



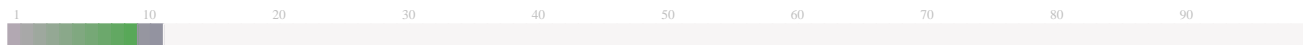
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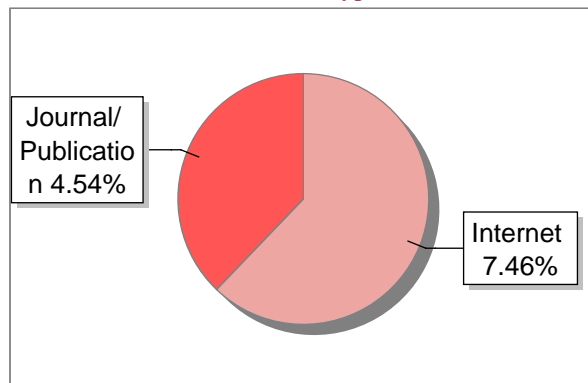
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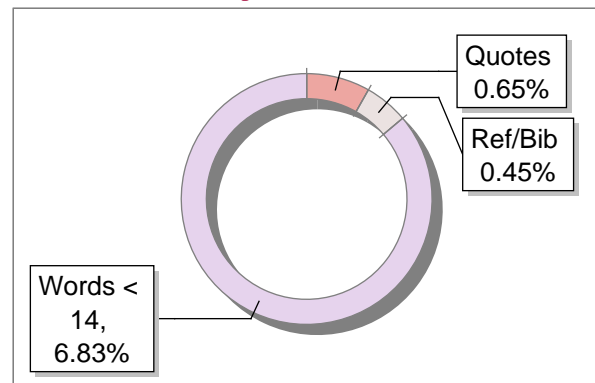
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46	IEEE 2017 IEEE Conference on Computational Intelligence in Bioinfor, by Wassan, Jyotsna Tal- 2017	<1	Publication

## ABSTRACT

Airline ticket prices nowadays can fluctuate greatly, even between neighbouring seats in the same lodge, even <sup>1</sup>for the same flight. Customers are eager to save as much money as possible, while airlines strive to maximise profits. Various computational tactics, such as demand expectation and value separation, are used by planes to increase their earnings. Experts recommend two types of models for customers to use to cut costs: models that predict the best time to buy a ticket, and models that predict the least expensive ticket price. According to our audit analysis, models on both sides rely on a specific order of elements such as the genuine ticket value information, the date of purchase, and the date of departure. This work aims to develop a tool that can use an artificial intelligence model to predict how much certain flights will cost. The client will receive the expected benefits, and using it as a point of reference, <sup>44</sup>they can book their flights at their convenience. To maximise profits, airlines today are actively working to keep the cost of plane tickets down. <sup>2</sup>As a result, frequent fliers typically know when is the greatest time to purchase cheap plane tickets. However, <sup>9</sup>there are a lot of people who aren't used to reserving tickets and end up spending more than they need to because they fall for discount traps set up by companies. The suggested framework provides customers with the information they need to order tickets at the most cost-effective time. With the use of Python tools like Pandas, NumPy, Matplotlib, seaborn, and sklearn, we have applied the AI life cycle to develop a crucial <sup>34</sup>mobile app that can predict the costs of future flights using AI computation applied to independently verified flight data.

## CHAPTER-1Introduction

<sup>1</sup>The purpose of this project is to create a tool that uses a machine learning model to estimate airfare for a variety of routes. Clients can book similar flights with confidence knowing they'll receive the advertised amenities.

Currently, airlines are attempting to limit the price of plane tickets as a means of increasing their profits. Many people often use air travel, and as a result, they have an understanding of when it's best to get cheap tickets. However, there are a lot of people who aren't savvy about ordering tickets and end up <sup>23</sup>spending more than they should since they fell for discount traps set by companies. By presenting the information needed to book at the best time, the proposed framework can help customers save thousands of rupees.

In order to forecast the cost of the flight, we have trained a <sup>36</sup>random forest classifier model with information on the many parameters that go into determining the cost of the travel.

<sup>21</sup>Our preliminary research indicates that models on both sides rely on a limited arrangement of details, such as the confirmed ticket amount, <sup>17</sup>the date of purchase, and the date of departure.

Calculation of prices based on many factors-

- Airline
- Date of Journey
- Date of Arrival
- Source
- Destination
- Departure Time
- Arrival Time
- Duration
- Total Stops
- Weekday/Weekend

Using data and statistical methods, software that employs machine learning (ML) can improve its predictive abilities over time without being explicitly taught to do so. A key component of machine learning is the utilisation of previously collected data to make predictions about future results.

In addition to aiding in product creation, machine learning helps businesses keep tabs on shifting client preferences and organisational tendencies. Machine learning is an integral aspect of many cutting-edge businesses today, including some of the most well-known names in the industry like Facebook, Google, and Uber. Numerous businesses now use machine learning as a key differentiator in the market.

Data scientists provide algorithms with labelled training data and define the variables they want the algorithm to examine for connections in a process known as supervised learning. The algorithm's input and output are both outlined.

## SCOPE OF THE STUDY

In supervised machine learning, the data scientist uses labelled inputs and target outputs to train the algorithm. The following are areas where supervised learning algorithms excel:

- 1.Data can be classified into two groups, or "bins," when using a binary classification system.
- 2.Classifying data into groups using more than two categories is called multi-class classification.
- 3.Forecasting a range of numbers using a model called regression.
- 4.The term "ensembling" refers to <sup>19</sup>the process of bringing together the results of several different machine learning models into a single, reliable forecast.



## NEED OF THE STUDY

Ticket prices are difficult to predict since while we may perceive a value now, tomorrow the price of a similar flight may be very different. It's possible that we frequently hear passengers complain about the unpredictability of airline ticket prices. These days, flying is the only practical option for long-distance trips. Aircraft use a complex pricing system called "yield the board" to determine the price of each flight. This method allows the price to fluctuate in response to a wide range of factors, including the proximity to the departure date, the availability of specific seats, the intensity of market competition, and so on. Due to the generally accepted fact that airfare increases as the purchase date gets closer to the departure date, many passengers now purchase <sup>20</sup> their plane tickets as far in advance as possible. This type of shopping behaviour, while common, is not always the best option. <sup>15</sup> In the case of a failure, travellers will incur additional costs if they have already paid for their plane tickets in advance.

Because of the following factors, it is certainly difficult for tourists to anticipate when the optimum time to purchase flight tickets is:

- **Incomplete Information:** Guests have limited access to the airline's private information. The truth is that they do not have access to vital details like the number of spare tickets and the agreement between different carrier businesses.
- **Fragmented Information:** Information available to explorers is segmented. To give just one example, it is certainly difficult for a typical explorer to determine the correlation between flight price and flight characteristics <sup>1</sup> such as the number of stops, departure time, and so on.
- **Irregular Change:** Despite the fact that explorers can collect tangible flight value, the price fluctuation is choppy. In actuality, it is quite difficult to foresee. Thus,
- Using historical flight prices as a guide, passengers can, at best, expect a rough estimate..

## OBJECTIVES OF THE STUDY

- The quarterly average price of Flights across market segments may now be predicted thanks to a machine learning approach.
- The air travel market was segmented using a combination of macroeconomic statistics and other features taken from the datasets.
- Our suggested approach uses feature aggregation techniques to make adjusted quarterly average Flight Price predictions.
- The cheapest ticket for a specific date can increase or decrease in price over time.

## REVIEW OF LITERATURE

Researchers propose utilising machine learning to estimate future flight prices, and they've already collected data from 1814 Aegean Airlines passenger trips to utilise in their analysis. To show how component determination can affect model precision, we used a variety of model preparations.

According to William Groves's case study, a knowledgeable expert can provide clients with precise purchase windows in the future. A model is built using a method called half-least-squares relapse.

Supriya Rajankar uses a small dataset made up of flights between Delhi and Bombay to provide an overview of flight charge forecast using AI calculation in her survey study. K-nearest neighbours (KNN), direct relapse, and support vector machine (SVM) are only few of the algorithms that are used in these calculations.

Tianyi wang suggested a system in which two databases are combined with macroeconomic data and AI calculations like support vector machine, XGBoost are used to represent the typical ticket cost based on source and objective sets. Using the modified R2 for system performance, the system achieves a high level of forecast accuracy of 0.869.

To help passengers decide whether to buy now or wait for a better price, "A linear quantile mixed regression model for prediction of airline ticket prices" compares four LR models to find the best fit model. Foreseeing the cheapest tickets, or "genuine bargains," the authors propose utilising linear quantile mixed models. However, this service only applies to economy class tickets and only on direct flights between San Francisco International Airport and New York's John F. Kennedy International Airport. To aid customers in making decisions, Wohlfarth et al. combined clustering as an initial step with many cutting-edge supervised learning algorithms (including classification tree (CART) and RF). In their system, flights with similar patterns in the price series are clustered using the K-Means technique. Then, they utilise CART to decipher the

rules and RF to convey the weight of each characteristic. The writers also highlighted the importance of the remaining seat count in determining ticket prices. <sup>2</sup> There are a lot of factors that influence the market competition, not just flight-related ones. The expenditures incurred by a travel agency due to overbuying or lost orders can be minimised if the market demand is predicted accurately, for example. In [19], the author uses a combination of ANN and GA to forecast the travel agency's earnings from the sale of airline tickets. Features such as the cost of crude oil on global markets, the weighted stock market index in Taiwan, and the unemployment rate in Taiwan on a monthly basis were used as inputs. More specifically, the GA picks the best input features to boost the ANNs' efficiency. An excellent Mean Absolute Regression of 9.11% was achieved by the model.

Indicate the error as a percentage. Beginning in 2017, <sup>39</sup> more sophisticated machine learning models were evaluated in an effort to enhance Flight Price's price forecast accuracy. In their study, Tziridis et al. utilised eight machine

Using a variety of machine learning (ML) models to forecast ticket prices and evaluate their efficacy. The highest accuracy attained by the best regression model was 88%. Bagging Regression Tree stands out as the superior model since it is consistent regardless of the input features used.

