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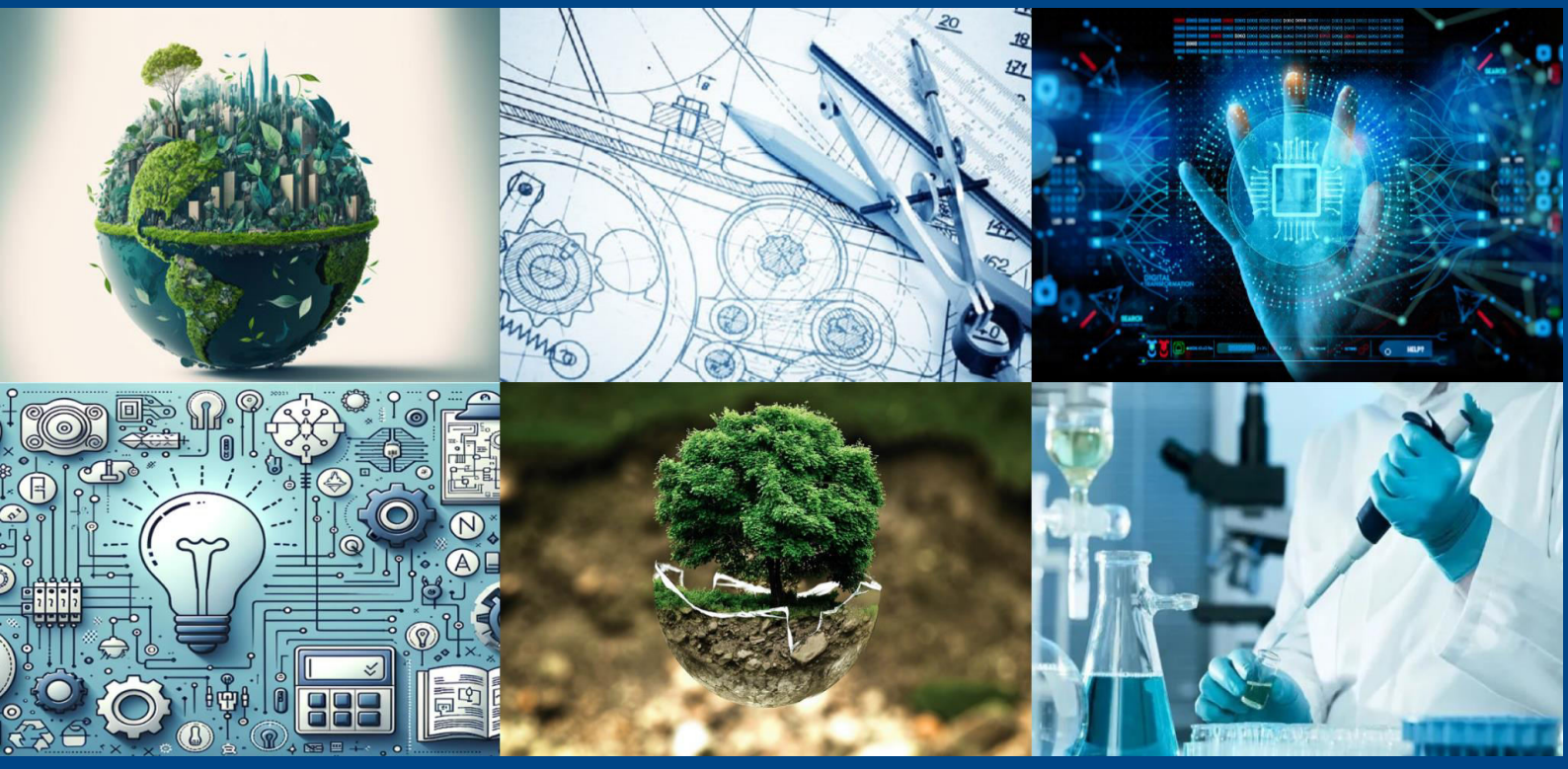

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Flight Delay Prediction System Using Machine Learning

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ABSTRACT: Flight delays are a significant challenge in the aviation industry, affecting airlines,passengers, and airport operations. This project presents a Flight Delay Prediction System thatutilizes machine learning to predict potential delays based on various factors, including airline,origin, destination, aircraft type, scheduled departure time, and distance.The system integrates XGBoost, a powerful gradient boosting algorithm, trained onhistorical flight data. To enhance accuracy,categorical variables such as airline names andairport codes are encoded safely to handle unseen valuesdynamically. Additionally, real-timeflight status information is retrieved using the Aviationstack API, allowing users to check thelive status of flights.A Flask-based web application serves as the frontend, providing an intuitive userinterface where users can input flight details and obtain delay predictions. The interface alsoincludes a "Check Flight Status" feature that redirects users to a dedicated status page, Keywords: Flight Delay Prediction , Machine LearningXGBoos , Gradient Boosting Algorithm , Historical Flight Data Categorical Encoding.

