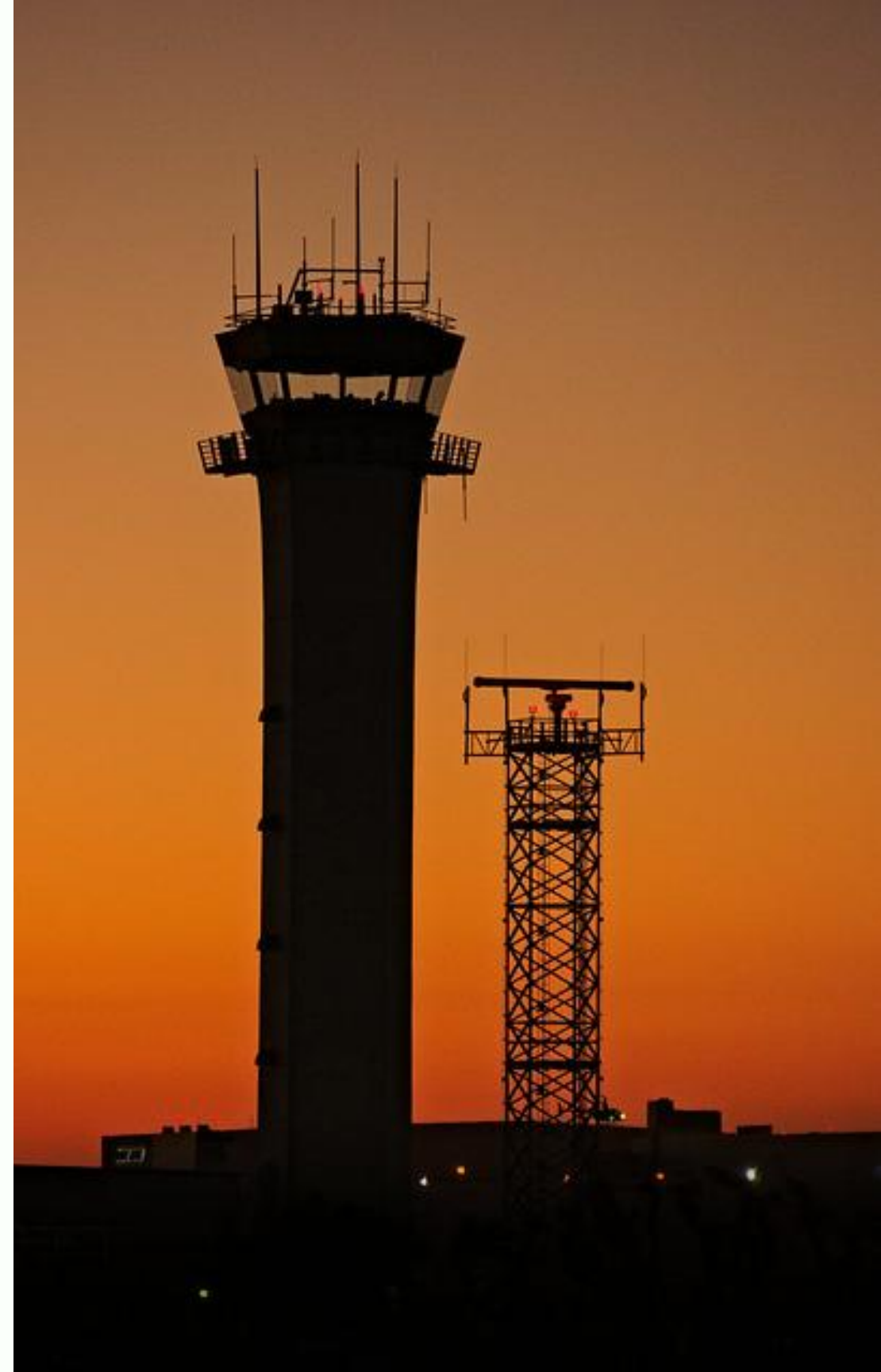


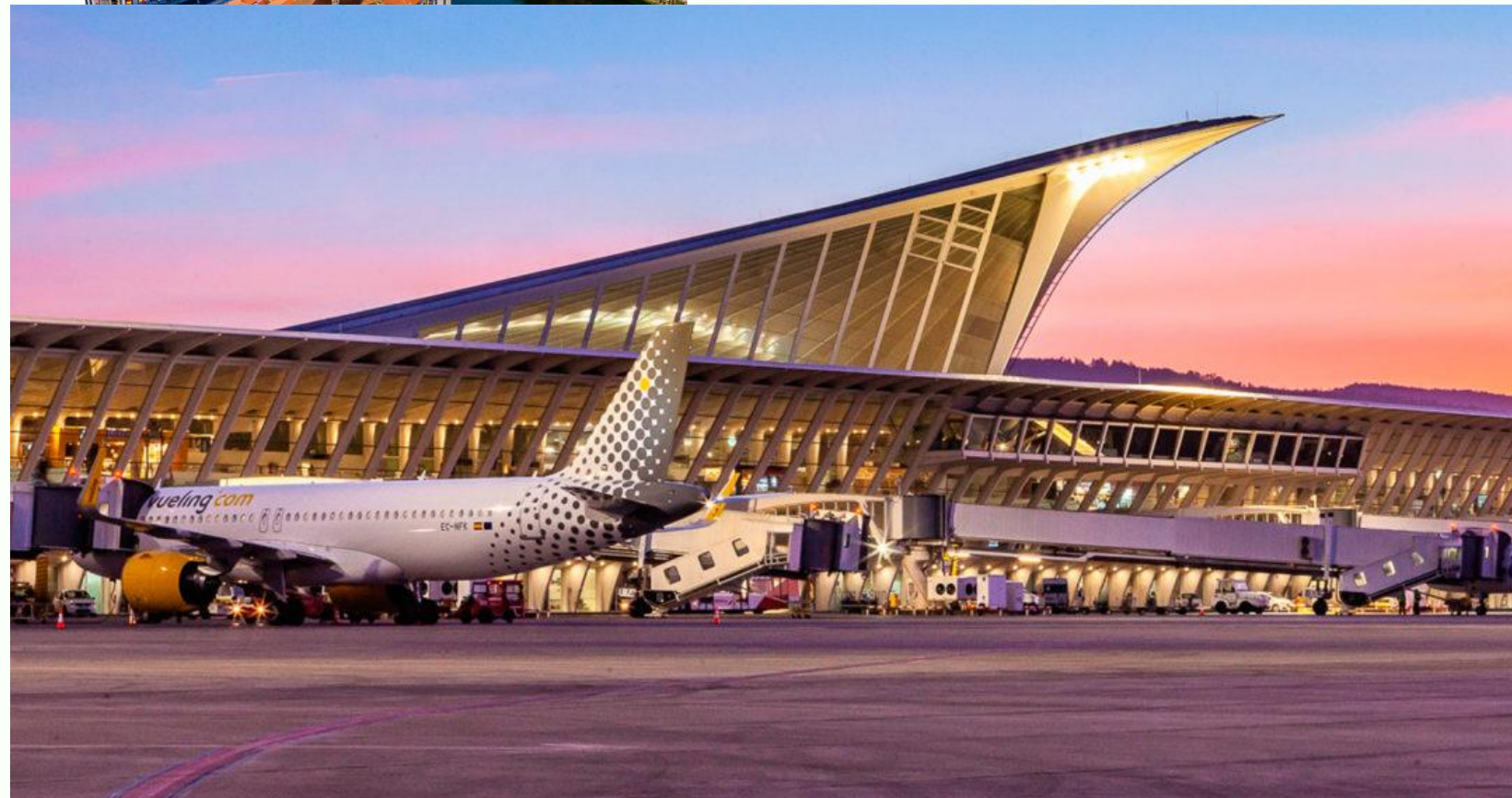
Real-Time Prediction of Go-Around Probability During Final Approach with Deep Learning