Using machine learning techniques, [2] linked a Partial Least Squares Regression (PLSR) model to find the optimal balance between price and visibility when purchasing airline tickets. The model achieved an accuracy of 75.3%. Janssen

In order to foresee the prices of low-cost plane tickets many days before departure, [3] introduced a direct quantile mixed relapse model. Linear Regression (77.06%), Naive Bayes (73.16%), Softmax Regression (76.84%), and Support Vector Machine (80.6%) models were all considered by Ren, Yuan, and Yang [4] for their ability to predict airline ticket prices. Using the Machine Learning models Ripple Down Rule Learner (74.5% accuracy), Logistic Regression (69.9% accuracy), and Linear SVM (69.4% accuracy), Papadakis [5] predicted that the price of the ticket would decrease in the future.

<sup>1</sup> Partial Least Square Regression (PLSR) was the method of choice for Gini and Groves as they worked to create a model to determine <sup>28</sup> when customers are most likely to make the most informed decision regarding when to buy airline tickets. From February 22, 2011, to June 23,

2011, information was gathered from the most popular online travel agencies. The resulting model's performance was validated against <sup>40</sup> additional data that was also collected.

Using the current daily Flight Prices provided by [www.infare.com](http://www.infare.com), Janssen developed a forecasting <sup>7</sup> model for the San Francisco to New York route using a Linear Quantile Blended Regression technique. The model took into account two key features: the number of days until departure and whether or not the scheduled flight is for the weekend or during the week. While the algorithm does a good job of predicting flight prices far in advance of the scheduled departure date, it struggles to do so closer to the actual departure date.

Wohlfarth developed a model to speed up the process of purchasing tickets by utilising a special pre-preparation stage called macked point processors and information mining systems (arrangement and bunching), as well as a quantifiable inquiry technique. This system is intended to transform disparate value arrangement data into enhanced value arrangement guidance <sup>21</sup> that can be used to strengthen unsupervised grouping computation. Values are grouped together in a direction based on how they are estimated relative <sup>3</sup> to one another. Model improvements for estimating the value of design modifications. The optimal coordinating group can be selected by a tree-based ordering calculation, and the advancement model can be compared to other candidates.

## RESEARCH METHODOLOGY

**RandomForest**-Collective models are used in random forest, and the basic building block is a set of decision trees. Decision trees are fed randomised datasets and make predictions based on those datasets. The output of a random forest model is the mean of the individual prediction values generated by the decision trees. Decision trees are the primary building blocks of a random forest, which is essentially a collection of models. Decision trees are fed arbitrary datasets and make predictions based on such datasets.

We're utilising a machine learning algorithm to construct this thing, and it'll utilise user-supplied data on their flights as input.

Regression and classification issues can be tackled with the use of a random forest, a machine learning technique. Ensemble learning, which utilises several classifiers to solve a problem, is used.

### Primary data collection Methods

Multiple decision trees make up a random forest algorithm. The random forest algorithm's "forest" is trained using bagging or bootstrap aggregation. Machine learning algorithms can be made more precise by employing bagging, an ensemble meta-algorithm.

The algorithm (random forest) decides depending on what the decision trees have predicted. It makes forecasts by averaging the results of many trees. The accuracy of the prediction rises as the number of trees grows.

### Data Set

The restrictions imposed by a decision tree algorithm are eliminated by a random forest. In doing so, it improves accuracy by decreasing the tendency to overfit data. For making forecasts, it doesn't need a lot of package configurations (like scikit-learn).

### Characteristics of the Random Forest Model

A decision tree algorithm can't compare to its precision.

It's an efficient method for dealing with incomplete records.

Even without fine-tuning the hyper-parameters, it can provide an accurate forecast. As a result, decision trees no longer suffer from the problem of overfitting.

Splitting at each node in a random forest tree selects features at random.

Understanding decision trees and the random forest algorithm

A random forest algorithm is composed of decision trees. <sup>6</sup> A decision tree is a tree-like structure used as a decision-making tool. To further comprehend how random forest algorithms function, a review of decision trees is in order.

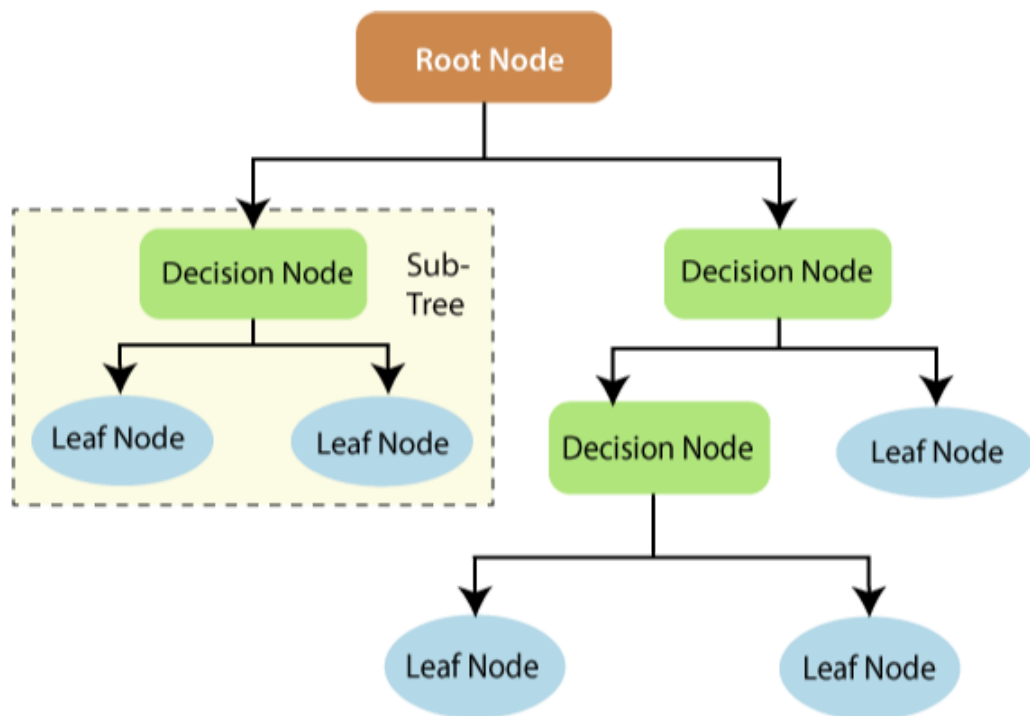
There are three parts to a decision tree: the root node, the leaf nodes, and the decision nodes. A training dataset is segmented into branches via a decision tree method, which subsequently subdivides into additional branches. This process is repeated till reaching a leaf node. No additional partitioning of the leaf node is possible..

## LIMITATIONS OF THE STUDY

- Dominguez-research Menchero's suggests the best time to make a purchase for a given schedule, service provider, and programme type using a nonparametric isotonic relapse technique.
- The model predicts the latest possible date to purchase a plane ticket.
- The anticipation takes into account two forms of the variable. An example is the time and date of purchase.

## INDUSTRY PROFILE

Attributes used to make a prediction are represented by "nodes" in the decision tree. The leaves can be accessed using the decision nodes. In a decision tree, there are three distinct kinds of nodes.



**Fig1. DecisionTreeinRandomForest**

More insight into the functioning of decision trees can be gleaned from the information theory. Decision trees are based on the principles of entropy and information gain. The process of creating decision trees relies on a firm grasp of these primary ideas.

Entropy is a measure of randomness and disorder. Given a set of independent variables, information gain quantifies the degree to which uncertainty in the target variable is minimised.

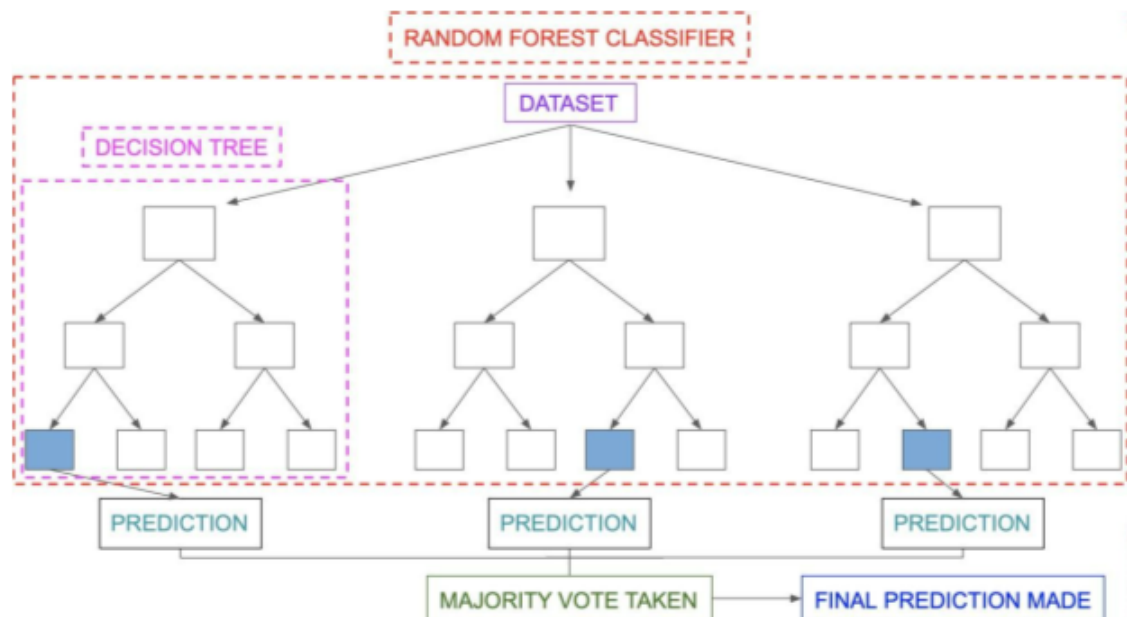


According to the theory of information gain, it is possible to learn more about a dependent variable by examining its constituent independent variables (features) (class). The information gain is estimated using both the entropy of the target variable (Y) and the conditional entropy of Y (given X). The entropy of Y is calculated by deducting the entropy of the conditional.

Decision trees can be trained with the use of information gathering. Reduced uncertainty in these trees is a result of this. If the knowledge gain is high, then a lot of randomness has been wiped out, or uncertainty has been reduced. Branch splitting is a crucial step in building decision trees, and it is influenced by entropy and information gain.

Random forest classification makes use of an ensemble approach to achieve the result. Several decision trees are trained using the training data. During the node-splitting process, this dataset's observations and features will be chosen at random.

A rain forest system relies on various decision trees. Every decision tree consists of decision nodes, leaf nodes, and a root node. The leaf node of each tree is the final output produced by that specific decision tree. The selection of the final output follows the majority-



voting system. In this case, the output chosen by the majority of the decision trees **Fig2. Random forest Classifier**

The benefits <sup>11</sup> of random forest include:-

1. It's capable of both regression and classification.
2. Using a random forest, you can get accurate predictions that are also easy to interpret.
3. As a result, it is capable of effectively processing massive datasets.
4. When compared to the decision tree algorithm, the random forest approach yields more accurate predictions..

