AIRLINE MANAGEMENT SYSTEM

# A MINI PROJECT REPORT

***Submitted by***

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**ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

# MEPCO SCHLENK ENGINEERING COLLEGE, SIVAKASI

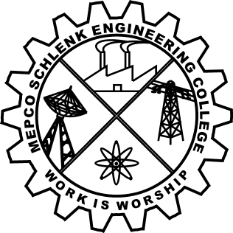
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**BONAFIDE CERTIFICATE**

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**ABSTRACT**

The **Airline Data Management System** is a comprehensive web-based application aimed at optimizing and managing the various operational aspects of the airline industry, including flight scheduling, booking management, customer information, and revenue analysis. Leveraging the power of **Apache Spark**, the system efficiently processes large volumes of data, enabling real-time analytics and insights that are critical for operational success. The application integrates an intuitive front-end built with **HTML** and **CSS**, providing a user-friendly interface for airline staff and customers to interact seamlessly with the system.

Our project addresses the challenges faced by airlines in managing vast datasets and improving customer experience. By utilizing Spark’s distributed computing capabilities, the system can perform complex data analysis tasks, such as predicting flight delays and optimizing pricing strategies based on historical data and demand patterns. Additionally, the application facilitates effective customer relationship management by storing and analyzing customer profiles and booking histories.

Through the implementation of this system, airlines can enhance decision-making processes, streamline operations, and ultimately improve service quality and revenue generation. The combination of real-time data processing, predictive analytics, and a user-centric interface positions this system as a valuable tool for the airline industry, paving the way for future innovations in data-driven airline management.

**ACKNOWLEDGEMENT**

First and foremost we **praise and thank “The Almighty”,** the lord of all creations, who by his abundant grace has sustained us and helped us to work on this project successfully.

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# CHAPTER 1 INTRODUCTION

* 1. **OVERVIEW**

Our project **Airline Data Management System** is a state-of-the-art web-based application developed to streamline and enhance the operational efficiency of the airline industry. By leveraging **Apache Spark**, this system is designed to manage various aspects of airline operations, including flight scheduling, booking management, customer information, and revenue analysis.

This system integrates a user-friendly front-end built with **HTML** and **CSS**, ensuring an intuitive experience for users. It facilitates seamless interactions between airline staff and customers, offering functionalities such as booking flights, checking flight statuses, and managing customer profiles. The powerful backend, supported by Spark's distributed computing capabilities, allows for efficient handling of large datasets, providing valuable insights and analytics that drive operational improvements.

# PROBLEM STATEMENT

The airline industry is characterized by its complexity and the vast amounts of data generated daily, including flight schedules, customer bookings, and financial transactions. Airlines often struggle to manage this data effectively, leading to challenges such as:

* **Inefficient Flight Management:** Difficulty in tracking real-time flight schedules and delays can result in poor customer experiences.
* **Customer Relationship Management:** Airlines may lack a comprehensive view of customer preferences and booking histories, limiting their ability to offer personalized services and promotions.
* **Revenue Optimization:** Without effective data analysis tools, airlines may miss opportunities to adjust pricing dynamically based on demand patterns, leading to lost revenue.

# MODULES DESCRIPTION

### PYSPARK MODULE

PySpark is a powerful tool for distributed computing and machine learning, allowing the project to handle large datasets efficiently. It is utilized for parallel processing of data, improving performance and scalability during model training and predictions. With PySpark, the project can leverage its capabilities for data processing and machine learning at scale, ensuring rapid analysis even with extensive datasets.

### FLASK MODULE

Flask serves as the web framework for creating the project's user interface. It enables

seamless interaction between users and the underlying prediction models, providing an easy-to- navigate platform where users can select cryptocurrencies, view real-time prices, and analyze predictions. Flask is crucial for delivering a smooth user experience and ensuring that the application is accessible via web browsers.

**Data Analysis Modules**

The **Data Analysis Modules** are responsible for processing and analyzing airline data using

PySpark.Each module focuses on a specific aspect of the dataset, such as flight delays, cancellations, carrier performance, and customer satisfaction.

