American Airlines

DELTA

FLIGHT PATH ↘

Flight Delay and Customer Experience Analysis for Operational Efficiency and Satisfaction

American Airlines

FLIGHT PATH

Deployment of Flight Delay Prediction System

DELTA

AGENDA

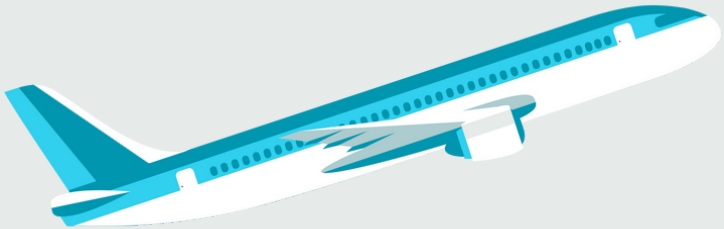
- About the Project
- Feature Selection
- Model Development and Evaluation
- Gradio Interface Overview
- Deployment Workflow
- Results and Insights

About the Project ↘

Brief overview of the goal: Predicting flight delays for American Airlines and Delta.

Objective: Minimize delays by providing actionable insights.

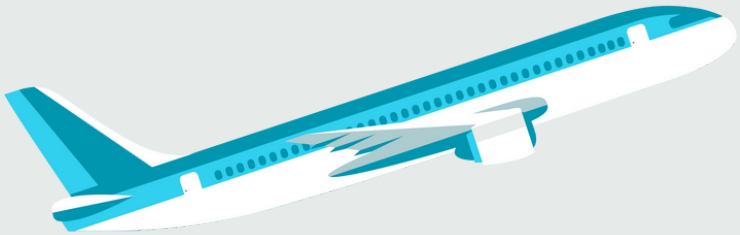
Key Focus: Machine learning-based prediction system deployed via Gradio.



Data Overview ↘

Data source: Flight delay data extracted from Bureau of Transportation and Statistics, U.S. From **2014 to 2023**.

Comparison: American Airlines and Delta in 5 major US airports (ATL, ORD, DFW, DEN, LAX).

