1   Arrival_Time                               10682 non-null  float64
 2   Duration                                   10682 non-null  int64  
 3   Total_Stops                                10682 non-null  int64  
 4   Price                                      10682 non-null  int64  
 5   Day                                        10682 non-null  int64  
 6   Month                                      10682 non-null  int64  
 7   Source_Banglore                            10682 non-null  uint8  
 8   Source_Chennai                             10682 non-null  uint8  
 9   Source_Delhi                               10682 non-null  uint8  
 10  Source_Kolkata                             10682 non-null  uint8  
 11  Source_Mumbai                              10682 non-null  uint8  
 12  Destination_Banglore                       10682 non-null  uint8  
 13  Destination_Cochin                         10682 non-null  uint8  
 14  Destination_Delhi                          10682 non-null  uint8  
 15  Destination_Hyderabad                      10682 non-null  uint8  
 16  Destination_Kolkata                        10682 non-null  uint8  
 17  Destination_New Delhi                      10682 non-null  uint8  
 18  Airline_Air Asia                           10682 non-null  uint8  
 19  Airline_Air India                          10682 non-null  uint8  
 20  Airline_GoAir                              10682 non-null  uint8  
 21  Airline_IndiGo                             10682 non-null  uint8  
 22  Airline_Jet Airways                        10682 non-null  uint8  
 23  Airline_Jet Airways Business               10682 non-null  uint8  
 24  Airline_Multiple carriers                  10682 non-null  uint8  
 25  Airline_Multiple carriers Premium economy  10682 non-null  uint8  
 26  Airline_SpiceJet                           10682 non-null  uint8  
 27  Airline_Trujet                             10682 non-null  uint8  
 28  Airline_Vistara                            10682 non-null  uint8  
 29  Airline_Vistara Premium economy            10682 non-null  uint8  
dtypes: float64(2), int64(5), uint8(23)
memory usage: 907.6 KB
```

Data Preperation for CASE-2

In [49]:

```
train_df_case2 = train_df_Airline_encoded[['Duration', 'Total_Stops', 'Price', 'Day',
       'Month', 'Dep_hr', 'Dep_min', 'Arrival_hr', 'Arrival_min',
       'Source_Banglore', 'Source_Chennai', 'Source_Delhi', 'Source_Kolkata',
       'Source_Mumbai', 'Destination_Banglore', 'Destination_Cochin',
       'Destination_Delhi', 'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi', 'Airline_Air Asia', '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_Trujet', 'Airline_Vistara', 'Airline_Vistara Premium economy']]
```

In [50]:

```
train_df_case2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10682 entries, 0 to 10682
Data columns (total 32 columns):
 #   Column                                   Non-Null Count  Dtype
---  ------                                   --------------  -----
 0   Duration                                 10682 non-null  int64
 1   Total_Stops                              10682 non-null  int64
 2   Price                                    10682 non-null  int64
 3   Day                                      10682 non-null  int64
 4   Month                                    10682 non-null  int64
 5   Dep_hr                                   10682 non-null  int64
 6   Dep_min                                  10682 non-null  int64
 7   Arrival_hr                               10682 non-null  int64
 8   Arrival_min                              10682 non-null  int64
 9   Source_Banglore                          10682 non-null  uint8
 10  Source_Chennai                           10682 non-null  uint8
 11  Source_Delhi                             10682 non-null  uint8
 12  Source_Kolkata                           10682 non-null  uint8
 13  Source_Mumbai                            10682 non-null  uint8
 14  Destination_Banglore                     10682 non-null  uint8
 15  Destination_Cochin                       10682 non-null  uint8
 16  Destination_Delhi                        10682 non-null  uint8
 17  Destination_Hyderabad                    10682 non-null  uint8
 18  Destination_Kolkata                      10682 non-null  uint8
 19  Destination_New Delhi                    10682 non-null  uint8
 20  Airline_Air Asia                         10682 non-null  uint8
 21  Airline_Air India                        10682 non-null  uint8
 22  Airline_GoAir                            10682 non-null  uint8
 23  Airline_IndiGo                           10682 non-null  uint8
 24  Airline_Jet Airways                      10682 non-null  uint8
 25  Airline_Jet Airways Business             10682 non-null  uint8
 26  Airline_Multiple carriers                10682 non-null  uint8
 27  Airline_Multiple carriers Premium economy  10682 non-null  uint8
 28  Airline_SpiceJet                         10682 non-null  uint8
 29  Airline_Trujet                           10682 non-null  uint8
 30  Airline_Vistara                          10682 non-null  uint8
 31  Airline_Vistara Premium economy          10682 non-null  uint8
dtypes: int64(9), uint8(23)
memory usage: 1.0 MB
```

Graphical Analysis of Independent and Dependent Features

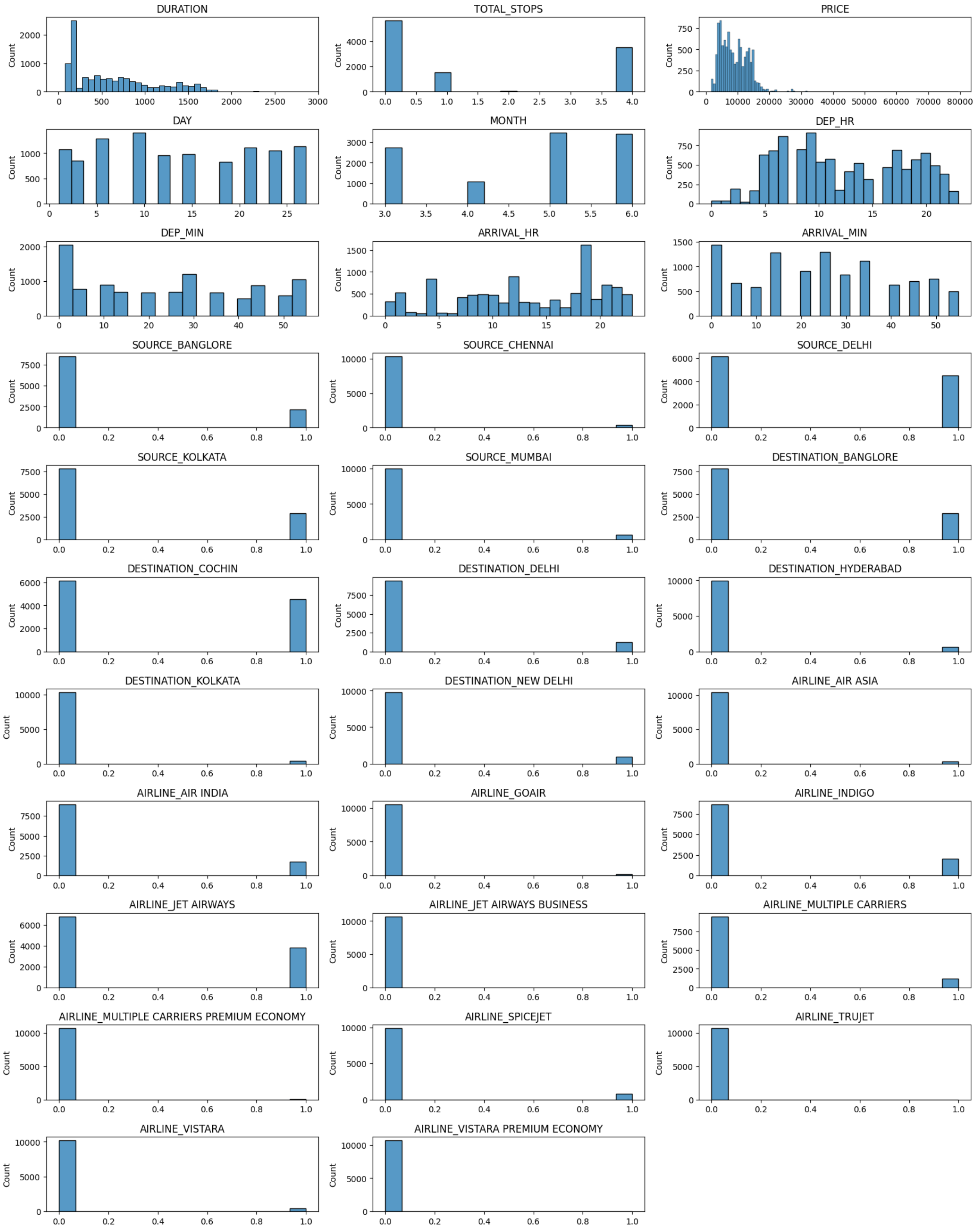
In [51]:

```
plt.figure(figsize=(20, 26))
plt.subplots_adjust(hspace=0.5)
plt.suptitle("Univariate Analysis", fontsize=30, ha='center', va='top')

# loop through the length of tickers and keep track of index
for n, col in enumerate(train_df_case2.columns):
    # add a new subplot iteratively
    ax = plt.subplot(11, 3, n + 1)

    # filter df and plot ticker on the new subplot axis
    sns.histplot(data=train_df_case2[col])
    # chart formatting
    ax.set_title(col.upper())
    ax.set_xlabel("")
```

Univariate Analysis



Multicollinearity

In [52]:

```
#plot color scaled correlation matrix
corr=train_df_case2.iloc[:,:].corr()
corr.style.background_gradient(cmap='coolwarm')
```

Out[52]:

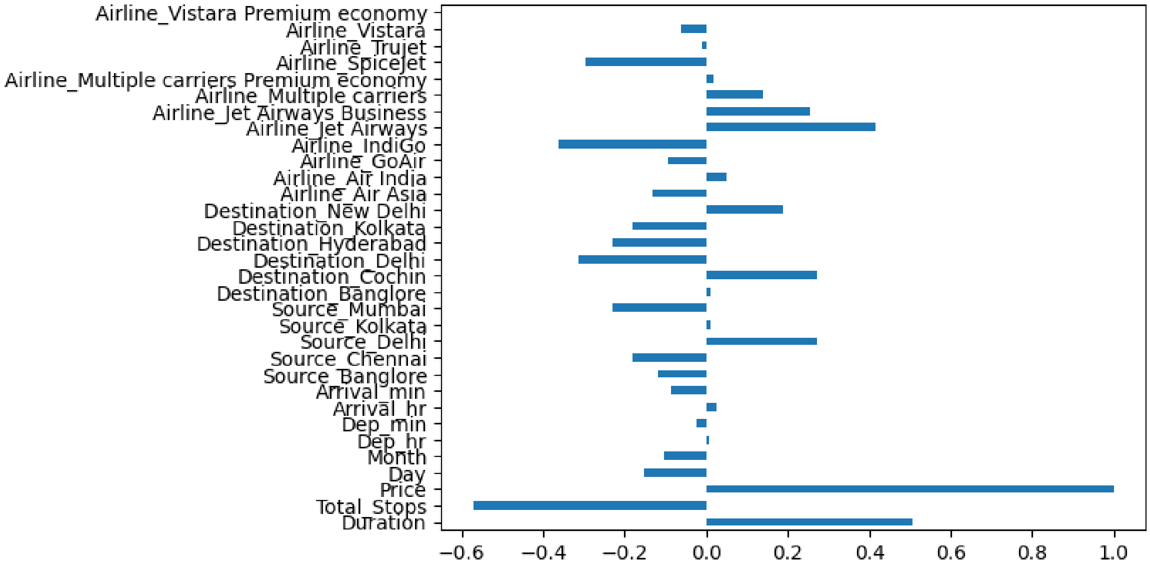
	Duration	Total_Stops	Price	Day	Month	Dep_hr	Dep_min	Arrival_hr	Arrival_min	Source_Banglore
Duration	1.000000	-0.602282	0.506480	-0.022439	0.014836	0.002088	-0.019099	0.051531	-0.069663	-0.267239
Total_Stops	-0.602282	1.000000	-0.571221	0.029225	-0.026328	0.039224	0.048901	-0.095650	0.175980	0.397025
Price	0.506480	-0.571221	1.000000	-0.153774	-0.103643	0.006799	-0.024458	0.024244	-0.086155	-0.118044
Day	-0.022439	0.029225	-0.153774	1.000000	-0.038359	0.002170	-0.008170	-0.003245	-0.017510	-0.050438
Month	0.014836	-0.026328	-0.103643	-0.038359	1.000000	0.039127	-0.059267	-0.003927	-0.100626	-0.244418
Dep_hr	0.002088	0.039224	0.006799	0.002170	0.039127	1.000000	-0.024745	0.005180	0.067911	-0.007887
Dep_min	-0.019099	0.048901	-0.024458	-0.008170	-0.059267	-0.024745	1.000000	0.043122	-0.017597	0.077354
Arrival_hr	0.051531	-0.095650	0.024244	-0.003245	-0.003927	0.005180	0.043122	1.000000	-0.154363	-0.024419
Arrival_min	-0.069663	0.175980	-0.086155	-0.017510	-0.100626	0.067911	-0.017597	-0.154363	1.000000	0.090993
Source_Banglore	-0.267239	0.397025	-0.118044	-0.050438	-0.244418	-0.007887	0.077354	-0.024419	0.090993	1.000000
Source_Chennai	-0.190651	0.270634	-0.179223	0.006611	0.005650	-0.014846	0.067110	-0.014795	-0.030493	-0.097862
Source_Delhi	0.295776	-0.482296	0.270676	0.100088	0.139222	-0.118780	-0.085534	-0.006790	-0.209882	-0.437149
Source_Kolkata	0.124437	-0.113010	0.009358	-0.060558	0.087177	0.155471	-0.024238	0.054693	0.118573	-0.308498
Source_Mumbai	-0.234809	0.315130	-0.230755	-0.014030	-0.039352	-0.017292	0.037705	-0.033512	0.081196	-0.134441
Destination_Banglore	0.124437	-0.113010	0.009358	-0.060558	0.087177	0.155471	-0.024238	0.054693	0.118573	-0.308498
Destination_Cochin	0.295776	-0.482296	0.270676	0.100088	0.139222	-0.118780	-0.085534	-0.006790	-0.209882	-0.437149
Destination_Delhi	-0.340182	0.515760	-0.313417	0.002632	0.090490	0.009469	0.003200	-0.030867	0.095250	0.720278
Destination_Hyderabad	-0.234809	0.315130	-0.230755	-0.014030	-0.039352	-0.017292	0.037705	-0.033512	0.081196	-0.134441
Destination_Kolkata	-0.190651	0.270634	-0.179223	0.006611	0.005650	-0.014846	0.067110	-0.014795	-0.030493	-0.097862
Destination_New Delhi	0.006732	-0.021872	0.189777	-0.075254	-0.453685	-0.022138	0.107129	0.000366	0.021271	0.607598
Airline_Air Asia	-0.101836	0.081551	-0.133050	0.008926	0.005652	0.045960	0.158211	-0.034993	0.078261	0.031828
Airline_Air India	0.261553	-0.007335	0.050432	-0.032490	-0.045981	-0.012879	-0.045688	0.088872	0.061231	-0.017601
Airline_GoAir	-0.092147	0.033030	-0.095151	-0.003122	-0.004494	-0.016373	0.076751	0.018526	0.096839	0.092099
Airline_IndiGo	-0.343503	0.261658	-0.361070	0.007281	-0.048504	-0.023395	-0.014714	-0.071491	0.035124	0.059224
Airline_Jet Airways	0.305519	-0.262310	0.416124	-0.017304	0.059735	0.113942	0.024455	-0.027377	-0.057698	-0.001754
Airline_Jet Airways Business	-0.011968	-0.014764	0.253303	-0.031713	-0.034787	-0.007524	0.009168	-0.014456	0.005232	0.027038
Airline_Multiple carriers	-0.012063	-0.276971	0.139793	0.042163	0.053685	-0.149992	-0.109370	0.067930	-0.167455	-0.180681
Airline_Multiple carriers Premium economy	-0.002508	-0.028182	0.017650	0.030839	-0.051222	-0.028672	-0.004624	0.013491	-0.001786	-0.017762
Airline_SpiceJet	-0.263434	0.289853	-0.296565	0.022154	-0.011977	-0.010451	0.092634	-0.090058	0.012543	0.011113
Airline_Trujet	-0.008537	-0.007812	-0.010381	-0.008569	-0.014199	0.000857	-0.010007	0.003739	-0.002750	-0.004924
Airline_Vistara	-0.019033	0.089530	-0.060654	-0.013169	-0.017252	0.023906	-0.077903	0.068834	0.069422	0.096785
Airline_Vistara Premium economy	-0.016163	0.023586	-0.000454	-0.020115	-0.019797	-0.003375	-0.011380	0.000776	0.000314	0.019116

In [53]:

```
corr.Price.plot(kind='barh')
```

Out[53]:

```
<AxesSubplot: >
```



Comment:

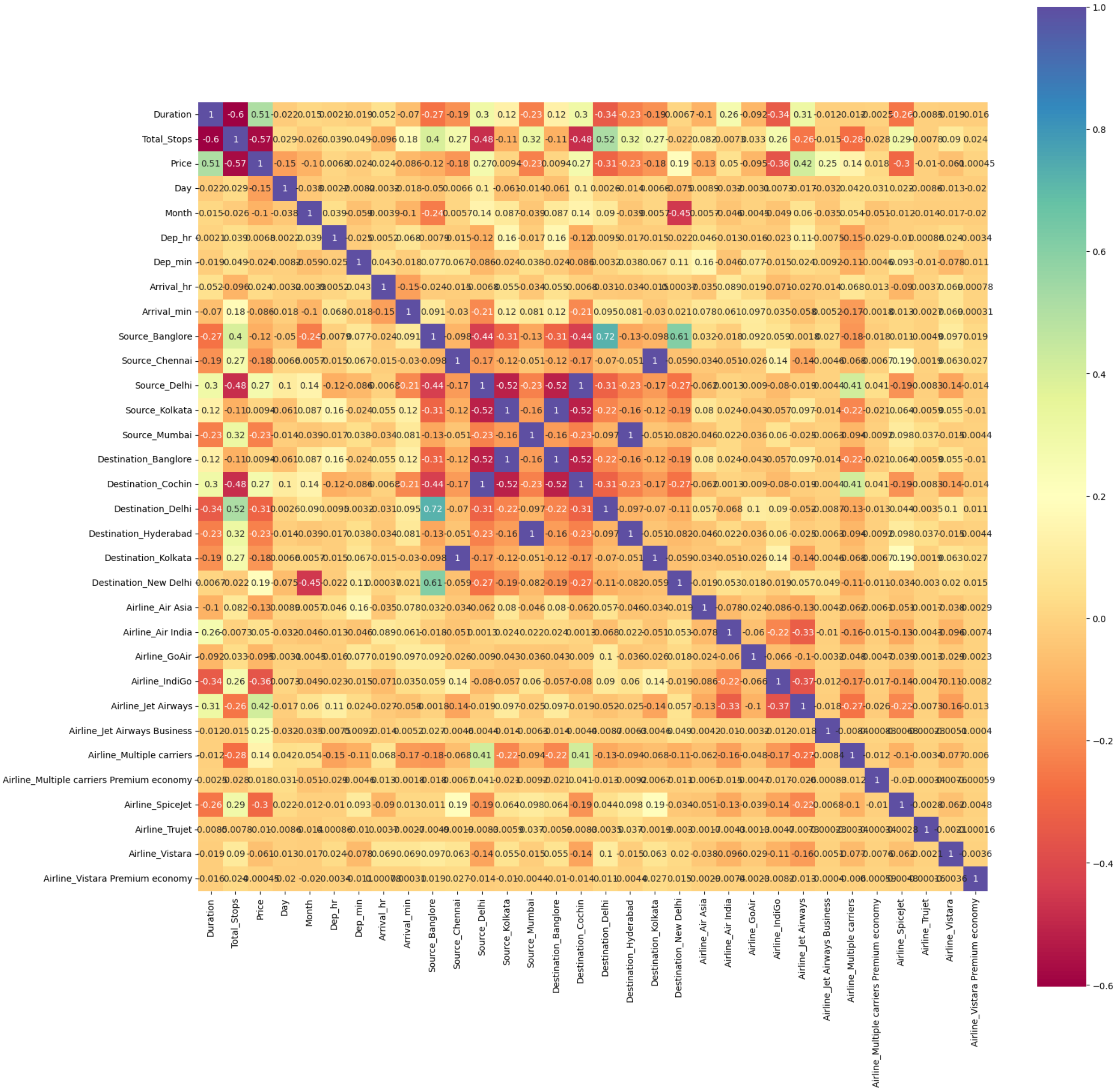
Most important Independent Features are **Total_Stops & Duration**

In [54]:

```
plt.figure(figsize=(20,20))
sns.heatmap(corr, annot=True, cmap='Spectral', square=True)
```

Out[54]:

```
<AxesSubplot: >
```



In [55]:

```
!pip install statsmodels
```

```
Requirement already satisfied: statsmodels in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pre
diction/.venv/lib/python3.10/site-packages (0.13.5)
Requirement already satisfied: numpy>=1.17 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pre
diction/.venv/lib/python3.10/site-packages (from statsmodels) (1.24.1)
Requirement already satisfied: scipy>=1.3 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pred
iction/.venv/lib/python3.10/site-packages (from statsmodels) (1.9.3)
Requirement already satisfied: packaging>=21.3 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare
_prediction/.venv/lib/python3.10/site-packages (from statsmodels) (22.0)
Requirement already satisfied: pandas>=0.25 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pr
ediction/.venv/lib/python3.10/site-packages (from statsmodels) (1.5.2)
Requirement already satisfied: patsy>=0.5.2 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pr
ediction/.venv/lib/python3.10/site-packages (from statsmodels) (0.5.3)
Requirement already satisfied: python-dateutil>=2.8.1 in /media/tinku/Education/iNEURON/ML/Projects/flig
ht_fare_prediction/.venv/lib/python3.10/site-packages (from pandas>=0.25->statsmodels) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_pr
ediction/.venv/lib/python3.10/site-packages (from pandas>=0.25->statsmodels) (2022.7)
Requirement already satisfied: six in /media/tinku/Education/iNEURON/ML/Projects/flight_fare_predictio
n/.venv/lib/python3.10/site-packages (from patsy>=0.5.2->statsmodels) (1.16.0)
```

In [56]:

```
# Compute VIF data for each independent variable
from statsmodels.stats.outliers_influence import variance_inflation_factor
vif = pd.DataFrame()
vif["features"] = train_df_case1.columns[1:]
vif["vif_Factor"] = [variance_inflation_factor(train_df_case1.iloc[:,1:].values, i) for i in range(train_df_case1.iloc
vif
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/sta
tsmodels/stats/outliers_influence.py:195: RuntimeWarning: divide by zero encountered in scalar divide
  vif = 1. / (1. - r_squared_i)
```

Out[56]:

	features	vif_Factor
0	Arrival_Time	1.045479
1	Duration	2.150151
2	Total_Stops	3.144120
3	Price	2.436829
4	Day	1.074750
5	Month	1.321251
6	Source_Banglore	inf
7	Source_Chennai	inf
8	Source_Delhi	inf
9	Source_Kolkata	inf
10	Source_Mumbai	inf
11	Destination_Banglore	inf
12	Destination_Cochin	inf
13	Destination_Delhi	inf
14	Destination_Hyderabad	inf
15	Destination_Kolkata	inf
16	Destination_New Delhi	inf
17	Airline_Air Asia	inf
18	Airline_Air India	inf
19	Airline_GoAir	inf
20	Airline_IndiGo	inf
21	Airline_Jet Airways	inf
22	Airline_Jet Airways Business	inf
23	Airline_Multiple carriers	inf
24	Airline_Multiple carriers Premium economy	inf
25	Airline_SpiceJet	inf
26	Airline_Trujet	inf
27	Airline_Vistara	inf
28	Airline_Vistara Premium economy	inf

Model Building

CASE-1

In [57]:

```
train_df_case1.head(3)
```

Out[57]:

	Dep_Time	Arrival_Time	Duration	Total_Stops	Price	Day	Month	Source_Banglore	Source_Chennai	Source_Delhi	...	Airline_GoAir	Airli
0	22.20	1.10	170	4	3897	24	3	1	0	0	...	0	
1	5.50	13.15	445	1	7662	1	5	0	0	0	...	0	
2	9.25	4.25	1140	1	13882	9	6	0	0	1	...	0	

3 rows × 30 columns

Seperate Independent and Dependent Features

In [58]:

```
X1 = train_df_case1.drop(columns=['Price'])
y1 = train_df_case1.Price
```

In [59]:

```
X1.head(3)
```

Out[59]:

	Dep_Time	Arrival_Time	Duration	Total_Stops	Day	Month	Source_Banglore	Source_Chennai	Source_Delhi	Source_Kolkata	...	Airline_Gc
0	22.20	1.10	170	4	24	3	1	0	0	0	...	
1	5.50	13.15	445	1	1	5	0	0	0	1	...	
2	9.25	4.25	1140	1	9	6	0	0	1	0	...	

3 rows × 29 columns

In [60]:

```
y1.head(3)
```

Out[60]:

```
0     3897
1     7662
2    13882
Name: Price, dtype: int64
```

Train Test Split

In [61]:

```
from sklearn.model_selection import train_test_split
X1_train, X1_test, y1_train, y1_test = train_test_split(X1, y1, test_size=0.25, random_state=42)
```

Algorithm : DecisionTreeRegressor

In [62]:

```
from sklearn.tree import DecisionTreeRegressor
```

In [63]:

```
# model training
dt_gen_1 = DecisionTreeRegressor()
dt_gen_1.fit(X1_train, y1_train)
```

Out[63]:

```
DecisionTreeRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [64]:

```
# model testing
y1_pred_dt = dt_gen_1.predict(X1_test)
```

In [65]:

```
# model performance
print("Train Score = ",dt_gen_1.score(X1_train, y1_train))
print("Test Score = ",dt_gen_1.score(X1_test, y1_test))
```

```
Train Score =  0.9707490055980877
Test Score =  0.7482205437012319
```

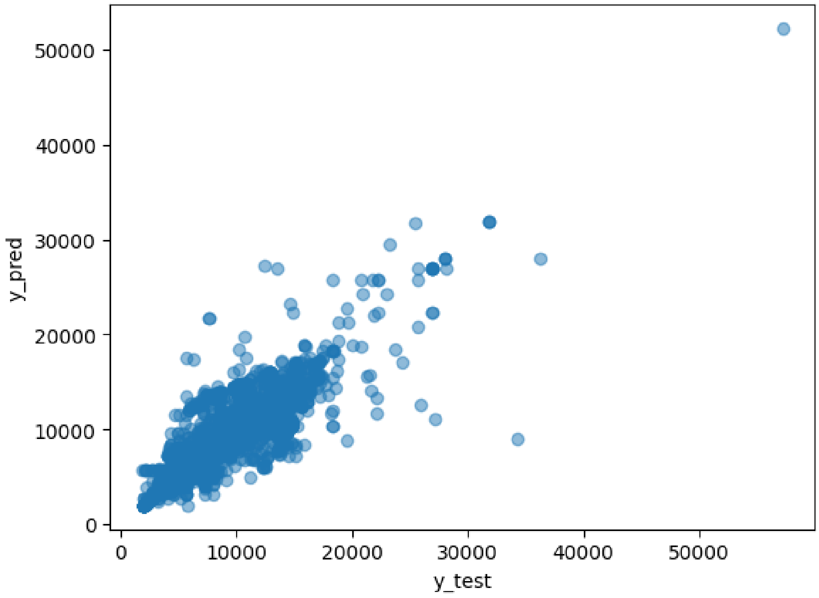
In [66]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y1_test, y1_pred_dt))
print('MSE:', metrics.mean_squared_error(y1_test, y1_pred_dt))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y1_test, y1_pred_dt)))
print('R2 Score:', metrics.r2_score(y1_test, y1_pred_dt))
```

```
MAE: 1326.410270809934
MSE: 5189936.584341487
RMSE: 2278.1432317441077
R2 Score: 0.7482205437012319
```

In [67]:

```
# predicted vs true
plt.scatter(y1_test, y1_pred_dt, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Algorithm : RandomForestRegressor

In [68]:

```
from sklearn.ensemble import RandomForestRegressor
# model training
rf_gen_1 = RandomForestRegressor()
rf_gen_1.fit(X1_train, y1_train)
```

Out[68]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [69]:

```
# model testing
y1_pred_rf = rf_gen_1.predict(X1_test)
```

In [70]:

```
# model performance
print("Train Score = ",rf_gen_1.score(X1_train, y1_train))
print("Test Score = ",rf_gen_1.score(X1_test, y1_test))
```

```
Train Score =  0.9517973201844394
Test Score =  0.817763990255957
```