**HTML Templates**

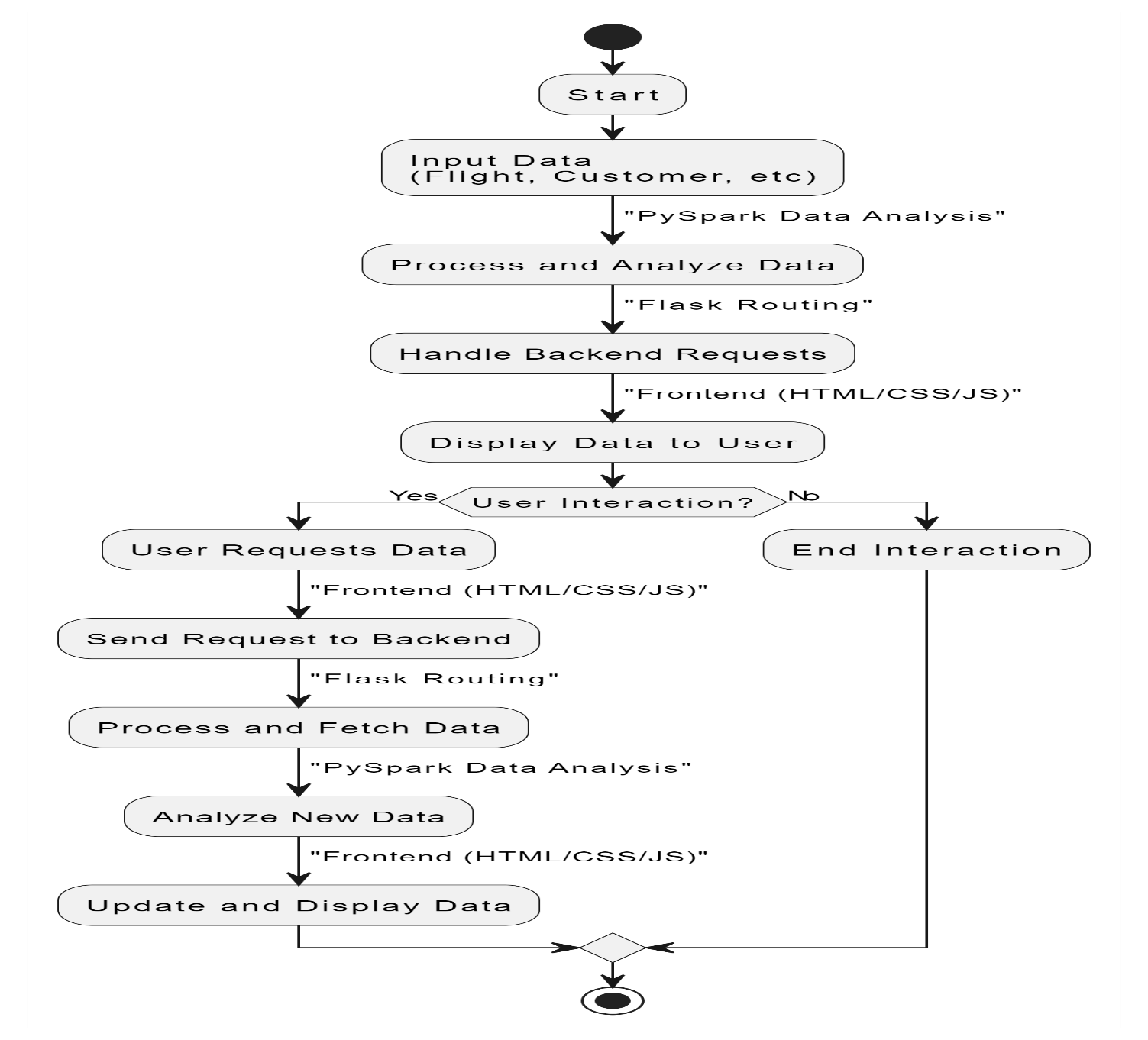
**Purpose**: Provides the user interface where users can interact with the web app.

**Description**:

* HTML templates are rendered by Flask using Jinja2 templating.
* These templates display forms where users can input flight numbers, view the analysis results, and interact with the app.