**Flutter**-Flutter is <sup>16</sup>a set of libraries and tools developed by Google that allow you to create attractive, natively built applications for mobile, web, desktop, and embedded devices using a single set of files. It's what is utilised to build the front end of an application that uses a machine learning model to forecast a pricing and send it to a user's mobile device. In addition, Flutter provides a wide variety of pre-built UI widgets for making cutting-edge apps. These widgets were made specifically for use in mobile environments, and utilising them to create an app is as easy as creating one in HTML.

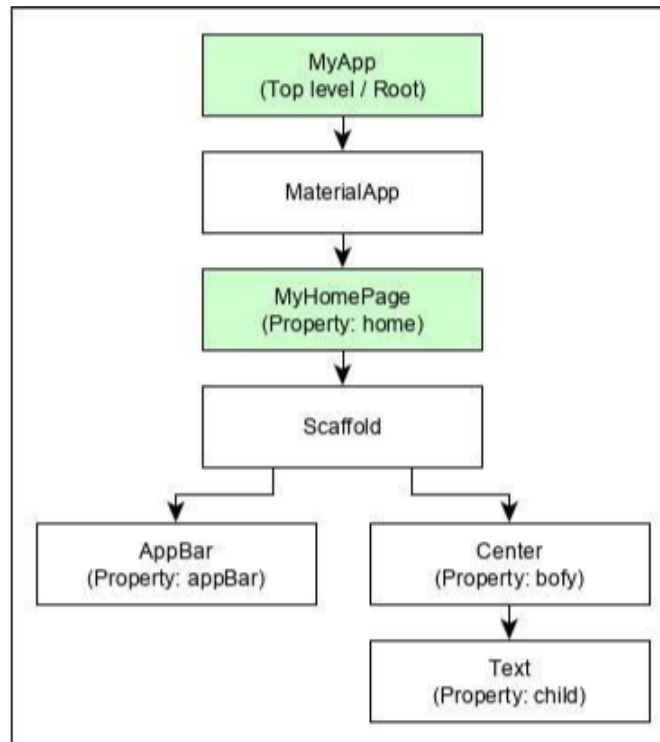
Specifically, the Flutter app is a widget in and of itself. Animations and motions are also supported by the Flutter widgets. Reactive programming is the foundation of the application's logic. A widget's state is completely discretionary. Flutter uses reactive programming to instantly (when the widget's state is changed) compare the widget's previous and new states and re-render the widget with only the necessary modifications.

In the subsequent chapters, we'll talk about the whole structure..Features of Flutter

1. Flutter framework offers the following features to developers–
2. Modern and reactive framework.
3. Uses Dart programming language and it is very easy to learn.
4. Fast development.
5. Beautiful and fluid user interfaces.
6. Huge widget catalog.
7. Run same UI for multiple platforms.
8. High performance application.

### Advantages of Flutter

1. If you want a high-performance, top-notch mobile app, Flutter has the gorgeous, configurable widgets you need. It satisfies any and all specific requirements. In addition to these, Flutter has a plethora of other benefits:
2. Dart's extensive library of software packages allows you to greatly broaden the functionality of your programme.
3. To create both programmes, developers only need to create a single code base (both Android and iOS platforms). Eventually, Flutter could be made available on additional platforms.
4. Tests for Flutter are easier to pass. Due to the shared codebase, only a single set of automated tests needs to be created.
5. Flutter's low barrier to entry makes it an attractive choice for rapid app creation. Because of its flexibility and adaptability, it may be tailored to meet specific needs.
6. Developers working with Flutter have complete freedom over the appearance and placement of widgets.
7. Amazing features for developers are available in Flutter, such as the revolutionary hot reload.



**Fig3.FlutterScreenArchitecture**

3. **Flask**-Flask is a Python framework for developing small web applications. Flask is widely used in the development community for tasks like as building web applications, handling HTTP requests, and rendering templates. The term "micro web application" is used to indicate that the application in question does not make use of a full-stack framework. We'll utilise this to create the application programming interface (API) that will send POST requests from our app to the machine learning model.

Python web app framework Flask. Armin Ronacher, who heads up a global community of Python fans called Pocco, is responsible for its development. The Werkzeug WSGI toolkit and the Jinja2 template engine form the foundation of Flask. They're both works by Pocco.

## WSGI

Standardization on the Online Server Gateway Interface (WSGI) has been reached for the creation of Python-based web applications. Web Server Gateway Interface (WSGI) is a specification for a standard way for online servers to communicate with web applications.

## Werkzeug

It's a WSGI toolkit that includes features like request and response objects. This allows a web framework to be constructed on top of it. Werkzeug is one of the foundations of the Flask framework.

## Jinja2

Jinja2 is a widely used Python templating engine. The ability to generate dynamic web pages is a key feature of web templating systems, which work by combining a template with a data source.

The `redirect()` method is a part of the Flask class. It receives a status code and a response object from the calling function, and then sends the user to a new URL.

A cookie is a little text file that is downloaded to a client's computer and kept there. Its goal is to keep track of user preferences and behaviour <sup>43</sup> in order to enhance the quality of the user experience and gather useful analytics.

The cookie attribute is stored in the Request object. A client's cookie data is a dictionary object containing all the cookie variables and their associated values. It's not all that a cookie remembers, though; it also keeps track of the site's domain name, path, and expiration date.

Flask uses response objects to store cookies. You can create a response object from the data returned by a view function by calling the `make_response()` function. Once done, a cookie can be saved with the response object's `set_cookie()` method.

It's not hard to read back a cookie. To retrieve a cookie's value, programmers utilise the `request.cookies` attribute's `get()` method..

#### 4. **Python**-Python is a popular programming language. It was created by Guido van Rossum, and released in 1991.

It is used for:

- 1.web development (server-side) (server-side),
- 2.software development,
- 3.mathematics,
- 4.system scripting.

What Python do:-

- 1.To develop websites, Python can be run on a server.
- 2.Python can be used in conjunction with other programmes to develop processes.
- 3.Python can connect to database systems. It can open and edit files as well.
- 4.Big data and advanced calculations are no problem for Python.
- 5.Python can be used for rapid prototyping, or for production-ready software

development.

Need for Python:-

1. Python operates on different platforms (Windows, Mac, Linux, Raspberry Pi, etc) (Windows, Mac, Linux, Raspberry Pi, etc).
2. Python has a straightforward grammar akin to the English language.
3. Python's syntax is conducive to shorter lines of code, making it a popular choice among programmers.
4. Since Python utilises an interpreter system, it is possible to immediately put code to use when it has been produced. Therefore, developing a prototype shouldn't take too long.
5. Python can be approached in three distinct paradigms: procedural, object-oriented, and functional.



13  
**5. Heroku** - Using Heroku, programmers can create, deploy, and manage their apps on the cloud. Flask API is hosted on a cloud server so that any device can make a request to it.

Heroku's FREE plan is more than adequate for a bot or any fun projects, and their paid plans are some of the best in the business, especially in the PaaS Niche. PostgreSQL on Heroku

Database as a service (DBaaS) platform Heroku offers is Postgres.

running PostgreSQL. Heroku Postgres has forks, followers, and dataclips in addition to continuous protection, rollback, and high availability.

The Redis Heroku

Redis has been improved using Heroku's special touches, and the result is Heroku Redis. The service is offered by Heroku and completely handled by the company. It facilitates instance management via command line interface, data association with Postgres for business insight via SQL tools, and performance visibility for customers.

Groups Using Heroku

Heroku Teams is a management platform for software development teams that enables customers to better coordinate their developers, workflows, and tools. Self-managing teams on Heroku have access to Heroku Pipelines and other collaboration tools, as well as the ability to create, manage, and add members. Furthermore, it offers centralised billing and outsourced administration.

Business Heroku

Heroku Enterprise's services promote better teamwork in large organisations by facilitating communication and sharing of information between departments. Features such as identity federation, private workspaces, and granular access restrictions help businesses keep track of their application development workflow, assets, and personnel.

The Heroku Bridge

Users of Heroku Connect can build apps that seamlessly connect with other systems.

using massive quantities of Salesforce. This is achieved by automatically syncing data across Heroku Postgres databases and Salesforce groups. Elements for Heroku

Add-ons (application development and management tools and services), Buildpacks (automated language and framework builds), and Buttons are all part of Heroku Elements (a tool for the one-click provisioning, configuring, and deployment of third party components, libraries and patterns).

## 6. AndroidStudio:-

The "Integrated Development Environment" (IDE) stack includes Android Studio. Android Studio, originally known as ADT (Android Programming Tools), is a "Android development environment centred on IntelliJ IDEA" that enhances and expands the functionality of the eclipse IDE.

An adaptable and user-friendly Gradle-based framework is already integrated into Android Studio. It's been developed across numerous generations using a wide range of APK versions. The package also includes a comprehensive template for use with Google services and a wide range of other devices. Apps developed in Android Studio can be used on any device running Android, including smartphones, tablets, Android Wear, Android TV, and Android Auto.

Android Studio's many helpful features, such as its ability to support development for all Android devices, its use of apply Changes to push code and resource changes to a running app without restarting the app, its use of a flexible Gradle-based build system, its use of a fast and feature-rich emulator, its integration with GitHub and Code templates to help you build commonly used app features and import sample code, and its extensive testing tools, all contribute to the studio's reputation as a highly productive tool for creating Android apps To that end, we've put together a comprehensive Android Studio lesson that should prove useful to any Android developer looking to learn the ropes.

- Android Studio's Functions
- It makes use of the adaptable Gradle build system.
- The app's emulator is lightning quick and packed with options.
- The unified environment in Android Studio allows us to create apps for any device running the Android operating system.
- If we can make edits to the app's resource code while it's running, we won't have to restart the whole thing.
- A wide variety of testing tools and frameworks are available within Android Studio.

- Not only does it work with NDK, but also C++!.
- It provides build-in supports for Google Cloud Platform. It makes it easy to integrate Google Cloud Messaging and App Engine.