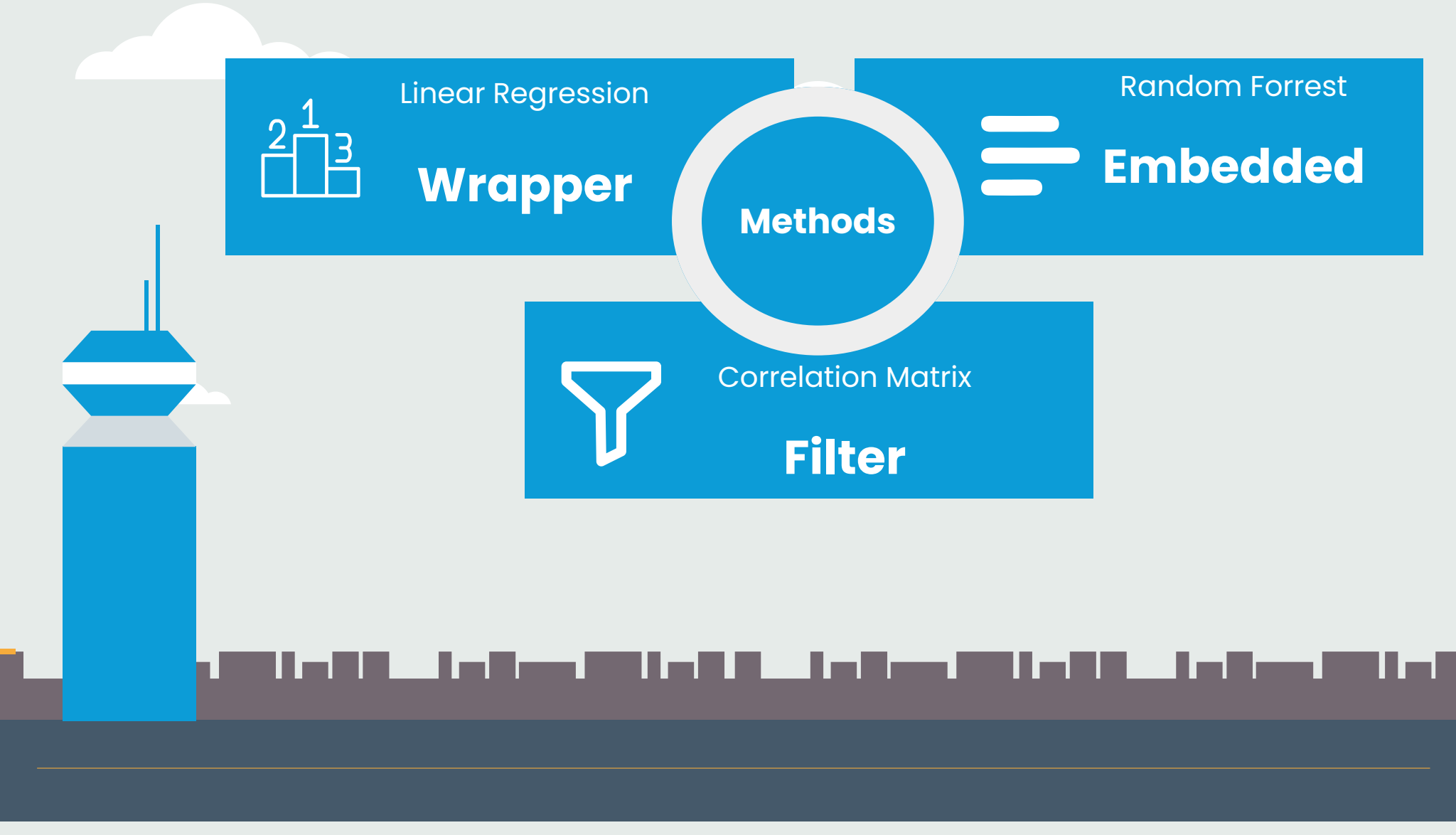


Baseline Model ↘

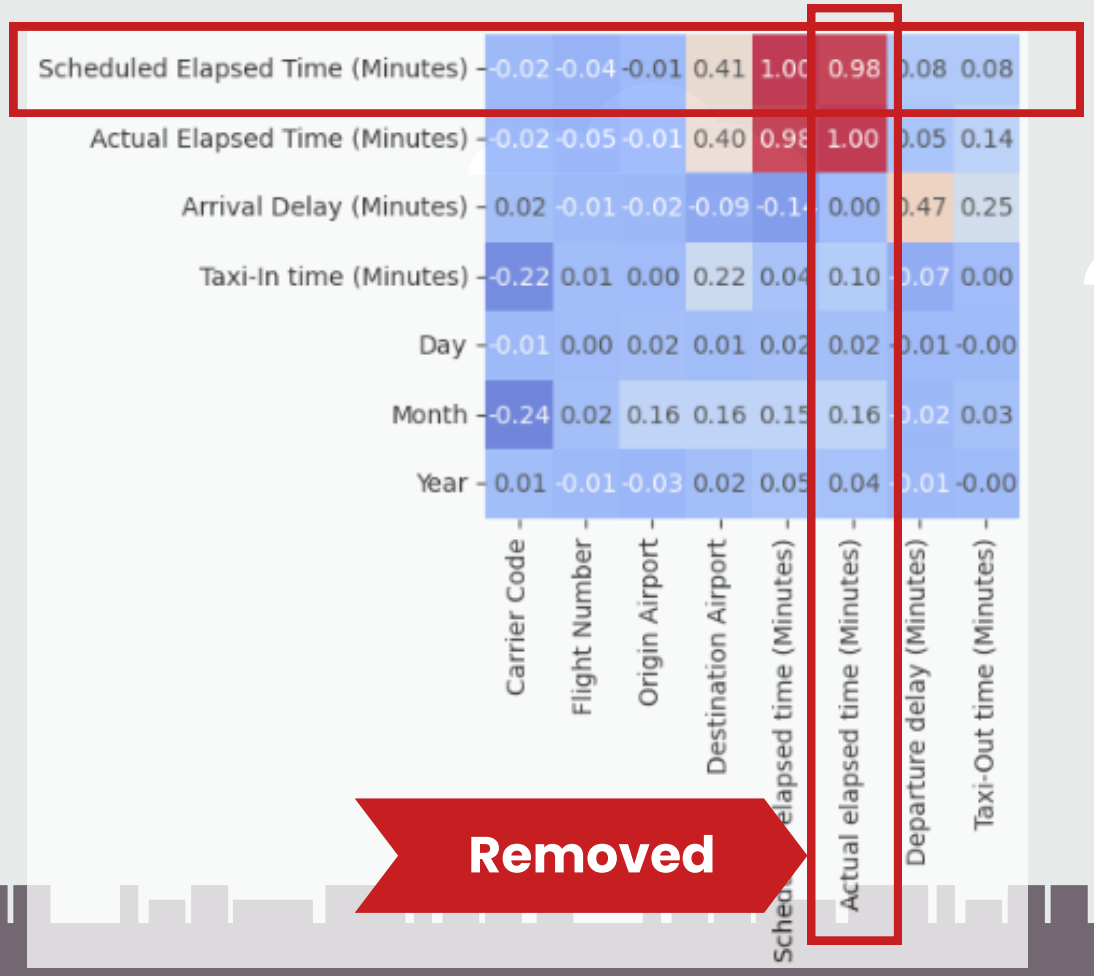
- Feature Engineering and Selecting relevant features for regression.
- Train a Regression Model (RF).
- Evaluate the Model.

