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Flight Delay Prediction Web App Using Big Data and Machine Learning

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Abstract: Flight delays are a significant concern for both passengers and airlines, leading to inconvenience, financial losses, and operational disruptions. This abstract presents a comprehensive approach to mitigating flight delays through the development of a full-stack web application leveraging big data and machine learning techniques.

The proposed system utilizes a vast array of data sources, including historical flight data, weather conditions, air traffic, airport congestion, and aircraft maintenance records. By integrating and analysing these diverse datasets, the application aims to identify patterns and correlations that contribute to flight delays. Machine learning algorithms play a pivotal role in predicting flight delays accurately. Through the application of supervised learning techniques such as regression, classification, and ensemble methods, the system learns from historical data to forecast the likelihood of delays for future flights. Additionally, advanced models capable of handling complex relationships and nonlinearities are employed to enhance prediction accuracy. The full-stack architecture of the web application encompasses both front-end and back-end components, ensuring a seamless user experience. The front-end interface provides users with intuitive features for inputting flight details, accessing delay predictions, and receiving real-time updates. Meanwhile, the back-end infrastructure manages data processing, model training, and prediction generation in a scalable and efficient manner.

The Flight Delay Prediction Full Stack Web Application represents a comprehensive solution for addressing flight delays through the synergistic integration of big data and machine learning technologies. By empowering stakeholders with timely and accurate predictions, the application has the potential to significantly mitigate the impact of flight delays on both passengers and airlines alike.

Keywords: Big data, Machine learning, Regression, Full stack architecture.

I. INTRODUCTION

The aviation industry, a cornerstone of global connectivity and economic growth, operates within a complex ecosystem where numerous factors converge to ensure the seamless movement of millions of passengers and cargo. Despite advancements in technology and operational procedures, flight delays persist as a formidable challenge, causing disruptions that reverberate through the entire industry. This research endeavours to address this challenge by harnessing the capabilities of Aviation Big Data and Machine Learning to predict and mitigate the impact of flight delays, ultimately enhancing operational efficiency and passenger satisfaction. In recent years, the proliferation of data sources within the aviation domain has been unprecedented.

Aviation Big Data encompasses a vast repository of information, including historical flight records, meteorological data, air traffic management logs, aircraft health monitoring parameters, and operational statistics. This wealth of data presents an unparalleled opportunity to unravel the intricate web of factors contributing to flight delays and to develop predictive models that can foresee potential disruptions. The aviation sector is inherently dynamic, with flights influenced by a multitude of variables such as weather conditions, air traffic congestion, and technical malfunctions. Machine Learning, with its ability to discern patterns and relationships within large and diverse datasets, emerges as a potent tool for extracting actionable insights from this complexity. By employing machine learning algorithms, including regression models, decision trees, and ensemble methods, this research seeks to create predictive models that transcend the limitations of traditional approaches, offering a more nuanced understanding of the factors influencing flight delays.

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Moreover, the study emphasizes the real-time aspect of data analysis. Integrating live updates into the predictive models enables dynamic adjustments based on evolving conditions. The inclusion of real-time meteorological information, air traffic updates, and live aircraft health data ensures that the predictions remain adaptive and accurate, reflecting the ever-changing nature of the aviation environment. In addition to leveraging historical and real-time data, this research explores the potential of Predictive Maintenance systems as a proactive measure to prevent delays caused by unforeseen technical issues. By monitoring the health of aircraft systems and predicting maintenance needs, airlines can address potential problems before they escalate into operational disruptions.

II. METHODOLOGY

A. System Design

Tableau for Visualization:

Data Visualization: Tableau is a powerful data visualization tool that allows you to create interactive and insightful visualizations from your data. You can connect Tableau directly to your backend database or API to visualize the historical flight data, predicted delays, and other relevant information.

Dashboard Creation: Tableau enables you to create interactive dashboards that provide a comprehensive overview of flight delays. You can design dashboards with various charts, graphs, maps, and filters to allow users to explore and analyse flight delay patterns easily.

Real-time Monitoring: Tableau also supports real-time data visualization, allowing you to monitor incoming flight data and predictions in real-time. This can be valuable for airlines or airport operators to track current flight statuses and potential delays.