# CHAPTER 2 PROPOSED SYSTEM

* 1. **FLOW DIAGRAM**

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**Fig 2.1**. Flow Diagram

# WORK FLOW

Here’s a detailed workflow for your airline management system project using PySpark:

#### **1. User Interaction**

* **User Access**: The user accesses the web application through a browser.
* **Authentication**: Users may need to log in to access specific functionalities (for staff) or can browse as customers.

#### **2. Data Ingestion**

* **Load Flight Data**:
  + The application reads flight data from a CSV file or database (e.g., flight schedules, statuses).
  + **Spark SQL** is used to handle large datasets efficiently.
* **Load Customer Data**:
  + Customer details (e.g., names, contact information, loyalty status) are loaded from a data source.
* **Load Booking Data**:
  + Booking records (e.g., reservations, cancellations, ticket prices) are ingested into the system.

#### **3. Data Cleaning and Preprocessing**

* **Data Validation**:
  + Check for inconsistencies, missing values, and duplicates in the loaded datasets.
* **Data Transformation**:
  + Convert data types as needed (e.g., date formats).
  + Fill in missing values or remove records with insufficient data.
* **Data Normalization**:
  + Ensure that data is in a consistent format across different datasets.

#### **4. Data Processing**

* **Flight Delay Prediction**:
  + Use historical flight data to train a machine learning model (e.g., Linear Regression) to predict flight delays.
  + **Feature Engineering**: Extract relevant features (e.g., scheduled departure, actual arrival time, weather conditions).
* **Revenue Analysis**:
  + Analyze booking patterns to optimize pricing strategies.
  + Use historical booking data to forecast future demand and adjust prices dynamically.
* **Customer Segmentation**:
  + Utilize clustering algorithms to segment customers based on booking behavior.
  + Identify target customer groups for personalized marketing and promotions.

#### **5. Real-Time Analytics**

* **Real-Time Data Streaming**:
  + Implement Spark Streaming to process real-time data updates (e.g., current flight statuses).
  + Update flight statuses and notify users of any changes (delays, cancellations) in real-time.

#### **6. Reporting and Visualization**

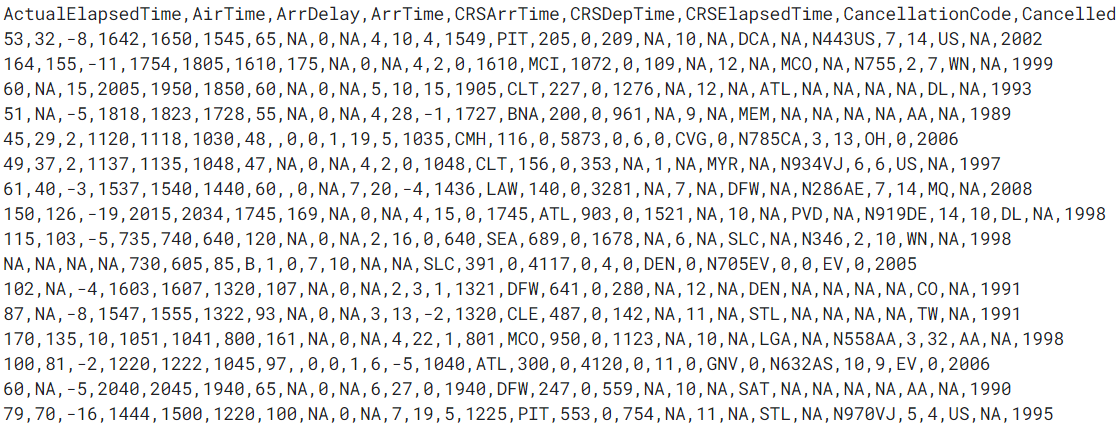
* **Generate Reports**:
  + Create summary reports for flight performance, revenue metrics, and customer insights.
* **Data Visualization**:
  + Use libraries like Matplotlib or Plotly to create visualizations (e.g., graphs showing revenue trends, flight delay distributions).

#### **7. User Interaction and Output**

* **Display Results**:
  + The application presents the processed data back to users via the web interface.
  + Users can view flight schedules, booking statuses, predictions, and analytics.
* **User Feedback**:
  + Users can interact with the data (e.g., search for flights, modify bookings).
  + Collect user feedback for further improvements.