MAE	1.30	11.69	MSE
R^2	93%		

Feature Selection ↘



Feature Selection ↘



Selected Features

Date-related: "Day", "Month", "Year".

Operational Times: Taxi-Out time, Taxi-In time, Scheduled Elapsed Time.

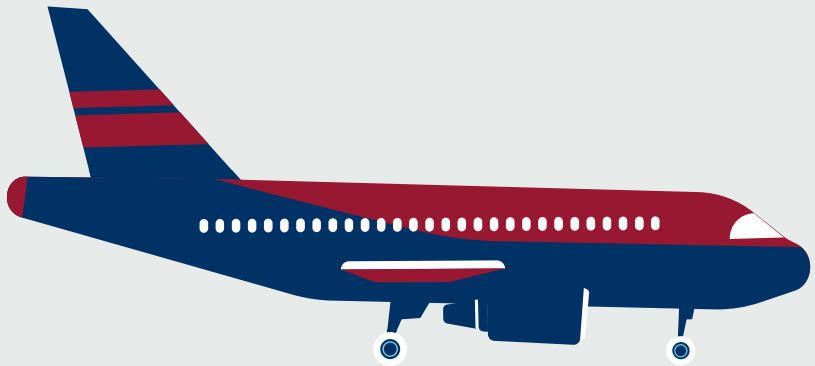
Delay & Schedule: Departure delay, Scheduled departure hour.

Categorical: Origin Airport, Carrier Code.

Model Overview ↘

Final Models Used:

- **MLP Neural Network** (deep learning approach).
- **XGBoost** (traditional tree-based method).
- **Approach:** Multiple Models run in Pycaret.

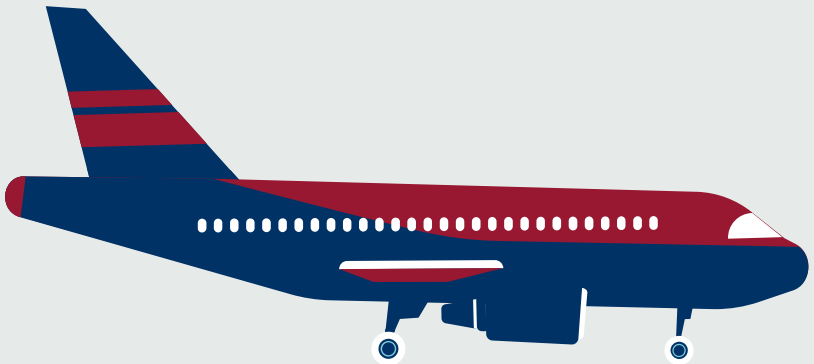


PyCaret ↘

	Model	MAE	MSE	RMSE	R2	RMSLE	MAPE
xgboost	Extreme Gradient Boosting	5.2643	52.3456	7.2348	0.5792	0.6705	0.8301
lightgbm	Light Gradient Boosting Machine	5.5776	57.0497	7.5529	0.5414	0.6945	0.8660
rf	Random Forest Regressor	5.7253	59.7534	7.7298	0.5197	0.7107	0.8855
et	Extra Trees Regressor	5.7157	59.8784	7.7378	0.5187	0.7127	0.8857
gbr	Gradient Boosting Regressor	6.1442	67.2644	8.2013	0.4593	0.7275	0.9586

MLP Model ↘

- **Architecture:** Multi-layer perceptron with several hidden layers.
- **Large dataset**: With 200K+ records, deep learning models benefit from more data and generalize better.
- **Optimized:** Regression tasks.