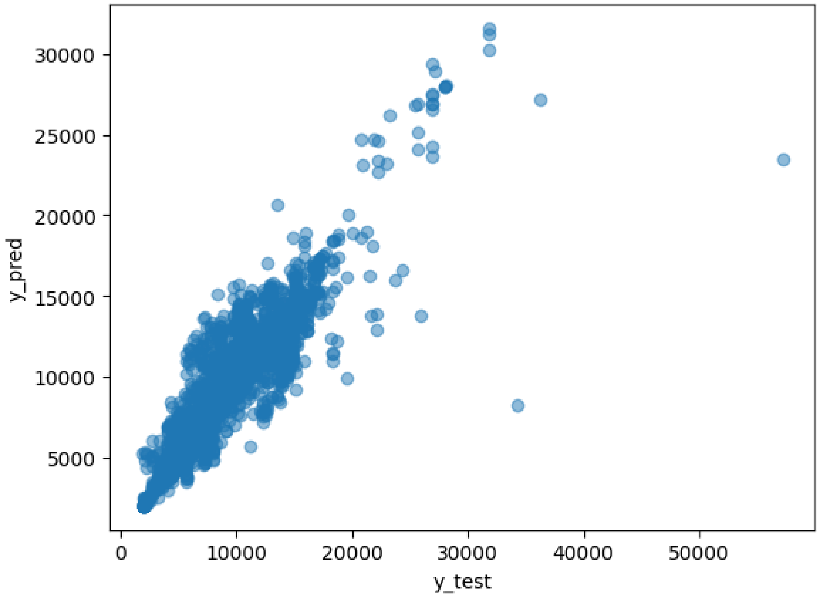
In [71]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y1_test, y1_pred_rf))
print('MSE:', metrics.mean_squared_error(y1_test, y1_pred_rf))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y1_test, y1_pred_rf)))
print('R2 Score:', metrics.r2_score(y1_test, y1_pred_rf))
```

```
MAE: 1160.9560734998809
MSE: 3756435.683270035
RMSE: 1938.1526470508031
R2 Score: 0.817763990255957
```

In [72]:

```
# predicted vs true
plt.scatter(y1_test, y1_pred_rf, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Algorithm : GradientBoostingRegressor

In [73]:

```
from sklearn.ensemble import GradientBoostingRegressor
# model training
gb_gen_1 = GradientBoostingRegressor()
gb_gen_1.fit(X1_train, y1_train)
```

Out[73]:

```
GradientBoostingRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [74]:

```
# model testing
y1_pred_gb = rf_gen_1.predict(X1_test)
```

In [75]:

```
# model performance
print("Train Score = ",gb_gen_1.score(X1_train, y1_train))
print("Test Score = ",gb_gen_1.score(X1_test, y1_test))
```

```
Train Score =  0.7852800379697236
Test Score =  0.7863695492147861
```

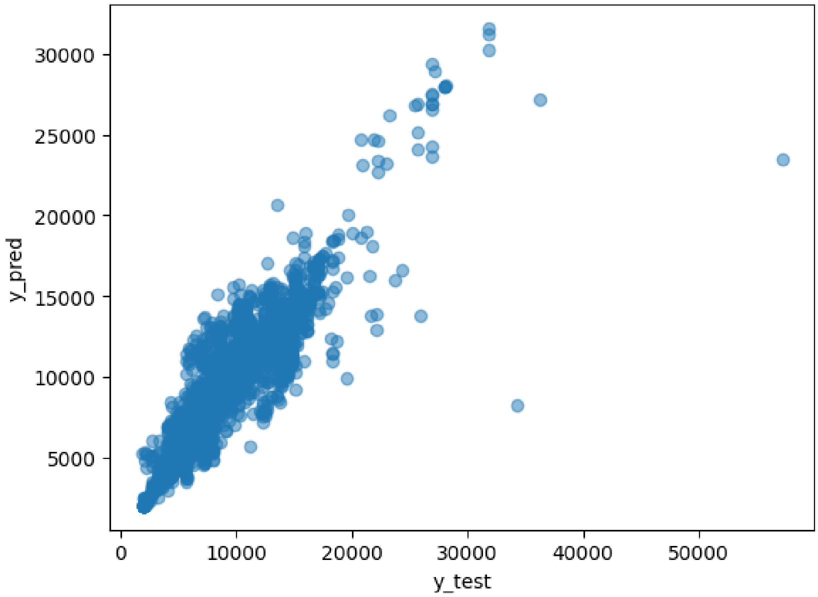
In [76]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y1_test, y1_pred_gb))
print('MSE:', metrics.mean_squared_error(y1_test, y1_pred_gb))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y1_test, y1_pred_gb)))
print('R2 Score:', metrics.r2_score(y1_test, y1_pred_gb))
```

```
MAE: 1160.9560734998809
MSE: 3756435.683270035
RMSE: 1938.1526470508031
R2 Score: 0.817763990255957
```

In [77]:

```
# predicted vs true
plt.scatter(y1_test, y1_pred_gb, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



CASE-2

In [78]:

```
train_df_case2.head(3)
```

Out[78]:

	Duration	Total_Stops	Price	Day	Month	Dep_hr	Dep_min	Arrival_hr	Arrival_min	Source_Banglore	...	Airline_GoAir	Airline_IndiGo	Air
0	170	4	3897	24	3	22	20	1	10	1	...	0	1	
1	445	1	7662	1	5	5	50	13	15	0	...	0	0	
2	1140	1	13882	9	6	9	25	4	25	0	...	0	0	

3 rows × 32 columns

Seperate Independent and Dependent Features

In [79]:

```
X2 = train_df_case2.drop(columns=['Price'])
y2 = train_df_case2.Price
```

In [80]:

```
X2.head(3)
```

Out[80]:

	Duration	Total_Stops	Day	Month	Dep_hr	Dep_min	Arrival_hr	Arrival_min	Source_Banglore	Source_Chennai	...	Airline_GoAir	Airline_I
0	170	4	24	3	22	20	1	10	1	0	...	0	
1	445	1	1	5	5	50	13	15	0	0	...	0	
2	1140	1	9	6	9	25	4	25	0	0	...	0	

3 rows × 31 columns

In [81]:

```
y2.head(3)
```

Out[81]:

```
0     3897
1     7662
2    13882
Name: Price, dtype: int64
```

Train Test Split

In [82]:

```
from sklearn.model_selection import train_test_split
X2_train, X2_test, y2_train, y2_test = train_test_split(X2, y2, test_size=0.25, random_state=42)
```

Algorithm : DecisionTreeRegressor

In [83]:

```
from sklearn.model_selection import cross_val_score
from sklearn.tree import DecisionTreeRegressor

# model training
dt_gen_2 = DecisionTreeRegressor()
dt_gen_2.fit(X2_train, y2_train)
```

Out[83]:

```
DecisionTreeRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [84]:

```
# model testing
y2_pred_dt = dt_gen_2.predict(X2_test)

# model performance
print("Train Score = ",dt_gen_2.score(X2_train, y2_train))
print("Test Score = ",dt_gen_2.score(X2_test, y2_test))
```

```
Train Score =  0.9707490055980877
Test Score =  0.7597033468901219
```

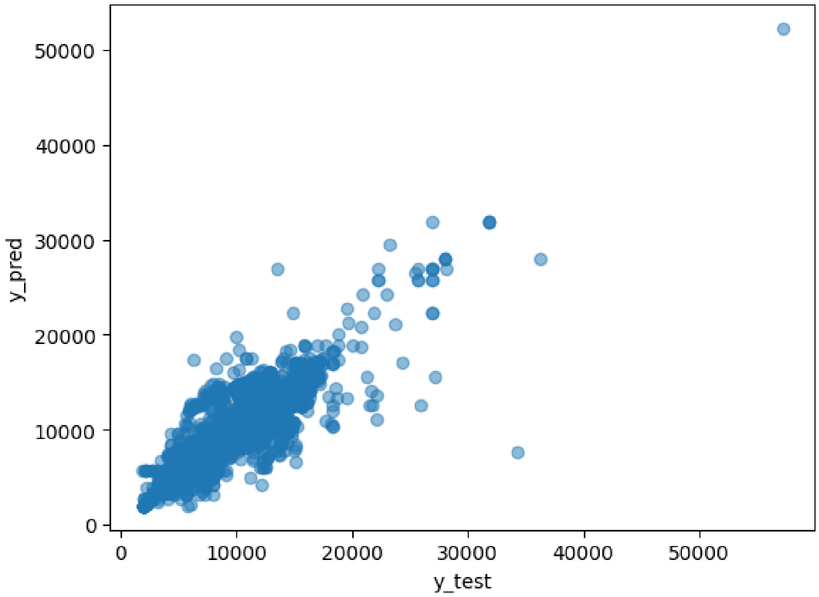
In [85]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y2_test, y2_pred_dt))
print('MSE:', metrics.mean_squared_error(y2_test, y2_pred_dt))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y2_test, y2_pred_dt)))
print('R2 Score:', metrics.r2_score(y2_test, y2_pred_dt))
```

```
MAE: 1304.9079620616499
MSE: 4953241.258849578
RMSE: 2225.587845682479
R2 Score: 0.7597033468901219
```

In [86]:

```
# predicted vs true
plt.scatter(y2_test, y2_pred_dt, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Algorithm : RandomForestRegressor

In [87]:

```
from sklearn.ensemble import RandomForestRegressor
# model training
rf_gen_2 = RandomForestRegressor()
rf_gen_2.fit(X2_train, y2_train)
```

Out[87]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [88]:

```
# model testing
y2_pred_rf = rf_gen_2.predict(X2_test)
```

In [89]:

```
# model performance
print("Train Score = ",rf_gen_2.score(X2_train, y2_train))
print("Test Score = ",rf_gen_2.score(X2_test, y2_test))
```

```
Train Score =  0.9524994022270415
Test Score =  0.8198168030494252
```