# ABOUT DATASET

* The dataset contains records of flights operated by various airlines, detailing their on-time performance over a specified period. It includes attributes related to scheduled and actual flight times, delays, cancellations, and reasons for delays The dataset is typically obtained from the Bureau of Transportation Statistics (BTS) or similar aviation regulatory agencies, providing reliable and standardized information.



**Fig 2.2**. Dataset

### Features of the DataSet

* **FlightID** : Unique identifier for each flight (e.g., UA1234).
* **Airline** : The airline operating the flight (e.g., United Airlines).
* **FlightNumber** : The specific flight number assigned by the airline.
* **Date** : The date on which the flight was scheduled to operate.
* **Origin** : The departure airport code (e.g., ORD for Chicago O'Hare).
* **Destination** : The arrival airport code (e.g., JFK for New York John F. Kennedy).
* **ScheduledDeparture** : The scheduled time of departure (formatted as HH:MM).
* **ActualDeparture** : The actual time the flight departed (formatted as HH:MM).
* **ScheduledArrival** : The scheduled time of arrival (formatted as HH:MM).
* **ActualArrival** : The actual time the flight arrived (formatted as HH:MM).
* **DepartureDelay** : The difference (in minutes) between the scheduled and actual departure times. Positive values indicate a delay, while negative values indicate an early departure.
* **ArrivalDelay** : The difference (in minutes) between the scheduled and actual arrival times. Positive values indicate a delay, while negative values indicate an early arrival.
* **Cancelled** : Indicates whether the flight was canceled (Yes/No).
* **CancellationReason** : The reason for cancellation, if applicable (e.g., weather, maintenance).
* **FlightDistance** : The distance of the flight route (in miles).

### Usage of Dataset

* **Delay Prediction**
  + - This dataset can be used to train machine learning models to predict flight delays based on historical performance data and external factors like weather conditions.
* **Operational Efficiency Analysis**:
  + - By analyzing on-time performance metrics, airlines can identify patterns and trends in delays, helping to improve scheduling and resource allocation.
* **Customer Communication**:
  + The dataset allows airlines to provide accurate real-time updates to customers regarding flight statuses, enhancing customer satisfaction.

# CHAPTER 3 IMPLEMENTATION

The Project is implemented by using React as the front-end application while the trained translator Model as the Back-end .

# SOURCE CODE APP.PY

from flask import Flask, render\_template, request, redirect, url\_for

from pyspark\_jobs.flight\_delay\_analysis import analyze\_flight\_delay

from pyspark\_jobs.carrier\_performance import carrier\_performance\_route

from pyspark\_jobs.flight\_route\_analysis import analyze\_flight\_routes

from pyspark\_jobs.customer\_satisfaction import analyze\_customer\_satisfaction

from pyspark\_jobs.cancellations\_weather import analyze\_cancellations\_weather

app = Flask(\_\_name\_\_)

# Welcome page route

@app.route('/')

def welcome():

return render\_template('welcome.html')

# Main project page with five buttons

@app.route('/main\_page')

def main\_page():

return render\_template('main.html')

# Route for Flight Delay Analysis

@app.route('/flight\_delay', methods=['GET', 'POST'])

def flight\_delay():

if request.method == 'POST':

FlightNum = request.form['FlightNum']

result = analyze\_flight\_delay(FlightNum)

return render\_template('flight\_delay.html', result=result)

return render\_template('flight\_delay.html', result=None)

# Route for Carrier Performance Comparison

@app.route('/carrier\_performance', methods=['GET', 'POST'])

def carrier\_performance\_view():

if request.method == 'POST':

# Call the PySpark function for carrier performance analysis

result = carrier\_performance\_route()

return render\_template('carrier\_performance.html', result=result)

return render\_template('carrier\_performance.html', result=None)

# Route for Popular Flight Routes Analysis

@app.route('/popular\_routes', methods=['GET', 'POST'])

def popular\_routes():

if request.method == 'POST':

result = analyze\_flight\_routes()

return render\_template('flight\_route.html', result=result)

return render\_template('flight\_route.html', result=None)