MLP Model Performance

Train R^2
0.63

Train MAE
5.11 min

Test R^2
0.63

Test MAE
5.17 min

Comparing Model Performance

MLP

100 epochs

Train MAE	Test MAE	R^2 Train	R^2 Test
5.11	5.17	0.63	0.63

XGBoost

Train MAE	Test MAE	R2 Train	R2 Test
3.67	4.9	0.79	0.63

MLP Model Evaluation ↘

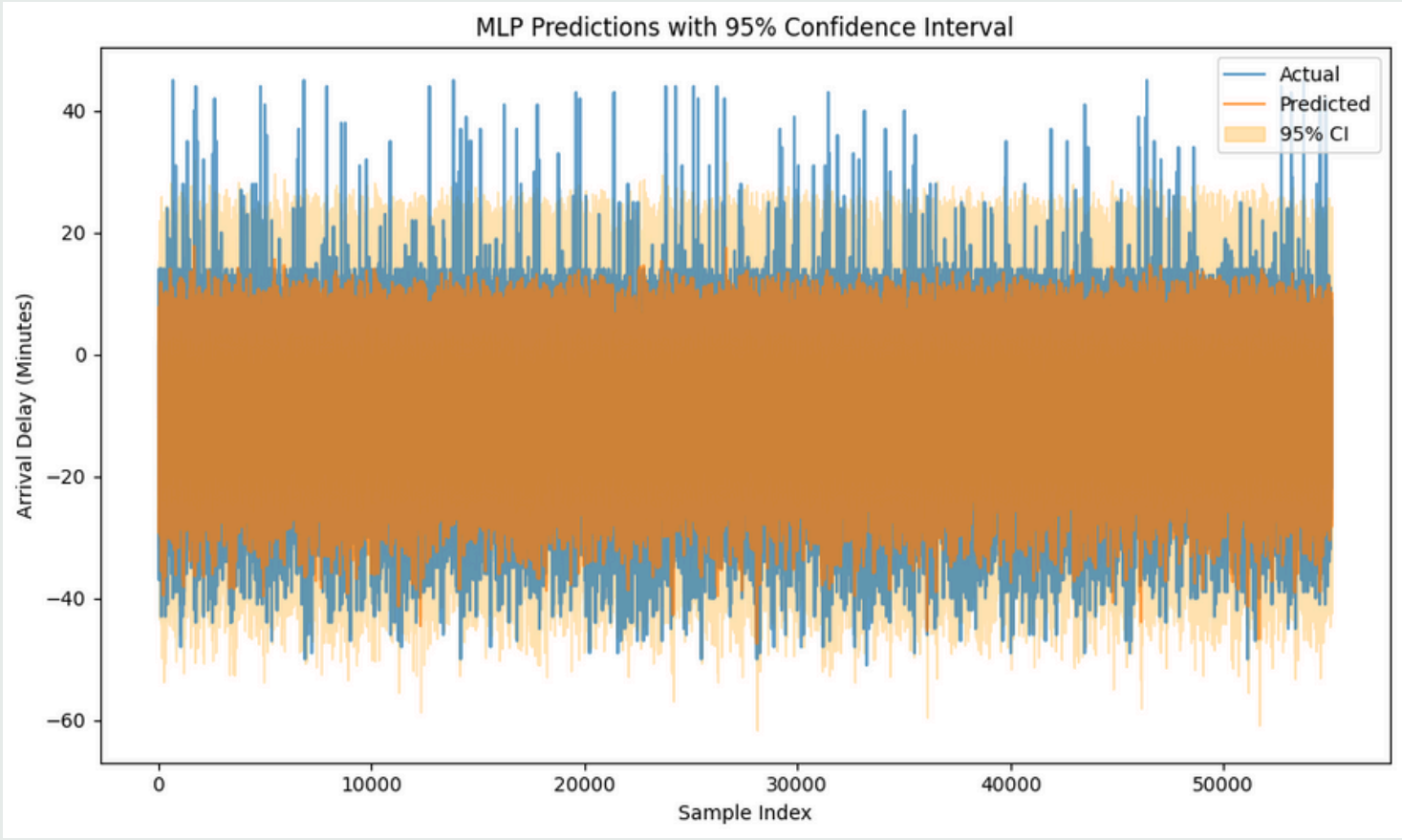
Consistent Generalization (Not Overfitting)

The train and test metrics are very close, especially R^2 (both **~0.63**) and MAE.

Prediction are accurate within the **95%** Confidence Interval of **±14.18 min**

MAE	5.17	52.51	MSE
R^2	63%	±14.18	CI

95% Confidence Interval



Deployment Goals ↘

Deliver a **user-friendly** interface for non-technical users.

