Team 94 Project Proposal

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Objectives and Problem Definition:

Our objective is to provide highly transparent delay prediction information to the air travelers in the US. To accomplish this, we propose to develop a visualization application that leverages the power of machine learning to predict domestic flight delays in the country. The application will feature an interactive user interface enabling the user to obtain an estimate of the expected delay for their flight. This objective is critical since customers anticipate three levels of service quality: desired, adequate, and predicted [1], where customers not only want to know if their schedule is delayed, but also the anticipated delay on their schedule.

Current Methods and Limitations:

Currently, the commercial airline industry relies on simple statistics about on-time arrival/departures that are sometimes provided to passengers alongside their airline reservation. In addition, certain internet based real time flight tracking services provide the same statistical data [2]. Some flight delay information can be derived indirectly from FAA's National Airspace System providing information on airport events in real time [3]. At present, there appear to be no commercially available services which can provide prediction or probability of delay for a specific flight.

In academia, there has been considerable work done on building and applying ML based models to analyze flight delays. Some studies have focused on certain specific aspects of aviation to predict delays. For example, use of Markov chain algorithm to model some processes (like baggage handling) which are critical to flight punctuality and then using these models to predict flight delays [4] or focusing on meteorological data and using Dual-channel Neural Networks to predict delays caused by weather factors [5]. These were useful studies but were lacking in that they did not wholistically look at flight and weather specific information together in their models. Other studies utilized a much wider array of parameters to model aircraft delay and used a variety of modeling techniques including but not limited to deep learning and neural networks [6], Random Forest [7], Support Vector [8], LinearR, ExtraRT [9], extreme gradient boosting algorithms [10] and Stacking algorithms [11]. Some studies expanded their datasets available for modeling by incorporating communication and surveillance data from air traffic management systems [12]. Although these studies were more detailed, as discussed later, they are not consumable commercially at their current stage. Some experts used as many as 10 ML algorithms to model and evaluate flight operations data and identify the features most suited for optimum prediction accuracy for each model [13]. One study by Stanford on pre-flight data compared Decision Tree, Logistic Regression and Neural Network and was able to show that all 3 of the techniques were able to produce comparable accuracies. The limitations observed was on the training data size [14]. This is a useful result for us because it emphasizes the importance of the datasets rather than the actual modeling method used.

Considerable non-commercial work has been done on the back end to build ML models for flight delay prediction. However, none of these are accessible to general consumers as they lack one crucial aspect which is a user-friendly front end where a traveler can navigate through an interactive interface and access flight delay prediction or forecast. Thus, even if adequate ML based models exist to accurately predict flight delays, they are inaccessible to an average consumer.

Our Solution and Innovation:

We intend to use Python and R for tasks pertaining to feature selection, feature analysis and model building. In our solution, multiple datasets will be used [15] [16], and essential features will be identified to create an optimal model. Feature selection techniques such as correlation coefficient matrices, stepwise regression, and ANOVA will be used to identify the most significant features. The data will then be split into training and test sets to fit and evaluate multiple models such as decision trees, logistic regression, and neural networks. Evaluation metrics such as accuracy, recall, f1 score, and precision will be used, and k-fold cross-validation will be performed to evaluate the performance of the

models. Once the best performing model is identified, hyperparameters will be tuned to improve its accuracy, and the selected model will be used to predict flight delays when passengers enter airline information [17].

The team intends to develop a visualization tool that presents delay information to air travelers in the US in a transparent and comprehensible manner. This visualization will include an interactive Graphical User Interface (GUI) that utilize various visualization techniques such as geographical maps, bar charts, and kanban boards etc. To accomplish this, we plan to integrate the model output mentioned earlier with our GUI-style application [18]. For constructing visualization applications, we are considering PyGUI, Tableau, or IOS mobile apps based on their usability and visual effectiveness.

Impact and Value:

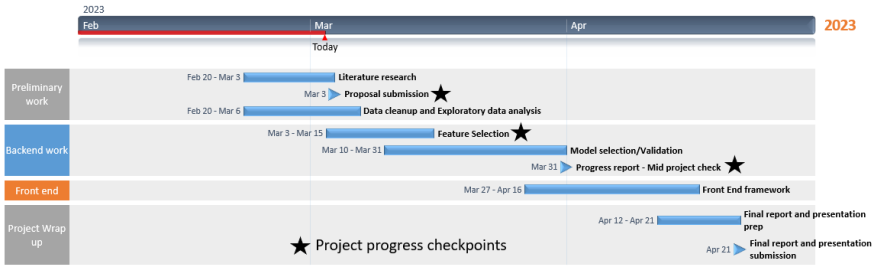
The application primarily targets air travelers in the US with airlines being the secondary stakeholder as they can directly implement the app and enable passengers to view expected delays while booking their flights. For travelers, the visualization tool can help make more informed flight booking decisions by providing information on flight delays and cancellations, allowing them to avoid flights that are prone to delays, thereby saving time and improving their overall quality of life. Additionally, airlines can benefit from the tool as passengers will have a better flying experience, leading to improved customer ratings and reviews. By analyzing the data from the tool, airlines can identify areas for improvement in their operations and make necessary changes, ultimately leading to a more efficient and customer-friendly operation.

Risks and Payoffs:

Using historical data to train a flight delay prediction model carries two significant risks. Firstly, there can be changes in flight patterns due to factors such as weather, airline schedules, or airport operations that may not be reflected in the historical patterns. Secondly, poor data quality can lead to inaccurate predictions, making it challenging to rely on the model's output for decision making. However, these risks are balanced by improved customer experience improved reputation for the airline. (See Appendix 1.1 & 1.2 for risk/payoff matrix)

Project Plan and Success Criteria:

The primary cost of the project will be zero in dollars besides the team's time investment, considering the absence of expenses related to hardware or software, and negligible computational costs. The team envisions completing the project within a period of three months, with each member devoting a few hours per week to its realization. Adherence to the timeline presented below is expected to ensure equitable contributions from all team members. In the context of this proposal, all team members have made an equal contribution.



The progress of the project will be assessed based on the completion of the items described in the project timeline above and the item status will be checked at regularly scheduled project progress checkpoints. In addition to the progress evaluation, the team plans to conduct further assessments on the model mentioned in the preceding section. Importantly, as pointed out in the HAL Open Science's paper, "Evaluation should be representative of how the model would perform when deployed in a real-life setting." [19] Therefore, the team intends to incorporate this perspective into the final product to ensure its suitability for real-world applications.

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Appendix

1.1 - ***Risks Matrix:***

Risks	**Likelihood**	**Impact**	**Mitigation**
Changes in flight patterns	Moderate	High	Monitor data and adjust the model accordingly
Poor data quality	Low	Medium	Implement data cleaning and validation processes

1.2 - ***Payoffs Matrix:***

Payoffs	**Probability**	**Impact**
Improved customer experience	High	High
Better reviews and improved reputation for the airline	Moderate	High