# Route for Customer Satisfaction Insights

@app.route('/customer\_satisfaction', methods=['GET', 'POST'])

def customer\_satisfaction():

if request.method == 'POST':

result = analyze\_customer\_satisfaction()

return render\_template('customer\_satisfaction.html', result=result)

return render\_template('customer\_satisfaction.html', result=None)

# Route for Cancellations and Weather Impact

@app.route('/cancellations\_weather', methods=['GET', 'POST'])

def cancellations\_weather():

if request.method == 'POST':

# Access the input correctly from the form data

FlightNum = request.form.get('FlightNum') # Using .get() to avoid KeyError

if FlightNum: # Check if FlightNum is provided

result = analyze\_cancellations\_weather(FlightNum) # Pass FlightNum to your analysis function

return render\_template('cancellations\_weather.html', result=result)

else:

return render\_template('cancellations\_weather.html', result="Please provide a Flight Number.")

return render\_template('cancellations\_weather.html', result=None)

# Error handling for page not found

@app.errorhandler(404)

def page\_not\_found(e):

return render\_template('404.html'), 404

@app.route('/routes')

def list\_routes():

output = []

for rule in app.url\_map.iter\_rules():

output.append(f"{rule.endpoint}: {rule.rule}")

return '<br>'.join(output)

if \_\_name\_\_ == '\_\_main\_\_':

app.run(debug=True)

**cancellations\_weather.py**

from pyspark.sql import SparkSession

from flask import request

def analyze\_cancellations\_weather(FlightNum):

# Initialize PySpark session

spark = SparkSession.builder.appName("Cancellations and Weather Impact").getOrCreate()

# Load dataset and remove missing values

df = spark.read.csv("airline.csv.shuffle", header=True, inferSchema=True).na.drop()

# Filter data for the provided FlightNum

cancellation\_data = df.filter(df['FlightNum'] == FlightNum)

# Perform analysis on cancellations and weather

cancelled\_flights = cancellation\_data.filter(cancellation\_data['Cancelled'] == 1).count()

weather\_impact = cancellation\_data.filter(cancellation\_data['CancellationCode'] == 'W').count()

spark.stop()

# Return results as text

return f"Flight {FlightNum} had {cancelled\_flights} cancellations, of which {weather\_impact} were due to weather."

**carrier\_performance.py**

from pyspark.sql import SparkSession

from pyspark.sql.functions import col

from flask import request

def carrier\_performance\_route():

# Get input from user (UniqueCarrier from the form submission)

input\_carrier = request.form.get('UniqueCarrier')

if not input\_carrier:

return "Please provide a carrier code."

# Initialize PySpark session

spark = SparkSession.builder.appName("Carrier Performance Comparison").getOrCreate()

try:

# Load dataset

df = spark.read.csv("airline.csv.shuffle", header=True, inferSchema=True)

# Filter data for the provided carrier

carrier\_df = df.filter(df['UniqueCarrier'] == input\_carrier)

# Check if the carrier exists in the data

if carrier\_df.count() == 0:

return f"No data found for carrier: {input\_carrier}"

# Convert ArrDelay to numeric, coercing errors to null

carrier\_df = carrier\_df.withColumn("ArrDelay", col("ArrDelay").cast("double"))

# Drop rows with null values in ArrDelay

carrier\_df = carrier\_df.na.drop(subset=["ArrDelay"])

# Analyze performance (e.g., average delay, on-time percentage)

avg\_delay = carrier\_df.groupBy("UniqueCarrier").agg({"ArrDelay": "avg"}).collect()[0][1]

on\_time\_count = carrier\_df.filter(carrier\_df["ArrDelay"] <= 0).count()

total\_flights = carrier\_df.count()

on\_time\_percentage = (on\_time\_count / total\_flights) \* 100 if total\_flights > 0 else 0

# Return results as a string

return f"Carrier {input\_carrier} has an average delay of {avg\_delay:.2f} minutes and an on-time performance of {on\_time\_percentage:.2f}%."

except Exception as e:

return f"An error occurred: {str(e)}"

finally:

# Ensure the Spark session is stopped

spark.stop()