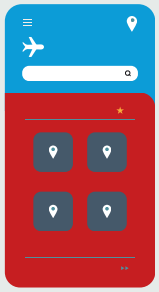
Provide **real-time** predictions of flight arrival delays.

Offer **actionable insights** and recommendations for airlines.

Gradio Workflow

User enters flight details

1



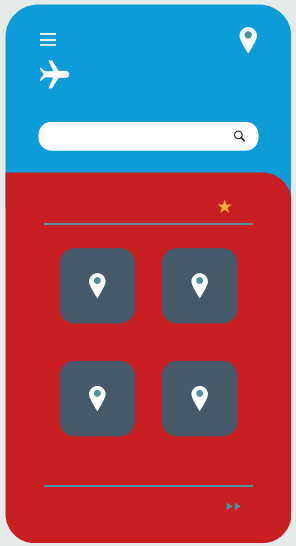
System process data and apply models

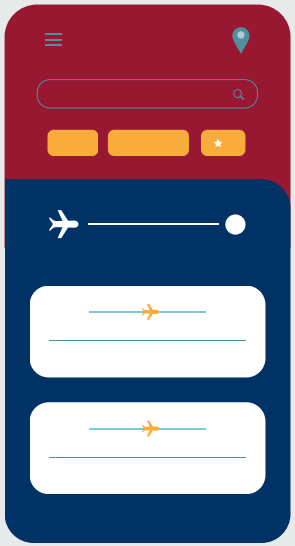
2

Predictions and Insights displayed in real-time

3

Gradio Interface Overview ↘





American Airlines

DELTA

Web-based application to interact with the models.

Input Fields:

- Flight date, taxi-out time, taxi-in time, etc.
- Dropdowns for selecting airport and carrier.

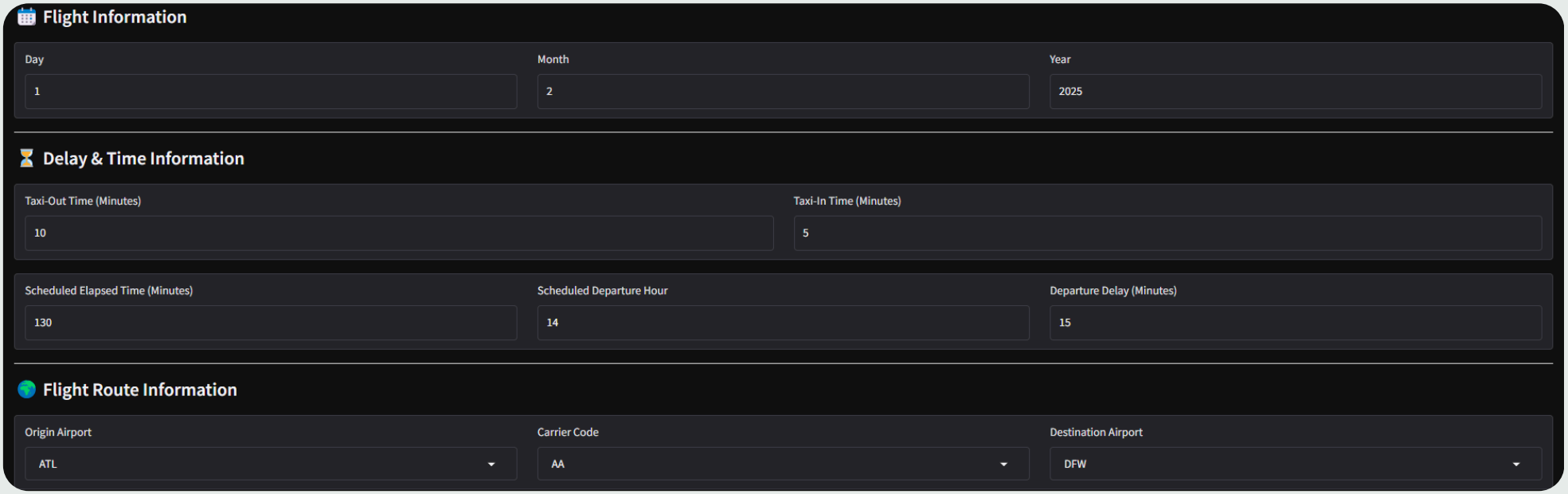
Output Fields:

- Predicted arrival delay, best and worst reviews.
- AI-generated operational recommendations.

.