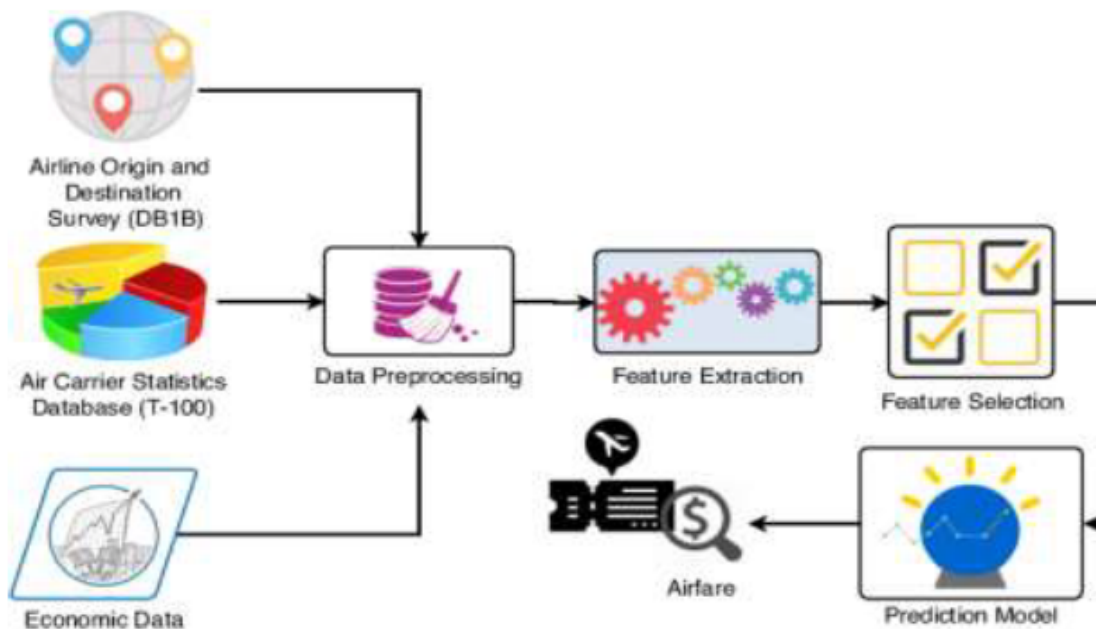
## **THEORITICAL FRAMEWORKS**

### **MEANING**

After determining that data is necessary, it must be cleaned and prepared in accordance with the needs of the model being used. We made use of a wide variety of statistical methods and logic, which we then put into effect by use of preexisting software programmes. With the help of a hybrid approach built from Chi-square, ANOVA, and Correlation tests, the authors of this study [4] are able to forecast flight prices based on a variety of factors, including departure and arrival attributes.

### **DESCRIPTION**

Models of random forests and decision trees are run, with the maximum airfare for each airline sector grouped together. In this article, we will analyse the flight fare prediction using a Machine Learning dataset, drawing some predictions about the price of the flight based on arrival time, what is the departure time, what is the duration of the flight, source, destination, and more. Then, we will perform the feature engineering and calculate the accuracy. There is no surefire way to predict how much a plane ticket will cost; while we might see a price today, tomorrow we might find a completely different story if we look up the price of the same flight. For this task, we have been given data on the price of plane tickets for multiple airlines and multiple routes in January, February, and March of 2021. Our goal is to use this information to develop a model that can forecast the price of these tickets using a wide range of input features.



Over View model

## SIGNIFICANCE OF THE PROJECT

Powered by the RavelSaathi Web Platform, RavelSaathi is an artificial intelligence (AI) software programme. For employees at the Airport Authority, it's a constant companion. A flight crew and passengers alike may benefit from this. Intelligent Fare pricing allows airlines to compete with other businesses, reduce their carbon footprint, and save money on utilities. To be more precise[8], this infrastructure is meant to facilitate the aviation industry's ability to charge market-competitive fares for their Flight service, obtain profitable margins, monitor Airport facilities, and reduce Energy use. <sup>22</sup> This web application has been compiled in multiple languages [11].

Python and its associated Frameworks and Libraries are used to implement the machine learning algorithm and API. Python is used in practically every part of the software development process in the IT sector today. The front-end <sup>35</sup> user interface was built with HTML, CSS, and JavaScript, while PHP was utilised to manage the application's back-end connections. The Flask framework has been used to construct APIs, and Wamp Server has been installed on a Windows computer to host the resulting web application.

## DATA ANALYSIS AND INTERPRETATION

The goal of this project is to increase ticket sales for Indian domestic airlines by creating a mobile app for "Flight Price Prediction" based on data from actual ticket purchases. To avoid losing money due to an empty flight or a spike in crude oil prices, our primary goal is to provide the client with a forecast system that will help them make the best possible decision regarding the Flight Price.

- a. For a limited time only, to analyse data from customers' ticket purchases using data science techniques.
- b. To hone the information, i.e. Getting rid of duplicates, ambiguities, etc.
- c. In order to extract useful features from a dataset for use in making predictions, feature engineering must be performed.
- d. In order to come up with ideas for implementing the features, aka "brainstorming,"
- e. To generate features, i.e. to construct novel features based on existing ones.

The following tasks make up the proposed system's contribution:

### 1) Prediction of Domestic Indian Airline Ticket Prices in India

There are 45 columns in the dataset, and we're only interested in the ones that will help us train the model and make predictions about the target variable.

### 2) Look into and assess what factors influence the airfare.

Data analytics will be used throughout the proposed system to conduct a thorough examination of the data, establish connections between the various data columns, uncover useful patterns of activity, and finally clean and refine the information in order to simplify it. Then, the system will derive additional characteristics from the large dataset to make processing more efficient.

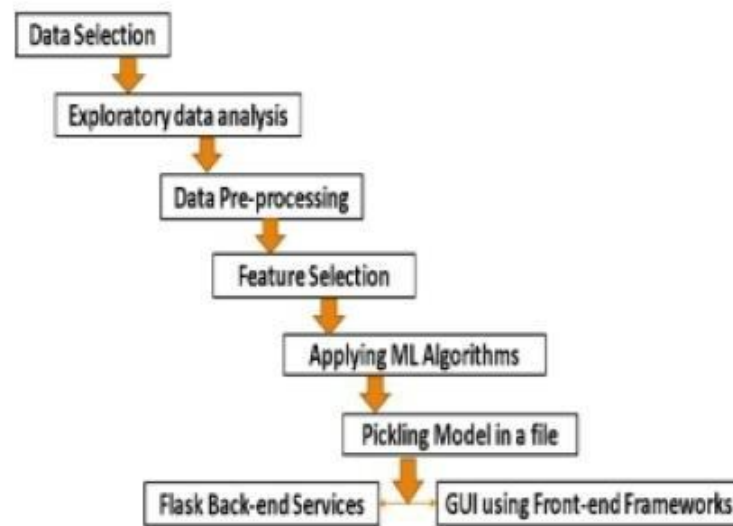
In this third section, we examine how well the ML models perform.

3) Methods like K-nearest neighbours Regression, Support Vector Machines, Random Forests, and a lot more. In order to train the model, Machine Learning algorithms will be utilised. Using Regression methods is necessary because the cost of a flight is a continuous variable. After all data has been entered, a report entitled "FLIGHT PRICE PREDICTION" will be generated by the system..

The proposed system is composed of four phases:

1. Data input
2. Feature extraction
3. Machine learning model selection
4. Prediction





**Fig4 Machine LearningLife Cycle**

### Phase1: DataInput

System will be fed a.csv file containing all ticket booking information from customers as input data. <sup>38</sup> Important features are extracted from 45 columns in the training data. The data only applies to U.S.-based airlines.

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

**Fig5Listofcolumnspresentinthedataset**

### Phase2: DataCleaning

It turns out that 80% of the time is spent on data cleaning and information retrieval. Given

that it comes from the public domain (the internet), this data is current. The airline business uses a database that is riddled with Null values, duplicates, merged values, inconsistencies in column labels, and irrelevant features like referential columns. <sup>32</sup> Here are some methods for scrubbing your data:

1. Removing null values
2. Formatting of date columns
3. Removing outliers

#### 4. Conversion of object, string and other data types into numeric form (Encoding).

```
Data columns (total 30 columns):
```

#	Column	Non-Null Count	Dtype
0	Total_Stops	10682 non-null	int64
1	Price	10682 non-null	int64
2	Journey_day	10682 non-null	int64
3	Journey_month	10682 non-null	int64
4	Dep_hour	10682 non-null	int64
5	Dep_min	10682 non-null	int64
6	Arrival_hour	10682 non-null	int64
7	Arrival_min	10682 non-null	int64
8	Duration_hours	10682 non-null	int64
9	Duration_mins	10682 non-null	int64
10	Airline_Air India	10682 non-null	uint8
11	Airline_GoAir	10682 non-null	uint8
12	Airline_IndiGo	10682 non-null	uint8
13	Airline_Jet Airways	10682 non-null	uint8
14	Airline_Jet Airways Business	10682 non-null	uint8
15	Airline_Multiple carriers	10682 non-null	uint8
16	Airline_Multiple carriers Premium economy	10682 non-null	uint8
17	Airline_SpiceJet	10682 non-null	uint8
18	Airline_Trujet	10682 non-null	uint8
19	Airline_Vistara	10682 non-null	uint8
20	Airline_Vistara Premium economy	10682 non-null	uint8
21	Source_Chennai	10682 non-null	uint8
22	Source_Delhi	10682 non-null	uint8
23	Source_Kolkata	10682 non-null	uint8
24	Source_Mumbai	10682 non-null	uint8
25	Destination_Cochin	10682 non-null	uint8
26	Destination_Delhi	10682 non-null	uint8
27	Destination_Hyderabad	10682 non-null	uint8
28	Destination_Kolkata	10682 non-null	uint8
29	Destination_New Delhi	10682 non-null	uint8

**Fig6.DataSet Columns After data cleaning**

#### **Phase3: Feature Extraction**

Most of the useful information from the airline dataset that influence ticket prices are extracted at this stage. The following are some potential characteristics:

First, the time and date of the reservation. Second, the time and date of departure.

Third, <sup>14</sup> the number of days till departure; fourth, the age range of travellers; and fifth, the type of cabin they will be travelling in (economy or business).

Characteristic #5: Origin

Point No. 6: The Final Resting Place

Figure 7: Model-Training Features After Extraction.