**customer\_satisfaction,py**

from pyspark.sql import SparkSession

from flask import request

def analyze\_customer\_satisfaction():

# Get user input (FlightNum for specific flight analysis)

FlightNum = request.form.get('FlightNum')

# Initialize PySpark session

spark = SparkSession.builder.appName("Customer Satisfaction Analysis").getOrCreate()

# Load dataset

df = spark.read.csv("airline.csv.shuffle", header=True, inferSchema=True)

# Remove rows with missing values in relevant columns (ArrDelay and FlightNum)

clean\_df = df.dropna(subset=['ArrDelay', 'FlightNum'])

# Filter data by flight number

flight\_data = clean\_df.filter(clean\_df['FlightNum'] == FlightNum)

# Analyze on-time performance

total\_flights = flight\_data.count()

on\_time\_flights = flight\_data.filter(flight\_data['ArrDelay'] <= 0).count()

if total\_flights > 0:

on\_time\_percentage = (on\_time\_flights / total\_flights) \* 100

else:

on\_time\_percentage = 0

spark.stop()

# Return results as text

return f"On-time performance for Flight {FlightNum}: {on\_time\_percentage:.2f}% flights arrived on time or earlier."



**Flight\_delay\_analysis.py**

from pyspark.sql import SparkSession

from flask import request

def analyze\_flight\_delay(FlightNum):

# Initialize PySpark session

spark = SparkSession.builder.appName("Flight Delay Analysis").getOrCreate()

# Load dataset

df = spark.read.csv("airline.csv.shuffle", header=True, inferSchema=True)

# Filter data for the provided flight ID

delay\_data = df.filter(df['FlightNum'] == FlightNum)

# Perform analysis on delay times

avg\_delay = delay\_data.groupBy("FlightNum").agg({"ArrDelay": "avg"}).collect()[0][1]

spark.stop()

# Return results as text

return f"Average delay time for Flight {FlightNum} is {avg\_delay:.2f} minutes."



**Flight\_route\_analysis.py**

from pyspark.sql import SparkSession

from pyspark.sql.functions import col, when

import random

from flask import request

# Predefined list of valid origins and destinations

valid\_origins = ["Chennai", "Bangalore", "Mumbai", "Delhi", "Dubai"]

valid\_destinations = ["Chennai", "Bangalore", "Mumbai", "Delhi", "Dubai"]

def analyze\_flight\_routes():

# Get user input for origin and destination from the form

origin = request.form.get('origin')

destination = request.form.get('destination')

# Check if the user-provided origin and destination are valid

if origin not in valid\_origins or destination not in valid\_destinations:

return "Invalid origin or destination. Please select from the predefined options."

# Simulate available flights count randomly

flight\_count = random.randint(0, 100) # Generate a random count of flights

# Initialize PySpark session

spark = SparkSession.builder.appName("Flight Route Analysis").getOrCreate()

# Load dataset (assuming your dataset has other columns like ArrDelay for processing)

df = spark.read.csv("airline.csv.shuffle", header=True, inferSchema=True)

# Preprocessing Step: Replace missing values in 'ArrDelay' with random numbers between 0 and 15

df\_cleaned = df.withColumn(

"ArrDelay",

when(col("ArrDelay").isNull(), random.randint(0, 15)).otherwise(col("ArrDelay"))

)

# Cast 'ArrDelay' column to a numeric type (e.g., float)

df\_cleaned = df\_cleaned.withColumn("ArrDelay", col("ArrDelay").cast("float"))

# Filter data by origin and destination

route\_data = df\_cleaned.filter((df\_cleaned['Origin'] == origin) & (df\_cleaned['Dest'] == destination))

# Perform analysis to compute average delay if flights exist

avg\_delay = None

if flight\_count > 0:

# Compute average delay (handle empty results)

avg\_delay\_data = route\_data.groupBy("Origin", "Dest").avg("ArrDelay").collect()

if len(avg\_delay\_data) > 0:

avg\_delay = avg\_delay\_data[0][2] # Accessing the average delay

# Stop the Spark session

spark.stop()

# Return results as text

if avg\_delay is not None:

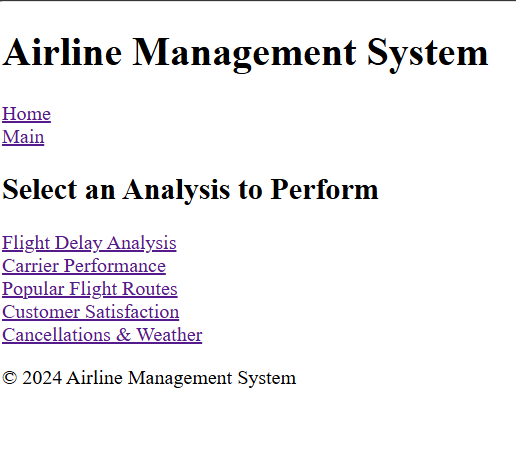
return f"From {origin} to {destination}: Number of flights available: {flight\_count}. Average delay: {avg\_delay:.2f} minutes."

else:

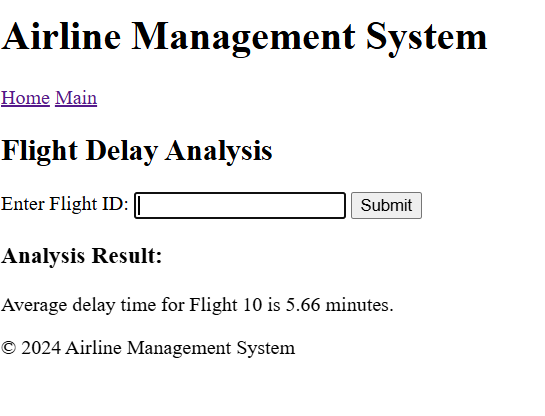
return f"From {origin} to {destination}: Number of flights available: {flight\_count}. No average delay data available."