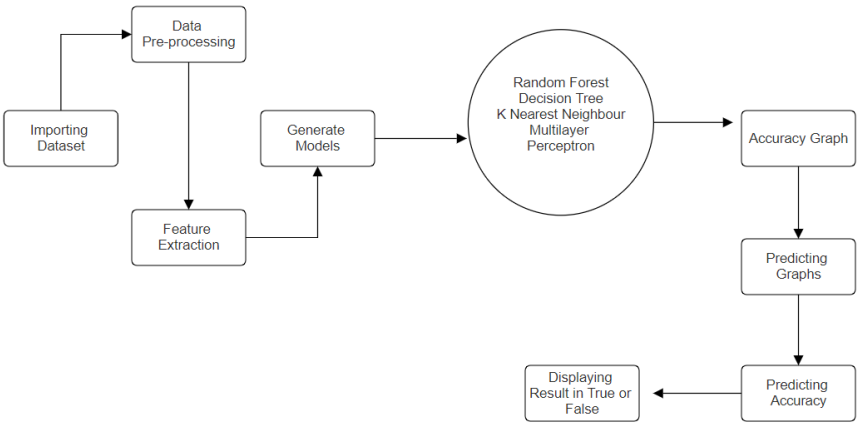

Fig 1: System Design

III. IMPLEMENTATION AND RESULTS

A. Probabilistic model and Machine Learning Techniques

A probabilistic model utilizes analysis tools to calculate the likelihood of an event occurring, relying on historical data. The model provides an estimated result in the form of a probability distribution function. The element of randomness significantly influences the decisions or outcomes generated by the probabilistic model.

B. Decision Tree Algorithm

Decision trees are versatile algorithms that can handle classification and regression tasks. Predictions are made by dividing the data set into smaller units based on different features.

C. Random Forest Algorithm

Random Forest is an ensemble learning method that combines multiple decision trees to make predictions. It is effective for handling large datasets with numerous features and capturing complex relationships within the data. Random forest

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is a popular machine learning algorithm that includes supervised learning methods.

Fig 2: Applying algorithm to data

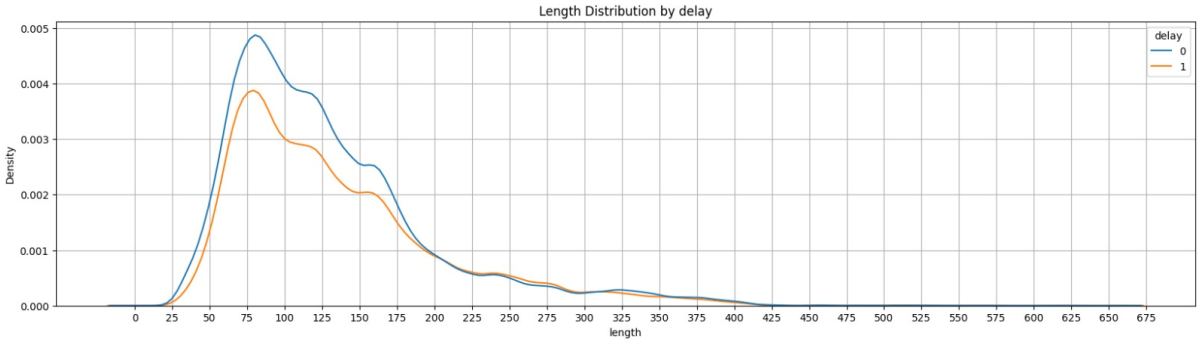

Fig 3: Output after applying algorithm

D. Connecting Frontend and Backend File

Making a front-end file using HTML5, CSS3 and JavaScript to get the input from the user various parameters like. Flight number, flight destination, flight origin, flight time

Creating an API for a web application, we typically designed and implemented endpoints that handle incoming requests, perform the necessary computations or queries, and return the results in a structured format like JSON.

Fig 4: Connecting Frontend and Backend File

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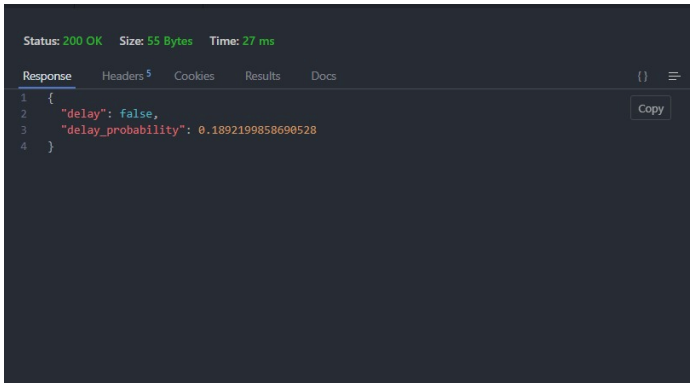

Fig 5: Output after user's input

IV. CONCLUSION

The Flight Delay Prediction Web App utilizing Big Data and Machine Learning presents a promising solution to enhance travel experiences by providing proactive insights into potential flight delays. By harnessing the power of advanced analytics, this application empowers travelers and airlines alike to make informed decisions, optimize schedules, and mitigate disruptions. Through continuous refinement and integration of real-time data, it stands as a testament to the potential of technology in transforming the aviation industry. As we embrace innovation and data-driven solutions, the future of air travel looks increasingly efficient, reliable, and passenger-centric.

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