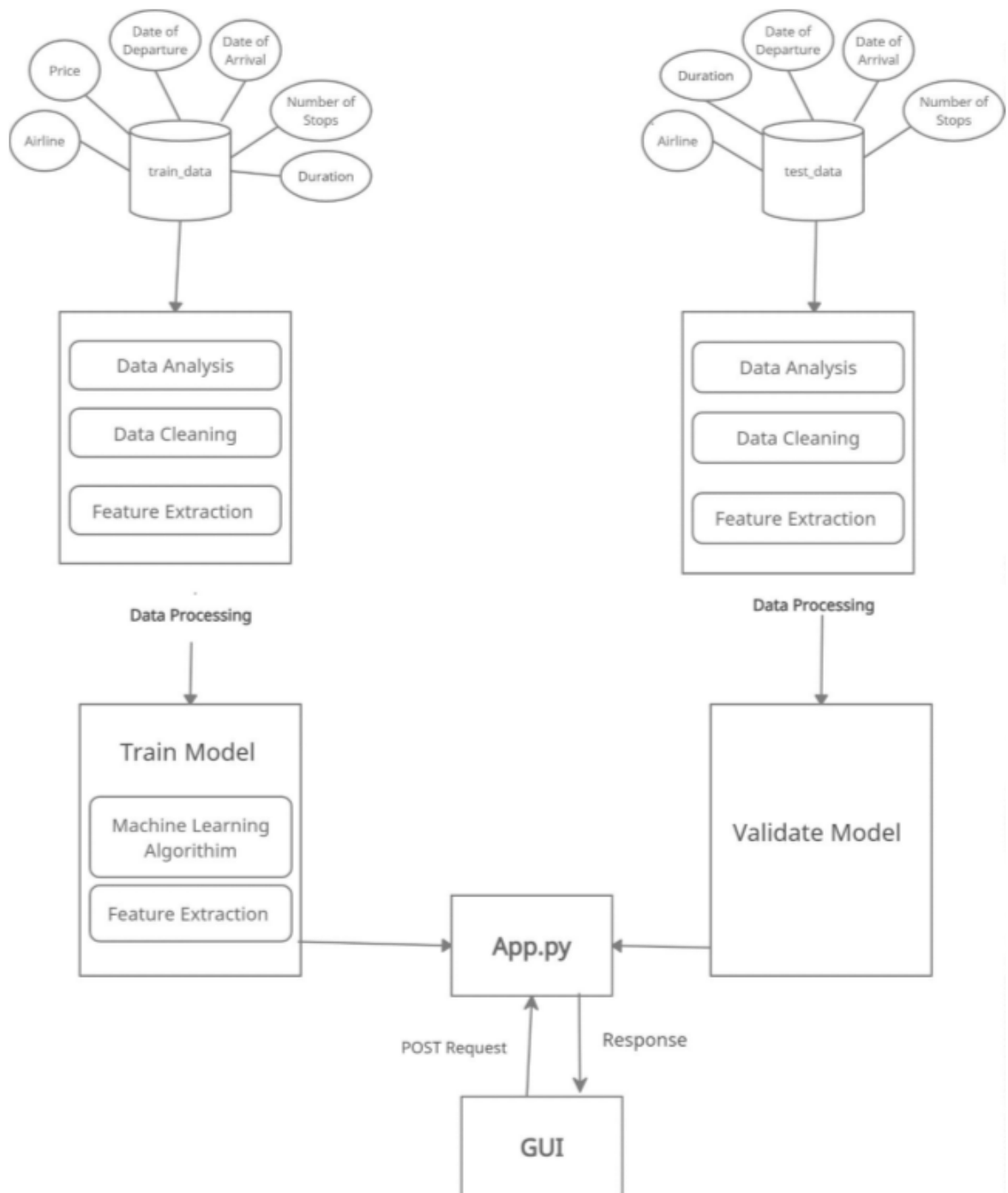
#### Phase4: MachineLearningModelSelection

Machine learning is an area of study that employs statistical methods to enable computers to learn from data sets without being specifically programmed to do so. For accurate prediction, supervised learning algorithms must be trained on sets of data that have been labelled. Our algorithm will be given a labelled dataset to analyse, and from there it will be tasked with making predictions about new incoming data. Thus, a supervised machine learning technique will be employed.

As part of our project, we implemented <sup>31</sup> several machine learning algorithms, including <sup>25</sup> linear regression, decision tree regression, and random forest regression, and we considered the accuracy of our results in light of the informational index we used for testing. Comparing the attainable degrees of accuracy, <sup>4</sup> we find that Random Forest Regression yields the highest levels of precision. We opted for Random Forest Regression in this way, and it is now central to how our User Interface functions.

Algorithms	Accuracy
LinearRegression	0.61
DecisionTree Regression	0.64
RandomForest Regression	0.81

**Table1.AccuracyofdifferentMLAlgorithm**



**Fig7.ArchitectureDiagram**

Improve the model's precision using a variety of cross-validation strategies, including gridsearchCV and randomizedsearchCV. The models' parameters, such the number of trees in a random forest or the maximum depth of a decision tree, can be modified with this method.

Please assist us in improving the precision even more. The trained machine learning model is deployed in the final three phases of the life cycle model. Consequently, we save the most accurate model that we can find to a file using the pickle module. Flask Framework will be used to build the app's back end, where API end points like GET and POST will be set up to handle tasks like data retrieval and display on the app's front end.

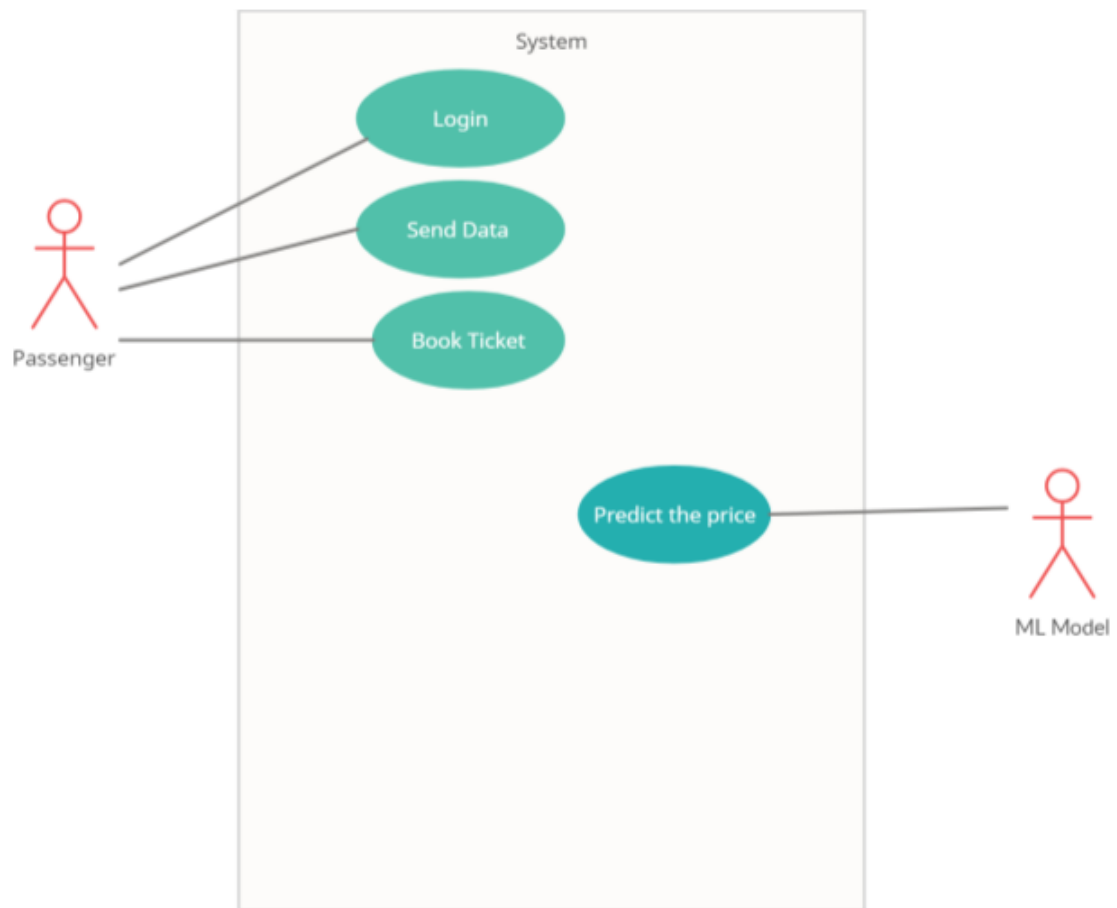
	A	B	C	D	E	F	G	H	I	J	K
1	Airline	Date of Journey	Source	Destination	Route	Dep. Time	Arrival Time	Duration	Total Stops	Additional Info	Price
2	IndiGo	24/03/2019	Banglore	New Delhi	BLR → DEL	22:20	01:10 22 Mar	2h 50m	non-stop	No info	3897
3	Air India	1/05/2019	Kolkata	Banglore	CCU → DKR → BBI → BLR	05:50	13:15	7h 25m	2 stops	No info	7662
4	Jet Airways	9/06/2019	Delhi	Cochin	DEL → UKD → BOM → COK	09:25	04:25 10 Jun	19h	2 stops	No info	13882
5	IndiGo	12/05/2019	Kolkata	Banglore	CCU → NAG → BLR	18:05	23:30	5h 25m	1 stop	No info	6218
6	IndiGo	01/03/2019	Banglore	New Delhi	BLR → NAG → DEL	16:50	21:35	4h 45m	1 stop	No info	13302
7	SpiceJet	24/06/2019	Kolkata	Banglore	CCU → BLR	09:00	11:25	2h 25m	non-stop	No info	3873
8	Jet Airways	12/03/2019	Banglore	New Delhi	BLR → BOM → DEL	18:55	10:25 13 Mar	15h 30m	1 stop	In-flight meal not included	11087
9	Jet Airways	01/03/2019	Banglore	New Delhi	BLR → BOM → DEL	08:00	05:05 02 Mar	21h 5m	1 stop	No info	22270
10	Jet Airways	12/03/2019	Banglore	New Delhi	BLR → BOM → DEL	08:55	10:25 13 Mar	25h 30m	1 stop	In-flight meal not included	11087
11	Multiple carriers	27/05/2019	Delhi	Cochin	DEL → BOM → COK	11:25	19:15	7h 50m	1 stop	No info	8625
12	Air India	1/06/2019	Delhi	Cochin	DEL → BLR → COK	09:45	23:00	13h 15m	1 stop	No info	8907
13	IndiGo	18/04/2019	Kolkata	Banglore	CCU → BLR	20:20	22:55	2h 35m	non-stop	No info	4174
14	Air India	24/06/2019	Chennai	Kolkata	MAA → CCU	11:40	13:55	2h 15m	non-stop	No info	4667
15	Jet Airways	9/05/2019	Kolkata	Banglore	CCU → BOM → BLR	21:50	09:20 10 May	12h 10m	1 stop	In-flight meal not included	9663
16	IndiGo	24/04/2019	Kolkata	Banglore	CCU → BLR	17:15	19:50	2h 35m	non-stop	No info	4804
17	Air India	3/03/2019	Delhi	Cochin	DEL → AMD → BOM → COK	16:40	19:15 04 Mar	26h 35m	2 stops	No info	14011
18	SpiceJet	15/04/2019	Delhi	Cochin	DEL → PNQ → COK	08:45	13:15	4h 30m	1 stop	No info	5830
19	Jet Airways	12/06/2019	Delhi	Cochin	DEL → BOM → COK	14:00	12:35 13 Jun	22h 35m	1 stop	In-flight meal not included	10262
20	Air India	12/06/2019	Delhi	Cochin	DEL → CCU → BOM → COK	20:15	19:15 13 Jun	23h	2 stops	No info	13381
21	Jet Airways	27/05/2019	Delhi	Cochin	DEL → BOM → COK	16:00	12:35 28 May	20h 35m	1 stop	In-flight meal not included	12898