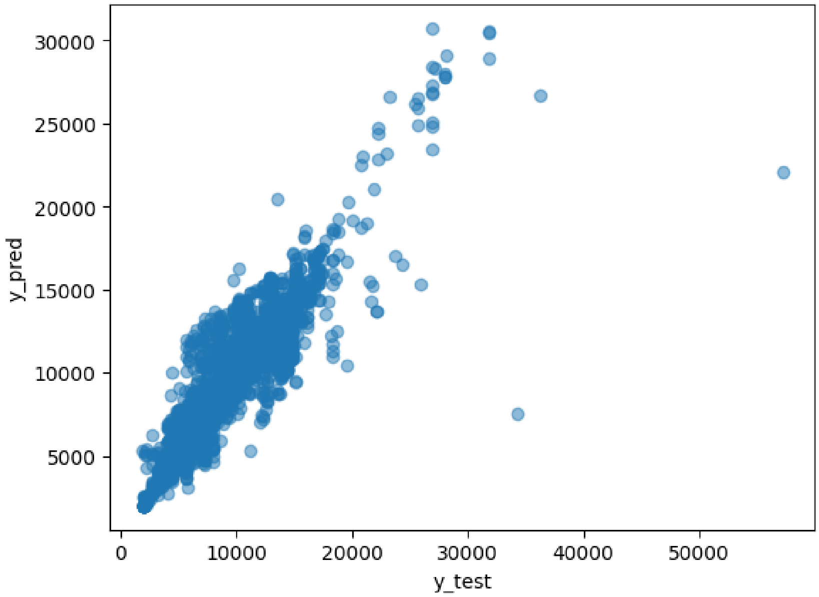
In [90]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y2_test, y2_pred_rf))
print('MSE:', metrics.mean_squared_error(y2_test, y2_pred_rf))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y2_test, y2_pred_rf)))
print('R2 Score:', metrics.r2_score(y2_test, y2_pred_rf))
```

```
MAE: 1145.5834103862462
MSE: 3714120.998925882
RMSE: 1927.2054895433132
R2 Score: 0.8198168030494252
```

In [91]:

```
# predicted vs true
plt.scatter(y2_test, y2_pred_rf, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Algorithm : GradientBoostingRegressor

In [92]:

```
from sklearn.ensemble import GradientBoostingRegressor
# model training
gb_gen_2 = GradientBoostingRegressor()
gb_gen_2.fit(X2_train, y2_train)
```

Out[92]:

```
GradientBoostingRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [93]:

```
# model testing
y2_pred_gb = rf_gen_2.predict(X2_test)
```

In [94]:

```
# model performance
print("Train Score = ",gb_gen_2.score(X2_train, y2_train))
print("Test Score = ",gb_gen_2.score(X2_test, y2_test))
```

```
Train Score =  0.7805053951328913
Test Score =  0.7813813631510734
```

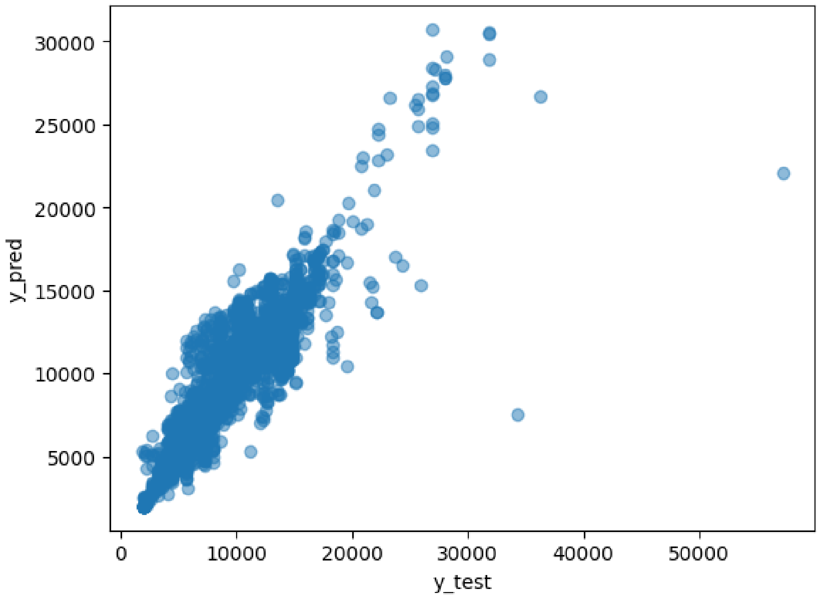
In [95]:

```
from sklearn import metrics
print('MAE:', metrics.mean_absolute_error(y2_test, y2_pred_gb))
print('MSE:', metrics.mean_squared_error(y2_test, y2_pred_gb))
print('RMSE:', np.sqrt(metrics.mean_squared_error(y2_test, y2_pred_gb)))
print('R2 Score:', metrics.r2_score(y2_test, y2_pred_gb))
```

```
MAE: 1145.5834103862462
MSE: 3714120.998925882
RMSE: 1927.2054895433132
R2 Score: 0.8198168030494252
```

In [96]:

```
# predicted vs true
plt.scatter(y2_test, y2_pred_gb, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Observation:

- We are getting highest acuracy in CASE-2 with RandomForestRegressor model
- We will perform Hyperparameter Tuning for model named **rf_gen_2**.

Hyperparameter Tuning for the best performing model

In [97]:

```
from sklearn.model_selection import RandomizedSearchCV
```

In [98]:

```
param_distributions = {'max_depth': list(range(5,55,5)),
                       'max_features': ['log2', 'sqrt'],
                       'min_samples_leaf': list(range(1,6)),
                       'min_samples_split': list(range(1,100,2)),
                       'n_estimators': list(range(100,1300,100))}
```

In [99]:

```
random = RandomizedSearchCV(estimator=rf_gen_2, param_distributions=param_distributions, n_iter=30, cv=10, verbose=2,
```

In [100]:

```
random.fit(X2_train, y2_train)
```

```
Fitting 10 folds for each of 30 candidates, totalling 300 fits
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.5s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.5s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.7s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.7s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.7s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.7s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.6s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.5s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
tal time=   0.7s
[CV] END max_depth=5, max_features=sqrt, min_samples_leaf=5, min_samples_split=63, n_estimators=200; to
```

In [101]:

```
random.best_params_
```

Out[101]:

```
{'n_estimators': 400,
 'min_samples_split': 21,
 'min_samples_leaf': 1,
 'max_features': 'log2',
 'max_depth': 35}
```

In [102]:

```
random.best_score_
```

Out[102]:

```
0.78169961519402
```

In [103]:

```
random.best_estimator_
```

Out[103]:

```
RandomForestRegressor(max_depth=35, max_features='log2', min_samples_split=21,
                      n_estimators=400)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [104]:

```
gen_model = RandomForestRegressor(max_depth=30, max_features='log2', min_samples_split=7, n_estimators=400)
gen_model.fit(X2_train, y2_train)
```

Out[104]:

```
RandomForestRegressor(max_depth=30, max_features='log2', min_samples_split=7,
                      n_estimators=400)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

Model Dumping

In [105]:

```
import pickle
pickle.dump(rf_gen_2,open('gen_pred_model.pkl','wb'))
pickle.dump(train_df_case2,open('train_data_modified.pkl','wb'))
```

Testing with Dumped Model

In [106]:

```
best_model = pickle.load(open('gen_pred_model.pkl','rb'))
```

In [107]:

```
best_model.feature_names_in_
```

Out[107]:

```
array(['Duration', 'Total_Stops', 'Day', 'Month', 'Dep_hr', 'Dep_min',
       'Arrival_hr', 'Arrival_min', 'Source_Banglore', 'Source_Chennai',
       'Source_Delhi', 'Source_Kolkata', 'Source_Mumbai',
       'Destination_Banglore', 'Destination_Cochin', 'Destination_Delhi',
       'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi', 'Airline_Air Asia', '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_Trujet', 'Airline_Vistara',
       'Airline_Vistara Premium economy'], dtype=object)
```

In [108]:

```
pred = best_model.predict(X2_test)
```

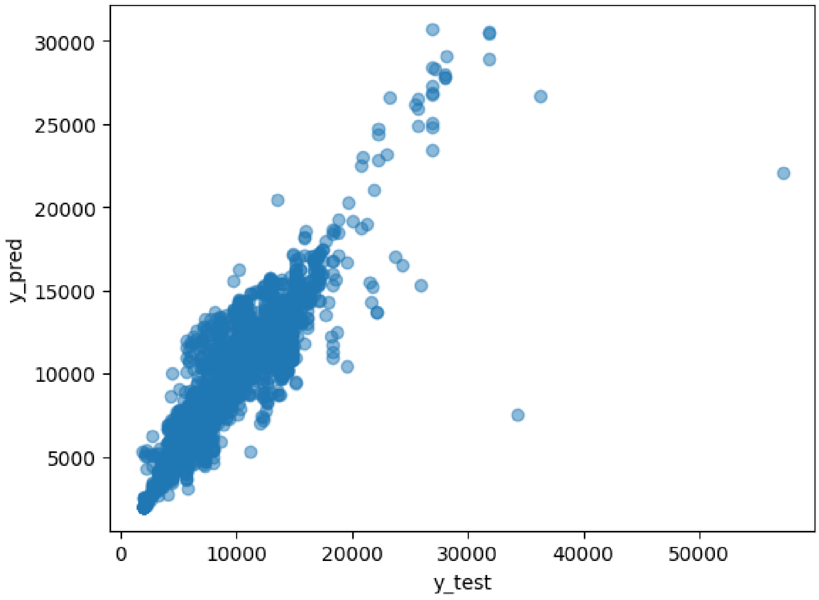
In [109]:

```
print('R2 Score:', metrics.r2_score(y2_test, pred))
```

```
R2 Score: 0.8198168030494252
```