I. INTRODUCTION

Air travel plays a crucial role in global connectivity, supporting business operations,tourism, and trade. However, flight delays remain a significant challenge, affecting airlines,passengers, and airport authorities. Delays can be caused by various factors, including weatherconditions, air traffic congestion, technical malfunctions, and operational inefficiencies.Predicting flight delays accurately can help mitigate disruptions, improve scheduling, andenhance the overall travel experience. This project, Flight Delay Prediction System, leverages Machine Learning (ML)techniques to forecast flight delays based on historical and real-time data. By analyzing keyflight parameters such as airline information, origin and destination airports, aircraft type,scheduled time, and weather conditions, the system aims to provide reliable delay predictions. The project integrates data from various sources, including the Aviationstack API andOpenSky API, to fetch live flight information. Additionally, XGBoost, a powerful MLalgorithm, is utilized for predictive modeling. The system also features a user-friendly Flask-based web application, allowing users to input flight details and receive delay predictions inreal time.

II. SYSTEM OVERVIEW

System Components: The system consists of the following key components:1 User Interface (UI): Developed using HTML, CSS, and Flask templates for interactive and user-friendly access. Accepts user inputs such as airline name, origin, destination, aircraft type,scheduled time, and distance. 2. Backend (Flask Framework): Handles user requests and processes inputs. Communicates with the machine learning model to generate flight delaypredictions. Fetches real-time flight status from the Aviationstack API. 3. Machine Learning Model: Uses XGBoost for flight delay prediction based on historical data. Categorical data (airline, origin, destination, aircraft type) is encoded usingLabel Encoding. The trained model is loaded via Joblib for real-time predictions. 4. Database (Optional for Future Enhancements): Can store flight records, user inputs, and historical delay data. Currently,the system processes data dynamically without a persistent database.5. External API Integration: The Aviationstack API retrieves real-time flight status based on airline and flight details. System Workflow he user enters flight details on the web interface. The backend processes inputs and encodes categorical values. If predicting a delay, the system applies the trained XGBoost model. If checking flight status, the system queries the Aviationstack API.The result (predicted delay or flight status) is displayed on the UI.

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III. LITERATURE REVIEW

Flight delay prediction is a critical area of research in aviation, aiming to enhanceoperational efficiency and passenger experience. Various studies have explored differentapproaches, including statistical models, machine learning, and deep learning techniques, topredict delays accurately. Several machine learning models such as Decision Trees, Random Forest,SupportVector Machines (SVM), and XGBoost have been widely used for delay prediction. Studiesindicate that XGBoost outperforms traditional models due to its ability to handle large datasetsefficiently. Researchers have also incorporated weather conditions, airport congestion, andairline schedules as key factors influencing delays.

IV. SYSTEM REQUIREMENT

System analysis involves examining the functional and non-functional requirements ofthe flight delay prediction system. This phase ensures that the system meets user expectationsand performs efficiently under various conditions.

Functional Requirements
The system is designed to perform the following functions:
Accept user input (airline, origin, destination, aircraft type, scheduled time, anddistance). Encode categorical data safely using label encoding.

Predict flight delays using a machine learning model (XGBoost). Fetch real-time flight status from Aviationstack API. Display prediction results and live status on the user interface.
Non-Functional Requirements

- Accuracy: The prediction model should achieve high precision in delay forecasting.
- Performance: The system should provide results within seconds to ensure smooth user experience.
- Scalability: Should support future enhancements like deep learning integration or additional APIs.
- Security: Protects user data and API access through secure authentication methods. Usability: The interface should be simple, responsive, and easy to navigate for all users.

System Architecture
The system follows a three-tier architecture:
Frontend: Built using Flask and HTML/CSS, allowing users to input data and view predictions.Backend: Implements Python with Flask to process inputs, handle model predictions, and fetch live flight data. Database & APIs: Uses Aviationstack API and a trained machine learning model stored with Joblib.management.

V. CONCLUSION

The Flight Delay Prediction System successfully integrates machine learning models and real-time flight data to predict delays and provide live flight status updates. The system was developed using Flask for the web interface, machine learning for delay predictions, and the Aviation stack API for real-time flight tracking. Key Achievements: Accurate Delay Prediction: The model effectively forecasts potential flight delays based on historical data. Real-time Flight Tracking: Integration with the Aviation stack API allows users to check live flight statuses. User-friendly Interface: The web-based application is intuitive and easy to navigate Limitations & Future Enhancements: The model's accuracy can be further improved by incorporating real-time weather conditions and airport congestion data. Enhancing the system to support mobile applications can increase accessibility. Future versions could implement AI-driven recommendations for alternative flight options in case of severe delays. In conclusion, the Flight Delay Prediction System is a significant step toward enhancing passenger experience and airline operations by providing predictive insights and real-time information.

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