**Fig8SampleTrainingDataset**

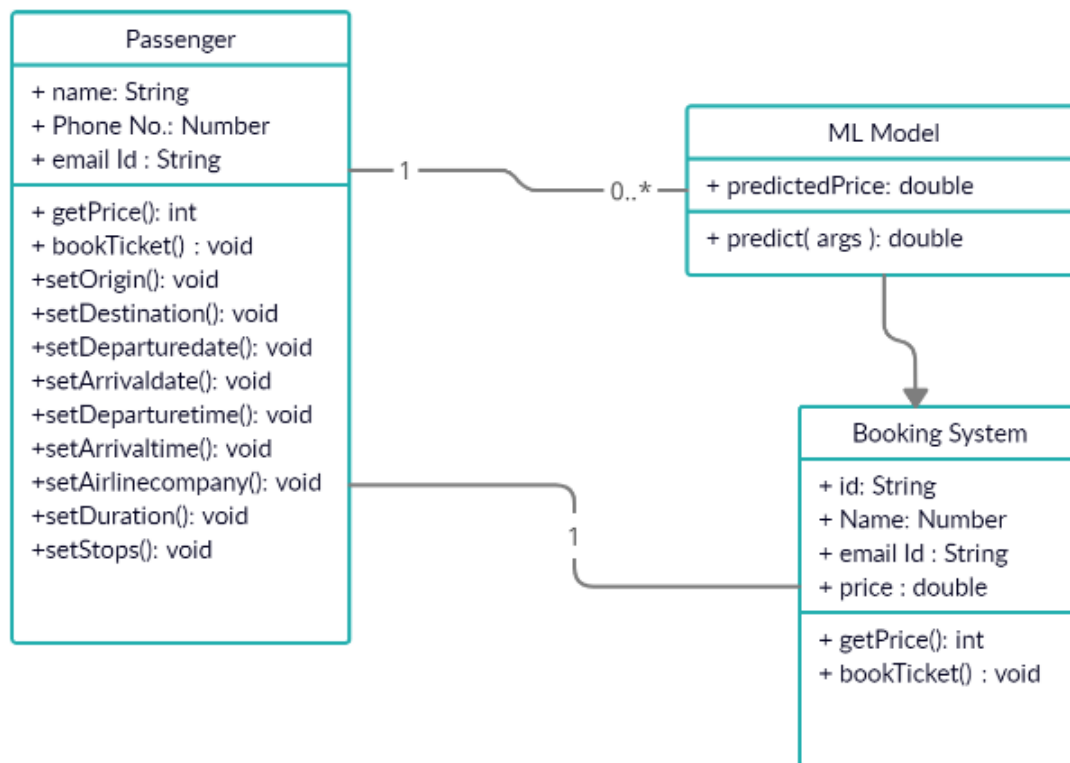
	A	B	C	D	E	F	G	H	I	J
1	Airline	Date of Journey	Source	Destination	Route	Dep Time	Arrival Time	Duration	Total Stops	Additional Info
2	Jet Airways	6/06/2019	Delhi	Cochin	DEL → BO	17:30	04:25 07 Jun	10h 55m	1 stop	No info
3	IndiGo	12/05/2019	Kolkata	Banglore	CCU → MA	05:20	10:20	4h	1 stop	No info
4	Jet Airways	21/05/2019	Delhi	Cochin	DEL → BO	19:15	19:00 22 May	23h 45m	1 stop	In-flight meal not included
5	Multiple c	21/05/2019	Delhi	Cochin	DEL → BO	08:00	21:00	13h	1 stop	No info
6	Air Asia	24/06/2019	Banglore	Delhi	BLR → DE	23:35	02:45 25 Jun	2h 50m	non-stop	No info
7	Jet Airways	12/06/2019	Delhi	Cochin	DEL → BO	18:15	12:35 13 Jun	18h 20m	1 stop	In-flight meal not included
8	Air India	12/06/2019	Banglore	New Delhi	BLR → TR	07:30	22:35	15h 5m	1 stop	No info
9	IndiGo	1/05/2019	Kolkata	Banglore	CCU → HY	15:15	20:30	5h 15m	1 stop	No info
10	IndiGo	15/03/2019	Kolkata	Banglore	CCU → BLU	10:10	12:55	2h 45m	non-stop	No info
11	Jet Airways	18/05/2019	Kolkata	Banglore	CCU → BG	18:30	22:35	6h 5m	1 stop	No info
12	Jet Airways	21/03/2019	Delhi	Cochin	DEL → MA	13:55	18:50 22 Mar	28h 55m	2 stops	In-flight meal not included
13	IndiGo	15/06/2019	Delhi	Cochin	DEL → HY	05:50	10:10	9h 20m	1 stop	No info
14	Multiple c	15/05/2019	Delhi	Cochin	DEL → BO	09:00	19:15	10h 15m	1 stop	No info
15	Jet Airways	12/03/2019	Banglore	New Delhi	BLR → BO	05:45	10:25	4h 40m	1 stop	No info
16	Jet Airways	3/06/2019	Delhi	Cochin	DEL → BO	19:15	12:35 04 Jun	17h 20m	1 stop	In-flight meal not included
17	Jet Airways	06/03/2019	Banglore	New Delhi	BLR → BO	21:35	08:15 07 Mar	10h 50m	1 stop	No info
18	Multiple c	6/06/2019	Delhi	Cochin	DEL → HY	13:15	22:30	9h 15m	1 stop	No info
19	Vistara	24/03/2019	Kolkata	Banglore	CCU → DL	09:55	22:10	12h 15m	1 stop	No info
20	Jet Airways	12/06/2019	Delhi	Cochin	DEL → BO	19:15	04:25 13 Jun	9h 10m	1 stop	In-flight meal not included
21	Jet Airways	12/03/2019	Banglore	New Delhi	BLR → BO	22:35	08:15 13 Mar	9h 20m	1 stop	No info
22	IndiGo	6/03/2019	Delhi	Cochin	DEL → BO	10:45	01:35 07 Mar	14h 50m	1 stop	No info

Fig9 SampleTestingDataset





**Fig 10.UseCase Diagram**



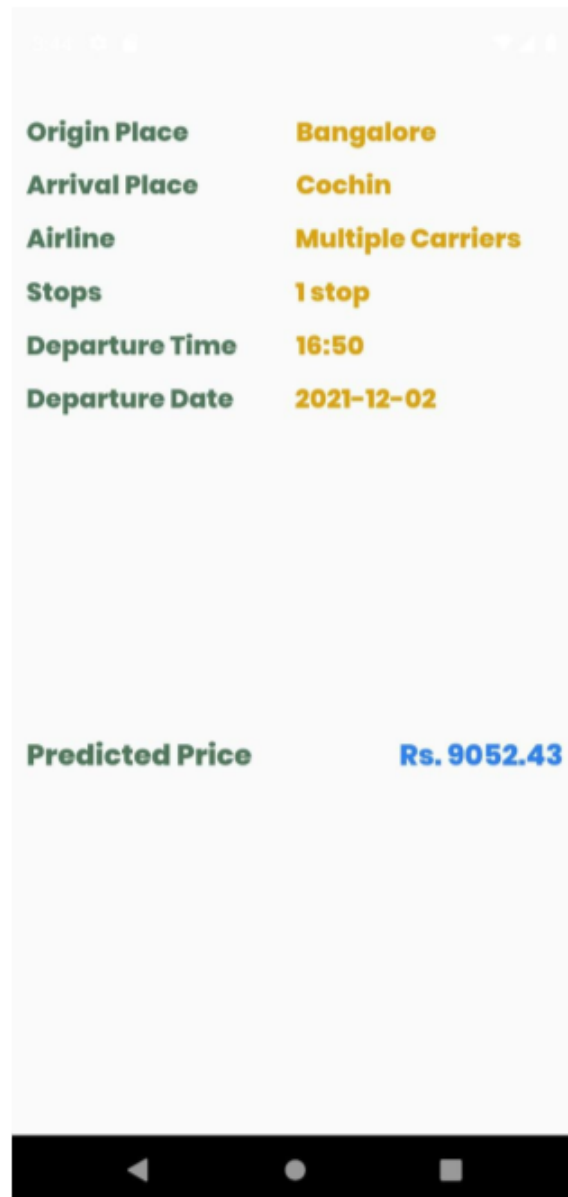
**Fig 11.ClassDiagram**

## Chapter – 4Functionality/WorkingofProject

The screenshot shows a mobile application interface for flight prediction. At the top, there is a green header bar with two options: 'Predict Price' (highlighted in yellow) and 'Book Flight'. Below the header is a white rounded rectangle containing the input fields. The 'FROM' field is set to 'Bangalore' and the 'TO' field is set to 'Cochin'. Below these are fields for 'Departure Date' (2021-12-02), 'Departure Time' (16:50), 'Air Lines' (Multiple Carriers), and 'No. of Stops' (1). At the bottom of the white rectangle is a yellow button labeled 'Check The Price'. The entire app is displayed on a black background with a white status bar at the top showing the time 3:44 and various icons.