In [110]:

```
# predicted vs true
plt.scatter(y2_test, y2_pred_gb, alpha = 0.5)
plt.xlabel("y_test")
plt.ylabel("y_pred")
plt.show()
```



Transform Test Data and Predict

In [111]:

```
def transformer_test_data(df: pd.DataFrame)-> pd.DataFrame:

    # initial validation
    features = ['Airline', 'Date_of_Journey', 'Source', 'Destination', 'Route',
       'Dep_Time', 'Arrival_Time', 'Duration', 'Total_Stops', 'Additional_Info']
    missing_features=[]
    for f in features:
        if f not in df.columns:
            missing_features.append(f)

    if len(missing_features) == 0:

        # drop unnecessary features if present
        useless = ["Route", "Additional_Info"]
        for i in useless:
            if i in df.columns:
                df.drop(columns=[i], inplace=True)

        # drop NaN values
        df.dropna(inplace=True)

        # type casting of Date_of_journey column
        df.Date_of_Journey = pd.to_datetime(df.Date_of_Journey, dayfirst=True)

        # creating Day and Month columns that contain integer values
        df["Day"] = df.Date_of_Journey.dt.day
        df["Month"] = df.Date_of_Journey.dt.month

        # Dropping "Date_of_Journey" column as it is not required anymore
        df.drop(columns=["Date_of_Journey"], inplace=True)

        # change data type of Dep_Time from object to datetime
        df.Dep_Time = pd.to_datetime(df.Dep_Time)

        # create two seperate columns named "Dep_hr" and "Dep_min"
        df["Dep_hr"] = df.Dep_Time.dt.hour
        df["Dep_min"] = df.Dep_Time.dt.minute

        # Dropping "Dep_Time" column as it is not required anymore
        df.drop(columns=["Dep_Time"], inplace=True)

        # change data type of Arrival_Time from object to datetime
        df.Arrival_Time = pd.to_datetime(df.Arrival_Time)

        # create two seperate columns named "Arrival_hr" and "Arrival_min"
        df["Arrival_hr"] = df.Arrival_Time.dt.hour
        df["Arrival_min"] = df.Arrival_Time.dt.minute

        # Dropping "Arrival_Time" column as it is not required anymore
        df.drop(columns=["Arrival_Time"], inplace=True)

        # we can convert all the values in Duration column into equivallent value in min
        def duration_in_min(dur):
            tt = 0
            for i in dur.split():
                if 'h' in i:
                    tt += int(i[:-1])*60
                if 'm' in i:
                    tt += int(i[:-1])
            return tt

        df.Duration = df.Duration.apply(duration_in_min)

        # Apply LabelEncoder on "Total_Stops" column
        from sklearn.preprocessing import LabelEncoder
        le = LabelEncoder()
        df.Total_Stops = le.fit_transform(df["Total_Stops"])

        print(list(df.columns))

        # insert missing categorical(Nominal) values
        airlines=['IndiGo', 'Air India', 'Jet Airways', 'SpiceJet', 'Multiple carriers', 'GoAir',
                 'Vistara', 'Air Asia', 'Vistara Premium economy', 'Jet Airways Business',
                'Multiple carriers Premium economy', 'Trujet']
        source=['Banglore', 'Kolkata', 'Delhi', 'Chennai', 'Mumbai']
        destination=['New Delhi', 'Banglore', 'Cochin', 'Kolkata', 'Delhi', 'Hyderabad']

        if len(airlines) > len(df.Airline.unique()):
            for i in set(airlines).difference(list(df.Airline.unique())):
                df.loc[len(df.index)] = [i, 'Kolkata', 'Banglore', 120, 0, 12, 8, 8, 30, 10, 30]

        # Apply OneHotEncode on "Airline", "Source", "Destination" columns
        df = pd.get_dummies(df, columns=["Source", "Destination", "Airline"])
        # final check that all required columns are present
        req_cols = ['Duration', 'Total_Stops', 'Day',
       'Month', 'Dep_hr', 'Dep_min', 'Arrival_hr', 'Arrival_min',
       'Source_Banglore', 'Source_Chennai', 'Source_Delhi', 'Source_Kolkata',
       'Source_Mumbai', 'Destination_Banglore', 'Destination_Cochin',
       'Destination_Delhi', 'Destination_Hyderabad', 'Destination_Kolkata',
       'Destination_New Delhi', 'Airline_Air Asia', '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_Trujet', 'Airline_Vistara', 'Airline_Vistara Premium economy']
        missing_columns=[]
        for col in req_cols:
            if col not in df.columns:
                missing_columns.append(col)
        if len(missing_columns) == 0:
            return df
        else:
            raise Exception(f"These features are missing in test data : {missing_columns}")
    else:
        raise Exception(f"These features are missing in test data : {missing_features}")
```

In [112]:

```
# import test data
test_df = pd.read_excel('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/archive/Test_set.xlsx')
test_df.head()
```

Out[112]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info
0	Jet Airways	6/06/2019	Delhi	Cochin	DEL → BOM → COK	17:30	04:25 07 Jun	10h 55m	1 stop	No info
1	IndiGo	12/05/2019	Kolkata	Banglore	CCU → MAA → BLR	06:20	10:20	4h	1 stop	No info
2	Jet Airways	21/05/2019	Delhi	Cochin	DEL → BOM → COK	19:15	19:00 22 May	23h 45m	1 stop	In-flight meal not included
3	Multiple carriers	21/05/2019	Delhi	Cochin	DEL → BOM → COK	08:00	21:00	13h	1 stop	No info
4	Air Asia	24/06/2019	Banglore	Delhi	BLR → DEL	23:55	02:45 25 Jun	2h 50m	non-stop	No info

In [ ]:

In [113]:

```
X_test = transformer_test_data(test_df)
```

```
['Airline', 'Source', 'Destination', 'Duration', 'Total_Stops', 'Day', 'Month', 'Dep_hr', 'Dep_min', 'Ar
rival_hr', 'Arrival_min']
```

In [114]:

```
X_test.tail()
```

Out[114]:

	Duration	Total_Stops	Day	Month	Dep_hr	Dep_min	Arrival_hr	Arrival_min	Source_Banglore	Source_Chennai	...	Airline_GoAir	Airlin
2667	155	4	27	3	14	20	16	55	0	0	...	0	
2668	395	0	6	3	21	50	4	25	0	0	...	0	
2669	915	0	6	3	4	0	19	15	0	0	...	0	
2670	860	0	15	6	4	55	19	15	0	0	...	0	
2671	120	0	12	8	8	30	10	30	0	0	...	0	

5 rows × 31 columns

In [115]:

```
test_pred = best_model.predict(X_test)
test_pred
```

Out[115]:

```
array([10749.43      ,  4244.78      , 15442.02666667, ...,
       13983.41      ,  7506.71      ,  8068.80266667])
```

Insert the predicted values in Price column in test data

In [116]:

```
# import test data
test_df = pd.read_excel('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/archive/Test_set.xlsx')
test_df["Price"] = test_pred[:-1]
test_df.head()
```

Out[116]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price
0	Jet Airways	6/06/2019	Delhi	Cochin	DEL → BOM → COK	17:30	04:25 07 Jun	10h 55m	1 stop	No info	10749.430000
1	IndiGo	12/05/2019	Kolkata	Banglore	CCU → MAA → BLR	06:20	10:20	4h	1 stop	No info	4244.780000
2	Jet Airways	21/05/2019	Delhi	Cochin	DEL → BOM → COK	19:15	19:00 22 May	23h 45m	1 stop	In-flight meal not included	15442.026667
3	Multiple carriers	21/05/2019	Delhi	Cochin	DEL → BOM → COK	08:00	21:00	13h	1 stop	No info	13264.912333
4	Air Asia	24/06/2019	Banglore	Delhi	BLR → DEL	23:55	02:45 25 Jun	2h 50m	non-stop	No info	3705.560000

In [ ]:

checking transformer_test_data function with invalid data

In [117]:

```
test_df = pd.read_excel('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/archive/Test_set.xlsx')
data = test_df[test_df["Airline"]!="Air Asia"]
data.head()
```

Out[117]:

	Airline	Date_of_Journey	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info
0	Jet Airways	6/06/2019	Delhi	Cochin	DEL → BOM → COK	17:30	04:25 07 Jun	10h 55m	1 stop	No info
1	IndiGo	12/05/2019	Kolkata	Banglore	CCU → MAA → BLR	06:20	10:20	4h	1 stop	No info
2	Jet Airways	21/05/2019	Delhi	Cochin	DEL → BOM → COK	19:15	19:00 22 May	23h 45m	1 stop	In-flight meal not included
3	Multiple carriers	21/05/2019	Delhi	Cochin	DEL → BOM → COK	08:00	21:00	13h	1 stop	No info
5	Jet Airways	12/06/2019	Delhi	Cochin	DEL → BOM → COK	18:15	12:35 13 Jun	18h 20m	1 stop	In-flight meal not included

In [119]:

```
X_data = transformer_test_data(data)
X_data.head()
```

```
---------------------------------------------------------------------------
Exception                                 Traceback (most recent call last)
Cell In[119], line 1
----> 1 X_data = transformer_test_data(data)
      2 X_data.head()

Cell In[111], line 106, in transformer_test_data(df)
    104         raise Exception(f"These features are missing in test data : {missing_columns}")
    105 else:
--> 106     raise Exception(f"These features are missing in test data : {missing_features}")

Exception: These features are missing in test data : ['Date_of_Journey', 'Route', 'Dep_Time', 'Arrival_T
ime', 'Additional_Info']
```

CASE - 3

Data Preperation for CASE-3

In [120]:

```
train_df_airline.Airline.unique()
```

Out[120]:

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

In [121]:

```
# dataset for each Airline
train_df_IndiGo = train_df_airline[train_df_airline.Airline == 'IndiGo']
train_df_AirIndia = train_df_airline[train_df_airline.Airline == 'Air India']
train_df_JetAirways = train_df_airline[train_df_airline.Airline == 'Jet Airways']
train_df_SpiceJet = train_df_airline[train_df_airline.Airline == 'SpiceJet']
train_df_Multiplecarriers = train_df_airline[train_df_airline.Airline == 'Multiple carriers']
train_df_GoAir = train_df_airline[train_df_airline.Airline == 'GoAir']
train_df_Vistara = train_df_airline[train_df_airline.Airline == 'Vistara']
train_df_AirAsia = train_df_airline[train_df_airline.Airline == 'Air Asia']
```

In [122]:

```
# creating lish of all df names corresponding to each airline
airline_names = ['IndiGo', 'Air India', 'Jet Airways', 'SpiceJet', 'Multiple carriers', 'GoAir', 'Vistara', 'Air Asia'
airline_df=[]
for i in airline_names:
    airline_df.append("train_df_"+i.replace(" ", ""))

airline_df
```

Out[122]:

```
['train_df_IndiGo',
 'train_df_AirIndia',
 'train_df_JetAirways',
 'train_df_SpiceJet',
 'train_df_Multiplecarriers',
 'train_df_GoAir',
 'train_df_Vistara',
 'train_df_AirAsia']
```

In [123]:

```
train_df_airline.head()
```

Out[123]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	Dep_hr	Dep_min
0	IndiGo	Banglore	New Delhi	BLR → DEL	22.20	1.10	170	non-stop	No info	3897	24	3	22	20
1	Air India	Kolkata	Banglore	CCU → IXR → BBI → BLR	5.50	13.15	445	2 stops	No info	7662	1	5	5	50
2	Jet Airways	Delhi	Cochin	DEL → LKO → BOM → COK	9.25	4.25	1140	2 stops	No info	13882	9	6	9	25
3	IndiGo	Kolkata	Banglore	CCU → NAG → BLR	18.05	23.30	325	1 stop	No info	6218	12	5	18	5
4	IndiGo	Banglore	New Delhi	BLR → NAG → DEL	16.50	21.35	285	1 stop	No info	13302	1	3	16	50

In [124]:

```
airline_df = [train_df_IndiGo, train_df_AirIndia, train_df_JetAirways, train_df_SpiceJet, train_df_Multiplecarriers, t
for df in airline_df:
    print(df.Airline.unique())
    print(df.Source.unique())
    print(df.Destination.unique())
    print()
```

```
['IndiGo']
['Banglore' 'Kolkata' 'Delhi' 'Chennai' 'Mumbai']
['New Delhi' 'Banglore' 'Delhi' 'Cochin' 'Kolkata' 'Hyderabad']

['Air India']
['Kolkata' 'Delhi' 'Chennai' 'Banglore' 'Mumbai']
['Banglore' 'Cochin' 'Kolkata' 'New Delhi' 'Hyderabad' 'Delhi']

['Jet Airways']
['Delhi' 'Banglore' 'Kolkata' 'Mumbai']
['Cochin' 'New Delhi' 'Banglore' 'Hyderabad' 'Delhi']

['SpiceJet']
['Kolkata' 'Delhi' 'Banglore' 'Chennai' 'Mumbai']
['Banglore' 'Cochin' 'New Delhi' 'Kolkata' 'Delhi' 'Hyderabad']

['Multiple carriers']
['Delhi']
['Cochin']

['GoAir']
['Delhi' 'Banglore' 'Kolkata']
['Cochin' 'Delhi' 'Banglore' 'New Delhi']

['Vistara']
['Banglore' 'Chennai' 'Mumbai' 'Kolkata' 'Delhi']
['Delhi' 'Kolkata' 'Hyderabad' 'New Delhi' 'Banglore' 'Cochin']

['Air Asia']
['Banglore' 'Kolkata' 'Delhi']
['Delhi' 'Banglore' 'Cochin' 'New Delhi']
```

In [125]:

```
# data = ['2023-01-11T12:34', '2023-01-11T03:05', 'Delhi', 'Cochin', '0', 'Multiple carriers']
for s in train_df_airline.Source.unique():
    print("Source -> ", s)
    print(train_df_airline[train_df_airline.Source == s].Airline.value_counts())
```

```
Source ->  Banglore
Jet Airways    788
IndiGo         523
Air India      332
Vistara        185
SpiceJet       181
GoAir           93
Air Asia        89
Name: Airline, dtype: int64
Source ->  Kolkata
Jet Airways    1256
Air India       512
IndiGo          445
SpiceJet        300
Vistara         183
Air Asia        150
GoAir            25
Name: Airline, dtype: int64
Source ->  Delhi
Jet Airways          1586
Multiple carriers    1196
Air India             746
IndiGo                705
SpiceJet               87
Air Asia               80
GoAir                  76
Vistara                45
Name: Airline, dtype: int64
Source ->  Chennai
IndiGo      184
SpiceJet    128
Vistara      43
Air India    25
Name: Airline, dtype: int64
Source ->  Mumbai
Jet Airways    219
IndiGo         196
Air India      136
SpiceJet       122
Vistara         23
Name: Airline, dtype: int64
```

In [131]:

```
airline_df = [train_df_IndiGo, train_df_AirIndia, train_df_JetAirways, train_df_SpiceJet, train_df_Multiplecarriers, t

def transform_airline_df(df):
    # drop unnecessary features
    df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)

    # OneHotEncoding on "Source", "Destination"
    df = pd.get_dummies(df, columns=["Source", "Destination"])

    # LabelEncoding on Total_Stops
    df.Total_Stops = le.fit_transform(df["Total_Stops"])
    return df

# for df in airline_df:
#     df = transform_airline_df(df)
#     print(df.Airline.unique(), df.shape)

#     print(df.shape, '\n', df.columns)
#     print("=@="*50)
```

In [132]:

```
train_df_IndiGo.head()
```

Out[132]:

	Airline	Source	Destination	Route	Dep_Time	Arrival_Time	Duration	Total_Stops	Additional_Info	Price	Day	Month	Dep_hr	Dep_min
0	IndiGo	Banglore	New Delhi	BLR → DEL	22.20	1.10	170	non-stop	No info	3897	24	3	22	20
3	IndiGo	Kolkata	Banglore	CCU → NAG → BLR	18.05	23.30	325	1 stop	No info	6218	12	5	18	5
4	IndiGo	Banglore	New Delhi	BLR → NAG → DEL	16.50	21.35	285	1 stop	No info	13302	1	3	16	50
11	IndiGo	Kolkata	Banglore	CCU → BLR	20.20	22.55	155	non-stop	No info	4174	18	4	20	20
14	IndiGo	Kolkata	Banglore	CCU → BLR	17.15	19.50	155	non-stop	No info	4804	24	4	17	15

Model Building for each Airline

Indigo

In [133]:

```
train_df_IndiGo_tf = transform_airline_df(train_df_IndiGo)
X_IndiGo = train_df_IndiGo_tf.drop(columns=["Price"])
y_IndiGo = train_df_IndiGo_tf.Price
X_IndiGo_train, X_IndiGo_test, y_IndiGo_train, y_IndiGo_test = train_test_split(X_IndiGo, y_IndiGo, test_size=0.33, ra
IndiGo = RandomForestRegressor()
IndiGo.fit(X_IndiGo_train, y_IndiGo_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[133]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [134]:

```
y_IndoGo_train_pred = IndiGo.predict(X_IndiGo_train)
y_IndoGo_test_pred = IndiGo.predict(X_IndiGo_test)
```

In [135]:

```
# model performance
print("Train Score = ",IndiGo.score(X_IndiGo_train, y_IndoGo_train))
print("Test Score = ",IndiGo.score(X_IndiGo_test, y_IndoGo_test))
```

```
Train Score =  0.9735604466413355
Test Score =  0.8120233569025643
```

In [183]:

```
IndiGo.feature_names_in_.shape
```

Out[183]:

```
(19,)
```

In [136]:

```
IndiGo.predict([list(X_IndiGo.iloc[13])])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[136]:

```
array([7229.99])
```

In [137]:

```
[list(X_IndiGo.iloc[13])]
```

Out[137]:

```
[[630, 0, 15, 5, 15, 0, 1, 30, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0]]
```

In [138]:

```
IndiGo.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[138]:

```
array([5120.4])
```

AirIndia

In [139]:

```
train_df_AirIndia_tf = transform_airline_df(train_df_AirIndia)
X_AirIndia = train_df_AirIndia_tf.drop(columns=["Price"])
y_AirIndia = train_df_AirIndia_tf.Price
X_AirIndia_train, X_AirIndia_test, y_AirIndia_train, y_AirIndia_test = train_test_split(X_AirIndia, y_AirIndia, test_s
AirIndia = RandomForestRegressor()
AirIndia.fit(X_AirIndia_train, y_AirIndia_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[139]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [140]:

```
# model performance
print("Train Score = ", AirIndia.score(X_AirIndia_train, y_AirIndia_train))
print("Test Score = ", AirIndia.score(X_AirIndia_test, y_AirIndia_test))
```

```
Train Score =  0.9633194887547871
Test Score =  0.8208167291276393
```

In [184]:

```
AirIndia.feature_names_in_.shape
```

Out[184]:

```
(19,)
```

In [141]:

```
AirIndia.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[141]:

```
array([7179.05])
```

JetAirways

In [142]:

```
train_df_JetAirways_tf = transform_airline_df(train_df_JetAirways)
X_JetAirways = train_df_JetAirways_tf.drop(columns=["Price"])
y_JetAirways = train_df_JetAirways_tf.Price
X_JetAirways_train, X_JetAirways_test, y_JetAirways_train, y_JetAirways_test = train_test_split(X_JetAirways, y_JetAir
JetAirways = RandomForestRegressor()
JetAirways.fit(X_JetAirways_train, y_JetAirways_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[142]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [143]:

```
# model performance
print("Train Score = ", JetAirways.score(X_JetAirways_train, y_JetAirways_train))
print("Test Score = ", JetAirways.score(X_JetAirways_test, y_JetAirways_test))
```

```
Train Score =  0.9118092391297598
Test Score =  0.6130907046627694
```

In [144]:

```
JetAirways.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 0, 0, 1, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[144]:

```
array([11898.78583333])
```

SpiceJet

In [145]:

```
train_df_SpiceJet_tf = transform_airline_df(train_df_SpiceJet)
X_SpiceJet = train_df_SpiceJet_tf.drop(columns=["Price"])
y_SpiceJet = train_df_SpiceJet_tf.Price
X_SpiceJet_train, X_SpiceJet_test, y_SpiceJet_train, y_SpiceJet_test = train_test_split(X_SpiceJet, y_SpiceJet, test_s
SpiceJet = RandomForestRegressor()
SpiceJet.fit(X_SpiceJet_train, y_SpiceJet_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning: 
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[145]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [146]:

```
# model performance
print("Train Score = ", SpiceJet.score(X_SpiceJet_train, y_SpiceJet_train))
print("Test Score = ", SpiceJet.score(X_SpiceJet_test, y_SpiceJet_test))
```

```
Train Score =  0.9641418489120887
Test Score =  0.7737002008874712
```

In [147]:

```
SpiceJet.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[147]:

```
array([4971.455])
```

Multiplecarriers

In [148]:

```
train_df_Multiplecarriers_tf = transform_airline_df(train_df_Multiplecarriers)
X_Multiplecarriers = train_df_Multiplecarriers_tf.drop(columns=["Price"])
y_Multiplecarriers = train_df_Multiplecarriers_tf.Price
X_Multiplecarriers_train, X_Multiplecarriers_test, y_Multiplecarriers_train, y_Multiplecarriers_test = train_test_spli
Multiplecarriers = RandomForestRegressor()
Multiplecarriers.fit(X_Multiplecarriers_train, y_Multiplecarriers_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning: 
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[148]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [149]:

```
# model performance
print("Train Score = ", Multiplecarriers.score(X_Multiplecarriers_train, y_Multiplecarriers_train))
print("Test Score = ", Multiplecarriers.score(X_Multiplecarriers_test, y_Multiplecarriers_test))
```

```
Train Score =  0.9154984614566914
Test Score =  0.617419964689822
```

In [150]:

```
X_Multiplecarriers_train.Source_Delhi.value_counts()
```

Out[150]:

```
1    801
Name: Source_Delhi, dtype: int64
```

In [151]:

```
y_Multiplecarriers_train.value_counts()
```

Out[151]:

```
13377    30
13587    28
9646     21
6795     18
8266     18
         ..
8601      1
24528     1
7887      1
8565      1
11761     1
Name: Price, Length: 248, dtype: int64
```

In [152]:

```
X_Multiplecarriers_test.head()
```

Out[152]:

	Duration	Total_Stops	Day	Month	Dep_hr	Dep_min	Arrival_hr	Arrival_min	Source_Delhi	Destination_Cochin
5522	535	0	27	6	10	20	19	15	1	1
2152	570	0	6	3	6	0	15	30	1	1
8993	900	0	12	6	6	0	21	0	1	1
9878	830	0	27	6	11	40	1	30	1	1
517	630	0	15	5	8	30	19	0	1	1

In [153]:

```
y_Multiplecarriers_test.head()
```

Out[153]:

```
5522     7741
2152    15147
8993     7005
9878     5797
517      9627
Name: Price, dtype: int64
```

In [154]:

```
Multiplecarriers.predict([[535, 0, 27, 6, 10, 20, 19, 15, 1, 1]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[154]:

```
array([8418.57])
```

GoAir

In [155]:

```
train_df_GoAir_tf = transform_airline_df(train_df_GoAir)
X_GoAir = train_df_GoAir_tf.drop(columns=["Price"])
y_GoAir = train_df_GoAir_tf.Price
X_GoAir_train, X_GoAir_test, y_GoAir_train, y_GoAir_test = train_test_split(X_GoAir, y_GoAir, test_size=0.33, random_s
GoAir = RandomForestRegressor()
GoAir.fit(X_GoAir_train, y_GoAir_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning: 
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[155]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [156]:

```
# model performance
print("Train Score = ", GoAir.score(X_GoAir_train, y_GoAir_train))
print("Test Score = ", GoAir.score(X_GoAir_test, y_GoAir_test))
```

```
Train Score =  0.9521499482721512
Test Score =  0.5041998681266219
```

In [157]:

```
GoAir.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 1, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[157]:

```
array([11264.97])
```

Vistara

In [158]:

```
train_df_Vistara_tf = transform_airline_df(train_df_Vistara)
X_Vistara = train_df_Vistara_tf.drop(columns=["Price"])
y_Vistara = train_df_Vistara_tf.Price
X_Vistara_train, X_Vistara_test, y_Vistara_train, y_Vistara_test = train_test_split(X_Vistara, y_Vistara, test_size=0.
Vistara = RandomForestRegressor()
Vistara.fit(X_Vistara_train, y_Vistara_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning: 
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[158]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [159]:

```
# model performance
print("Train Score = ", Vistara.score(X_Vistara_train, y_Vistara_train))
print("Test Score = ", Vistara.score(X_Vistara_test, y_Vistara_test))
```

```
Train Score =  0.9618971023537907
Test Score =  0.8174643884821173
```

In [160]:

```
Vistara.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[160]:

```
array([7277.89])
```

AirAsia

In [161]:

```
train_df_AirAsia_tf = transform_airline_df(train_df_AirAsia)
X_AirAsia = train_df_AirAsia_tf.drop(columns=["Price"])
y_AirAsia = train_df_AirAsia_tf.Price
X_AirAsia_train, X_AirAsia_test, y_AirAsia_train, y_AirAsia_test = train_test_split(X_AirAsia, y_AirAsia, test_size=0.
AirAsia = RandomForestRegressor()
AirAsia.fit(X_AirAsia_train, y_AirAsia_train)
```

```
/tmp/ipykernel_149750/2200169594.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.h
tml#returning-a-view-versus-a-copy (https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.htm
l#returning-a-view-versus-a-copy)
  df.drop(columns=['Airline', 'Route', 'Dep_Time', 'Arrival_Time', 'Additional_Info'], inplace=True)
```

Out[161]:

```
RandomForestRegressor()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [162]:

```
# model performance
print("Train Score = ", AirAsia.score(X_AirAsia_train, y_AirAsia_train))
print("Test Score = ", AirAsia.score(X_AirAsia_test, y_AirAsia_test))
```

```
Train Score =  0.9578085281167095
Test Score =  0.7765318351254906
```

In [163]:

```
AirAsia.predict([[230, 0, 15, 5, 15, 0, 1, 30, 1, 0, 0, 0, 1, 0, 0]])
```

```
/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/.venv/lib/python3.10/site-packages/skl
earn/base.py:409: UserWarning: X does not have valid feature names, but RandomForestRegressor was fitted
with feature names
  warnings.warn(
```

Out[163]:

```
array([5864.01])
```

In [ ]:

```

```

Dumping All Airline Models

In [166]:

```
import pickle
pickle.dump(IndiGo, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/IndiGo.pkl', 'wb
pickle.dump(AirIndia, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/AirIndia.pkl',
pickle.dump(JetAirways, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/JetAirways.p
pickle.dump(SpiceJet, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/SpiceJet.pkl',
pickle.dump(Multiplecarriers, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/Multip
pickle.dump(GoAir, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/GoAir.pkl', 'wb')
pickle.dump(Vistara, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/Vistara.pkl', '
pickle.dump(AirAsia, open('/media/tinku/Education/iNEURON/ML/Projects/flight_fare_prediction/pkl_files/AirAsia.pkl', '
```

In [167]:

```
# DICT WITH ALL Airline Models
airline_model_dict = {
    "AirAsia":AirAsia,
    "IndiGo": IndiGo,
    "AirIndia":AirIndia,
    "JetAirways":JetAirways,
    "SpiceJet":SpiceJet,
    "Multiplecarriers": Multiplecarriers,
    "GoAir":GoAir,
    "Vistara":Vistara
}
```

In [178]:

```
# DICT THAT CONTAINS LIST OF  AVAILABLE AIRLINE FROM ANY PARTICULAR SOURCE
avl_airline = {}
for s in list(train_df_airline.Source.unique()):
    avl_airline[s] = [x.replace(" ", "") for x in train_df_airline[train_df_airline.Source == s].Airline.unique()]
```

In [179]:

```

avl_airline
```

Out[179]:

```
{'Banglore': ['IndiGo',
  'JetAirways',
  'AirIndia',
  'Vistara',
  'AirAsia',
  'SpiceJet',
  'GoAir'],
 'Kolkata': ['AirIndia',
  'IndiGo',
  'SpiceJet',
  'JetAirways',
  'Vistara',
  'GoAir',
  'AirAsia'],
 'Delhi': ['JetAirways',
  'Multiplecarriers',
  'AirIndia',
  'SpiceJet',
  'GoAir',
  'IndiGo',
  'Vistara',
  'AirAsia'],
 'Chennai': ['AirIndia', 'Vistara', 'IndiGo', 'SpiceJet'],
 'Mumbai': ['Vistara', 'AirIndia', 'JetAirways', 'IndiGo', 'SpiceJet']}
```

END OF NOTEBOOK