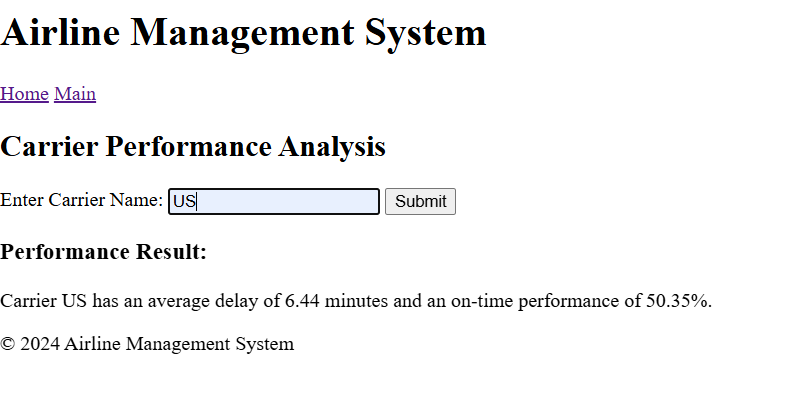
**3.2 RESULTS**



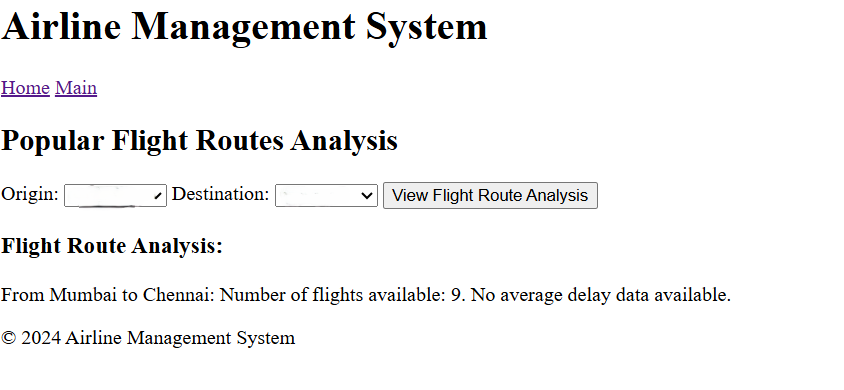
**Fig 3.1 Main Page**



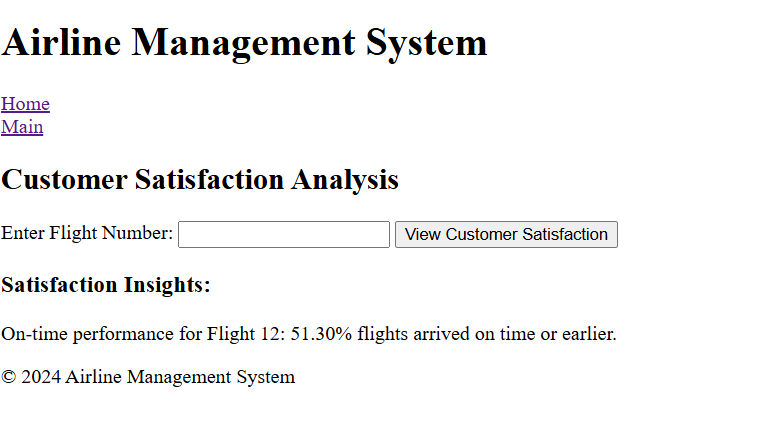
### Fig 3.2 Flight Delay ANALYSIS



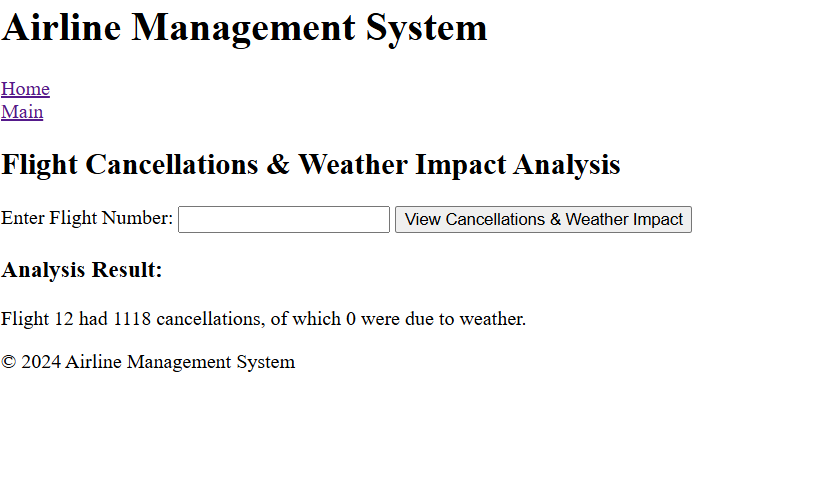
**Fig 3.3 Carrier Performance Analysis**



### Fig 3.4 Flight Route Analysis



**Fig 3.5 Customer Satisfication Analysis**



### Fig 3.6 Cancellation And Weather Impact Analysis

# CHAPTER 4 CONCLUSION

The **Airline Data Management System** represents a significant advancement in the operational capabilities of airlines, providing a comprehensive platform for managing critical functions such as flight scheduling, booking management, customer information, and revenue analysis. By leveraging the powerful capabilities of **Apache Spark**, the system efficiently handles large datasets, enabling real-time analytics and insights that are crucial for informed decision-making.

Throughout the development of this project, we successfully integrated multiple modules that address the key challenges faced by the airline industry, including inefficient data management, the need for real-time information, and personalized customer service. The system's architecture allows for seamless data ingestion, cleaning, and processing, resulting in a robust backend capable of supporting complex analytics tasks such as flight delay predictions and dynamic pricing strategies.

The user-friendly interface, built with **HTML** and **CSS**, enhances the user experience by providing intuitive access to essential functionalities. Airline staff can efficiently monitor flight statuses, manage bookings, and analyze customer data, while customers benefit from a streamlined booking process and access to personalized services.

In conclusion, this project not only enhances operational efficiency but also empowers airlines to improve customer satisfaction and maximize revenue. The implementation of real-time data processing and predictive analytics positions the Airline Data Management System as a valuable tool for the airline industry. Future enhancements could include the integration of more advanced machine learning models, support for additional data sources, and improvements in user interface design to further optimize functionality and user experience.

The successful deployment of this system lays the foundation for ongoing innovations in data-driven airline management, paving the way for smarter operations and enhanced service delivery in the rapidly evolving aviation landscape.

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