**Fig 12.MakePrediction**

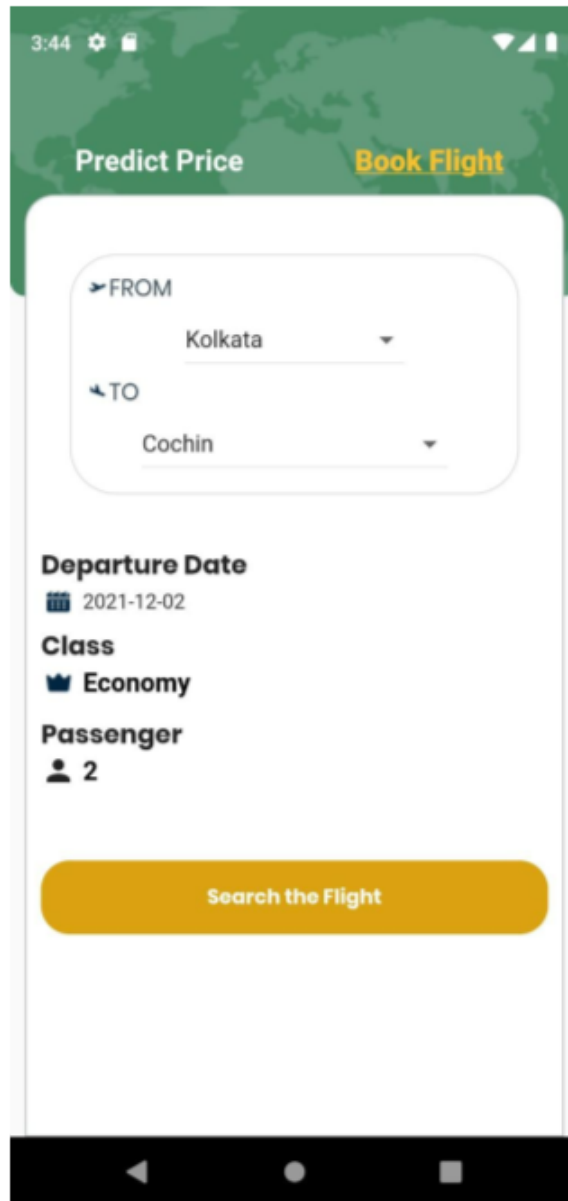
The user inputs information about the flight for which a pricing estimate is being sought. The user enters the desired flight's origin and destination cities, departure date and time, airline, and number of stops.



**Fig 13.PredictionPage**

On this page, you'll see a forecasted price depending on the input you've provided.

<sup>24</sup> The data is fed into a machine learning model, which then makes a prediction about the future value of the asset.



**Fig 14.BookingFlight**

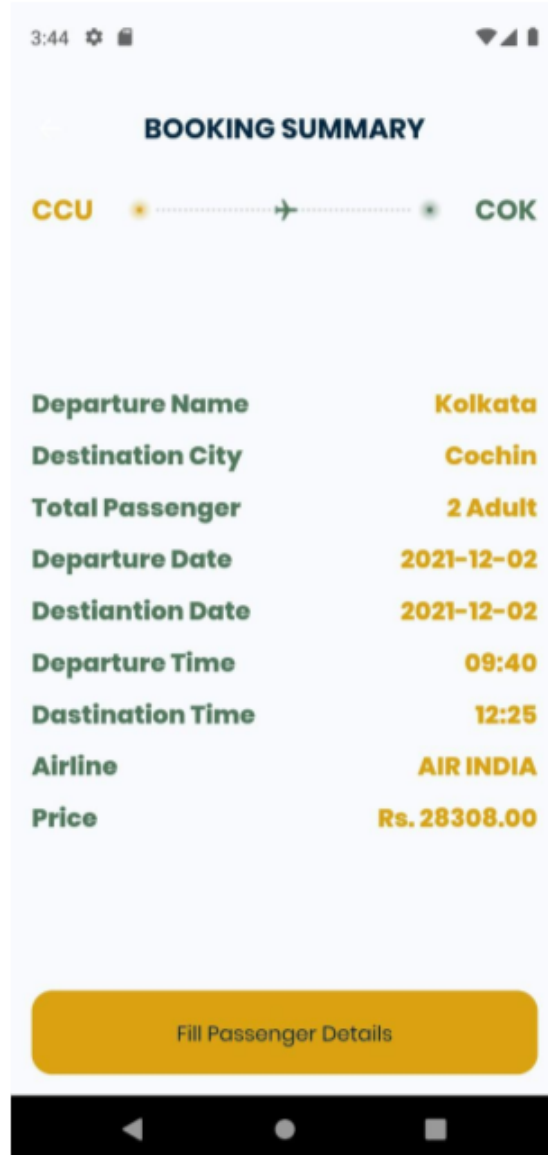
26

You can use this function to look for flights and purchase tickets if you'd rather do so than try to guess the cost of your trip.



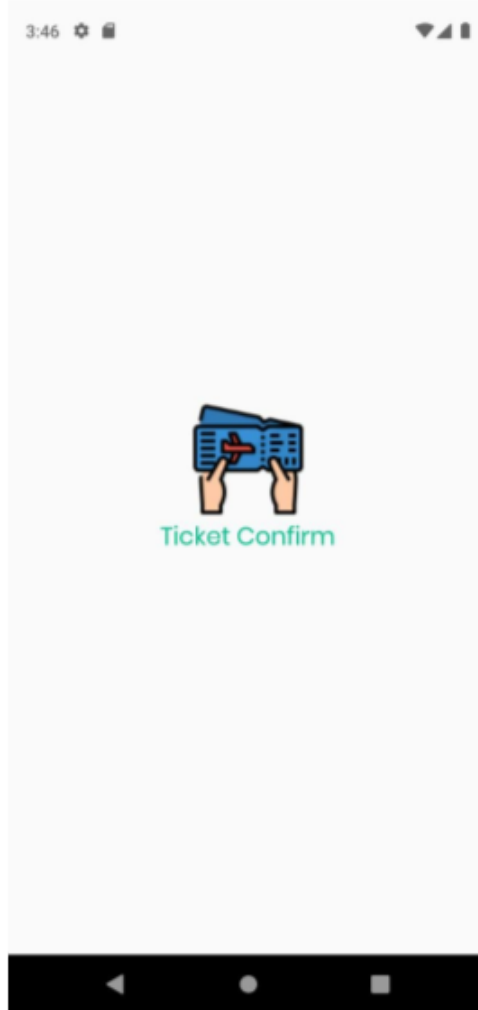
**Fig 15.Flight Result**

Data is transmitted to the Amadeus developer API, which returns flight options. The number of departing flights, the dates and times of those flights, the destinations those flights will fly to, and the airlines that will operate those flights are all displayed.



**Fig16.BookingDetails**

This screen appears after a search has been performed and displays information on the selected flight.



**Fig 17**

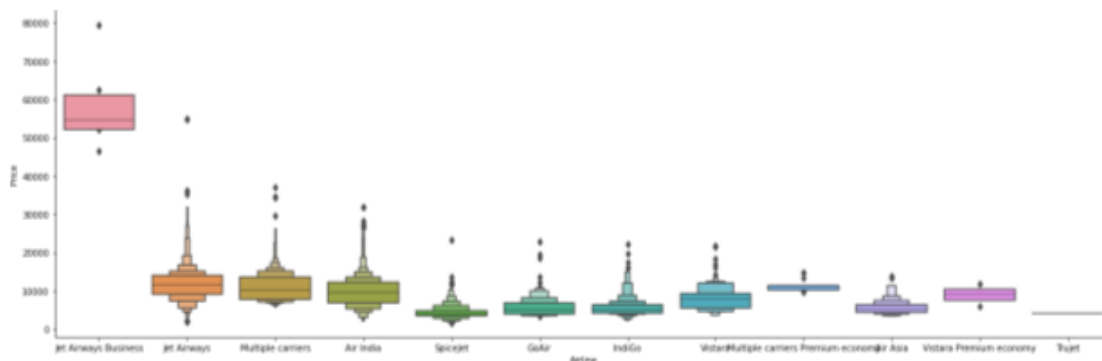
This page notifies the user that their flight ticket is booked.



We used a test data set to evaluate the precision with which various Machine Learning Algorithms, including Linear Regression, Decision Tree Regression, and Random Forest Regression, had predicted outcomes. As we compare the various accuracy levels, we discover that Random Forest Regression provides the best accuracy, at 81%. Thus, we opted for the Random Forest Regression method and built the interface around it.

Algorithms	Accuracy
LinearRegression	0.62
DecisionTreeRegression	0.65
RandomForestRegression	0.81