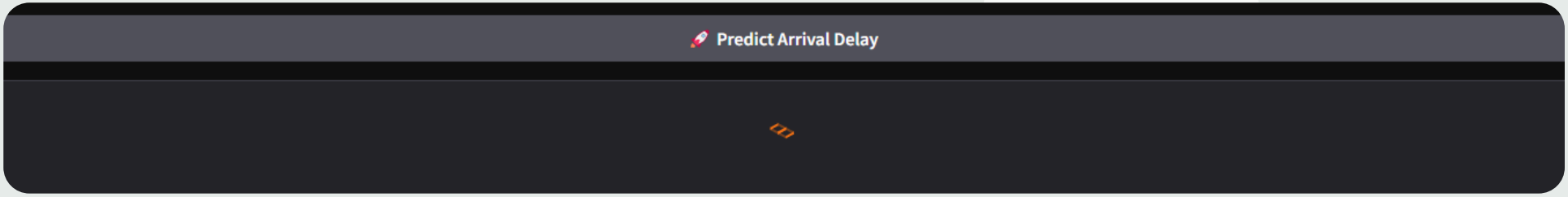
Gradio Workflow ↘

User enters flight details

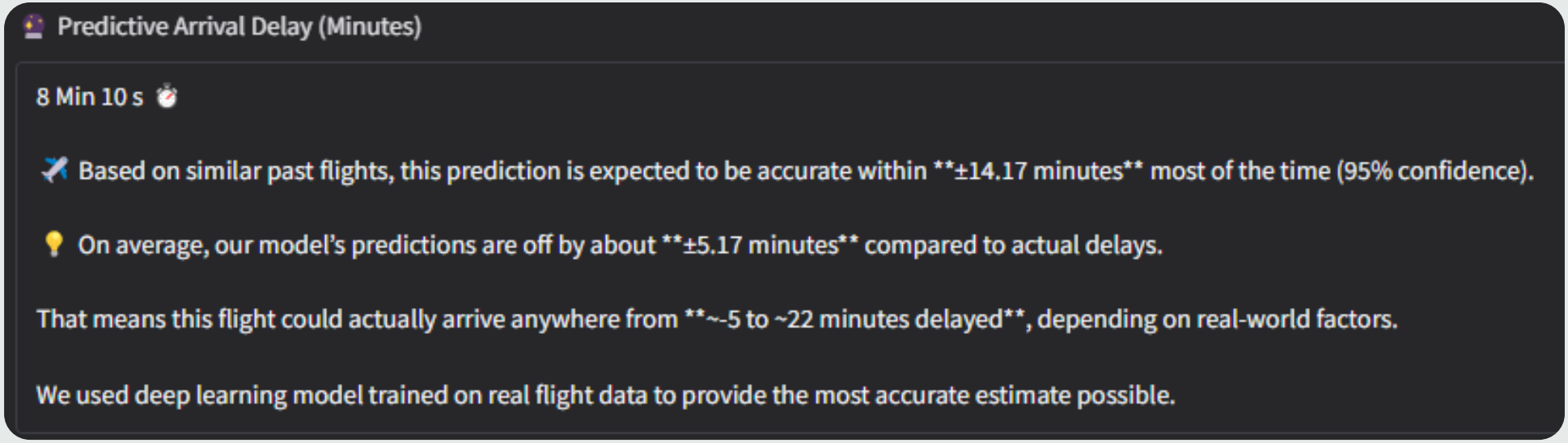


Gradio Workflow ↘

System processes the data, applies the models



Predictions and insights are displayed in real-time



Gradio Workflow ↘

Sentiment Analysis

👍 Best Comment

✅ Trip Verified | Arrived at airport to find a 2 hour delay which is going to make us miss our connecting flight from Chicago
house sitter. Guess no picnics for memorial day.

👎 Worst Comment

Not Verified | Rebooked my flight from Lubbock to Dallas stranding me in Dallas overnight. Fargo has very few flights from

Real-time Prediction ↘

Predicts the flight arrival delay with a **95%** confidence interval and expected error.

Confidence intervals provide clear expectations for delays.

Real-time Prediction ↘

AI-based Recommendations

AI-Generated Recommendation

1. Decrease the Departure Delay: Departure delay contributes significantly to the overall delay. In this case, it is 15 minutes
aircraft.

2. Improving Taxi-Out Time: The taxi-out time, which is the time from gate departure to take-off, is 10 minutes. This duratio

3. Realistic Scheduling: The scheduled elapsed time should be realistic and account for any possible contingencies. If the s

Overall, these changes require an integrated effort involving ground staff, flight crews, maintenance teams, as well as bett

Thank you!