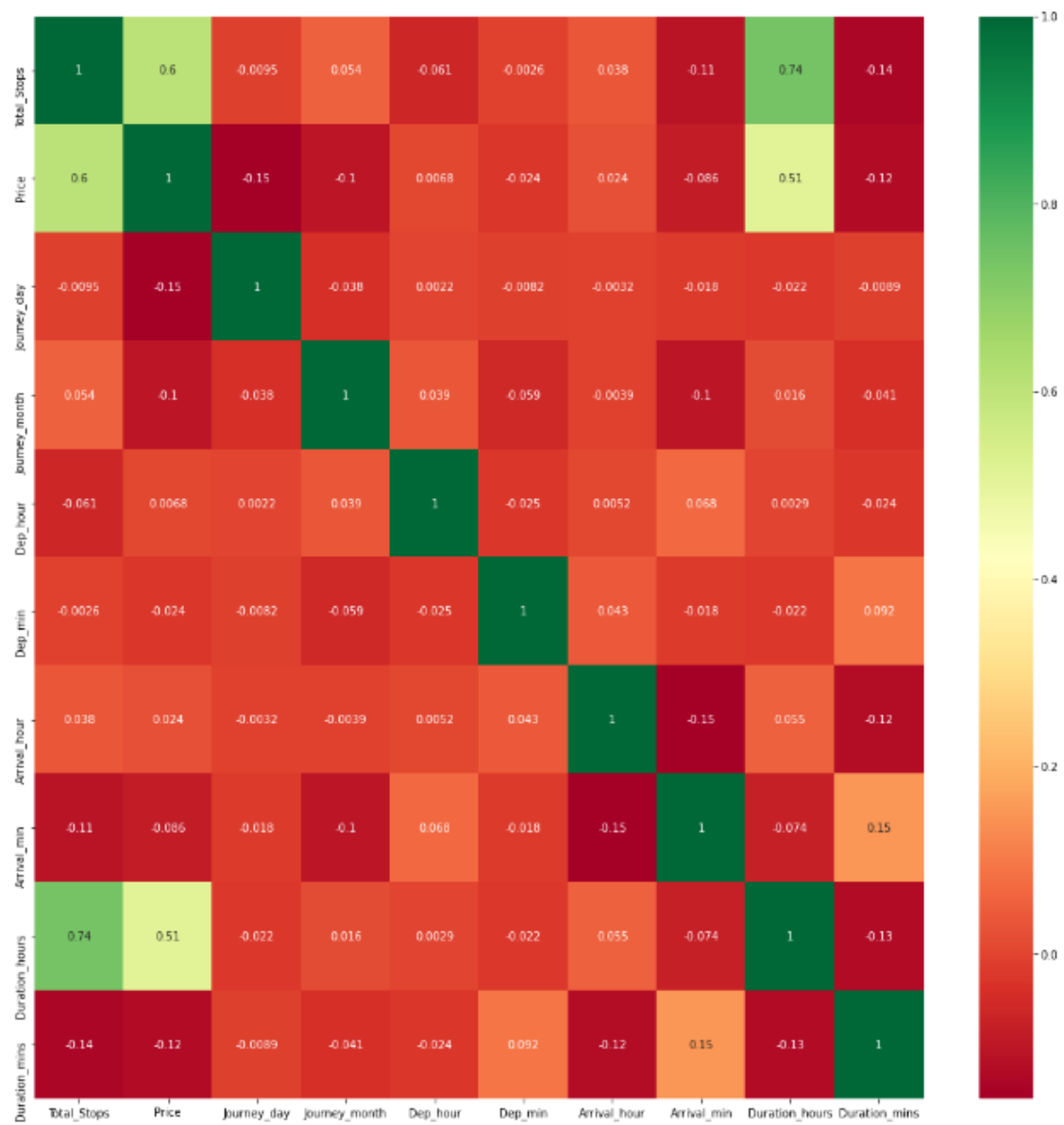
**Table 2.experimentresult**



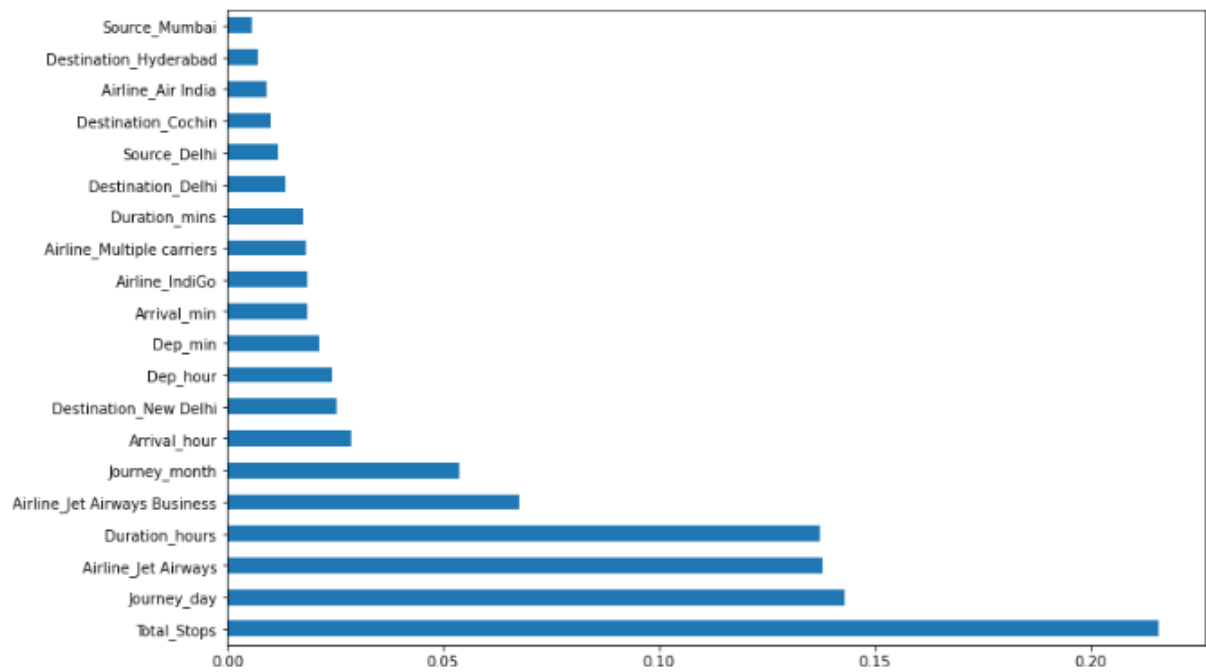
**Fig 18BoxPlotfor Airline VS Price**

Clearly, the airline's brand is significant. The highest price point is found in the "Jet Airways Business" category.

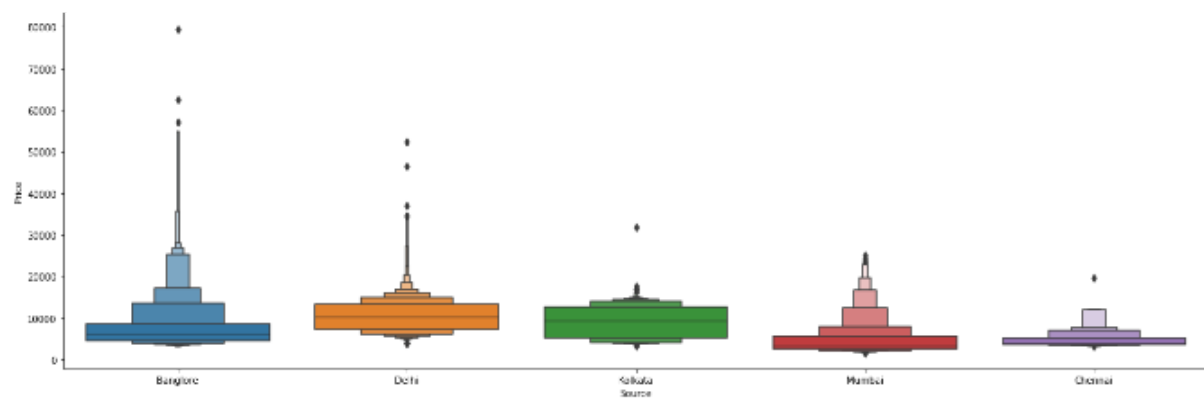
It's important to note that the prices of other airlines are not constant.



**Fig 19Heat Map**



**Fig20ImportanceoftheAttributes**



**Fig 21BoxPlotfor Destination VSPrice**

## 1. The Use of Performance Indicators

The accuracy of the AI models created by different calculations can be reflected upon <sup>45</sup> using performance metrics, which are factual models.

MAE (Mean Absolute Error) (Mean Absolute Error)

The M.A.E. is a statistical measure of how far off the mark the actual values of a quality are from <sup>8</sup> the values that were predicted for it.

$$MAE = 1/n[\Sigma(y-\hat{y})]$$

If your MAE is low, your model is performing well.

MSE (Mean Square Error) (Mean Square Error)

When calculating the mean square error, the difference between the actual and expected value of a result is squared, and then the squared values are added together, rather than just the absolute value.

$$MSE = 1/n[\Sigma(y-\hat{y})^2]$$

Because we are squaring the mistakes, MSE penalises particularly large ones. For optimal model performance, MSE should be as small as possible.

RMSE

The less the value of the root-mean-squared error (RMSE) between different models, the more impressive that model's presentation is. Coefficient of reliability, or R<sup>2</sup>, helps you evaluate how well your free variable tracked model variation.

$$R^2 = 1 - \frac{\Sigma(\hat{y} - \bar{y})^2}{\Sigma(y - \bar{y})^2}$$

R-squared values range from zero to one. In general, the closer its value is to one, the better it is.

Compared to other models, this one is a role model.

We utilised 1000 estimators and 42 random states to build our Random forest regression tree.

Unstructured data, in which dependencies among features are difficult to discover, is a natural fit for this approach.

```
MAE: 1174.2753922793852
MSE: 4360534.11473772
RMSE: 2088.1891951491657
```

## **Fig22.PerformanceMatrix**

### **Limitations:**

There aren't any major negatives to the current setup, although there are restrictions.

a. The system lacks the information necessary for accurate forecasting.

b. It's not quite clear what's going on because the system's accuracy shifts when you switch algorithms, however it only shifts significantly when you take out crucial features..

## ConclusionandSuggestions

### Conclusion

Currently, expectation-based services are used in a wide variety of settings, from stock value indication tools used by stock traders to services like Zestimate, which estimate the market value of a home. As a result, the airline industry needs this kind of service to assist customers in purchasing tickets. <sup>27</sup> Many studies have been conducted on this topic using various methods, and further research is anticipated to improve the accuracy of the expectation using diverse computations. Better, <sup>29</sup> more detailed information can also be used to improve accuracy.

### Suggestions

In the future, we plan to expand our system to include air ticket exchange <sup>42</sup> data, which can provide more information about a specific flight's time and date of takeoff and appearance, seat area, covered auxiliary items, and so on. By combining this data with the current market segment and macroeconomic highlights in our system, we can create a more impressive and thorough Flight Price value forecast model on a daily basis. Unpredictable surges in demand for flights due to extraordinary events can also affect ticket prices in a particular sector of the market. Consequently, we will also compile data on events from additional sources, such as social media platforms and news organisations, to enrich our prediction model. While we focus on improving the existing models by modifying their hyper-boundaries to find the optimal technology for Flight Price value expectation, we will also investigate additional advanced ML models including Deep Learning models.

## REFERENCES

- [1] JaywratSinghChampawat,UdhhavArora,Dr.K.Vijaya,“INDIANFLIGHTFAREPREDICTION:APROPOSAL”
- [2] TianyiWang,SamiraPouyanfar,HaimanTian,YudongTao,MiguelAlonsoJr.,StevenLuisandShu-ChingChen,“AFrameworkforFlight PricePricePrediction:AMachineLearningApproach”
- [3] VinodKimbhaune,HarshilDonga,AsutoshTrivedi,SonamMahajanandVirajMahajan.,“FlightFarePrediction System”
- [4] JibinJoseph,AbhijithP,AryasreeS,JinsuAnnaJoseph,MeghanaSaraOommen,AbinTAbraham“Flight TicketPricePredictingWith theUseof Machine Learning”
- [5] AakankshaV.Jain,AanalS.Raval,RuchiK.Oza,“Flight PricePricePredictionBasedonReviewsUsingMachineLearning Techniques”
- [6] JayaShukla,AditiSrivastava,andAnjaliChauhan,“AirlinePricePredictionusingMachineLearning”
- [7] DominguezMenchero, J.Santo,Reviera,“optimalpurchasetiminginairlinemarkets”,201