Authors: Unai Zuazo Angulo
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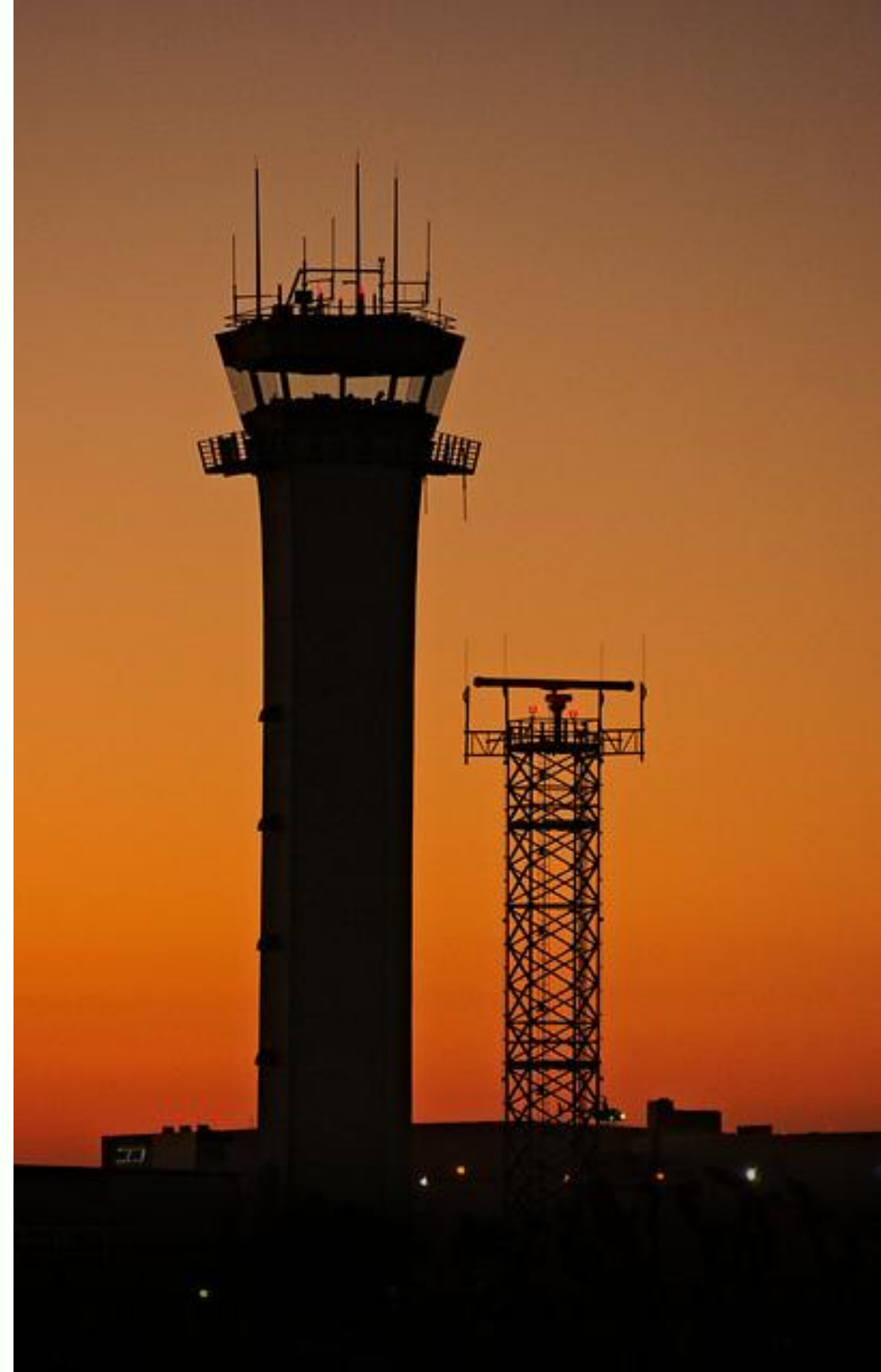




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Introduction and Problem Context

1

The "Go-Around" (GA)

A Go-Around is an aborted landing maneuver. It is considered a critical safety procedure to avoid hazardous situations. Less than 1% of approaches result in a GA.

2

Operational Security Implications

Go-arounds increase workload for both pilots and controllers, leading to a higher risk of incidents. They also have economic and logistical impacts.

3

Problem: Reactive Management

Current go-around management is predominantly reactive, responding only after the risk situation has already emerged, rather than anticipating it.

4

Objective

Develop a predictive model, identify the main contributing factors, and build a support tool for ATCOs.

Methodology

Data Processing

- Feature Engineering
- Cleaning and Filtering

1

2

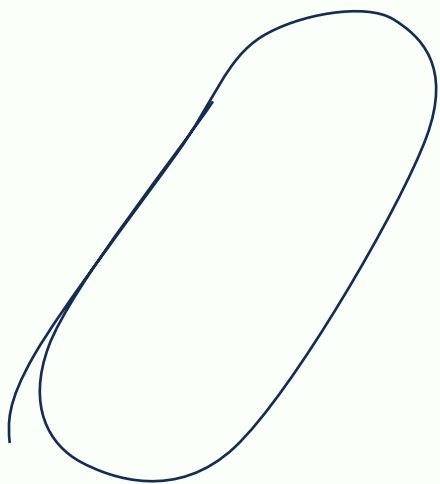
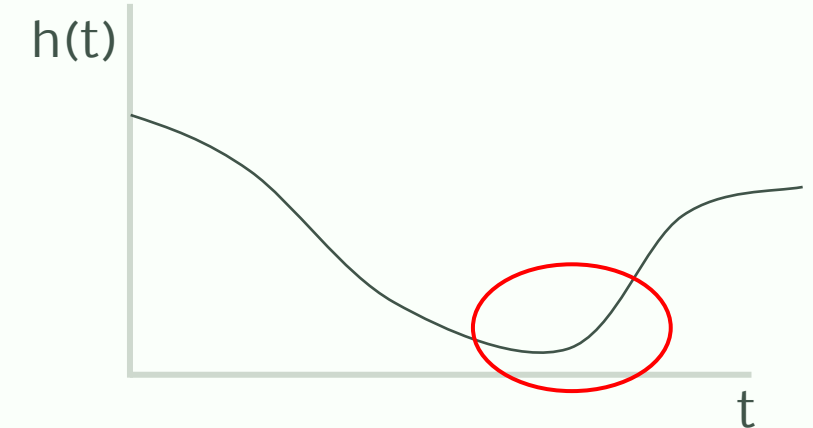
3

Real-time Implementation

Development of
LandIA

Model Development and Validation

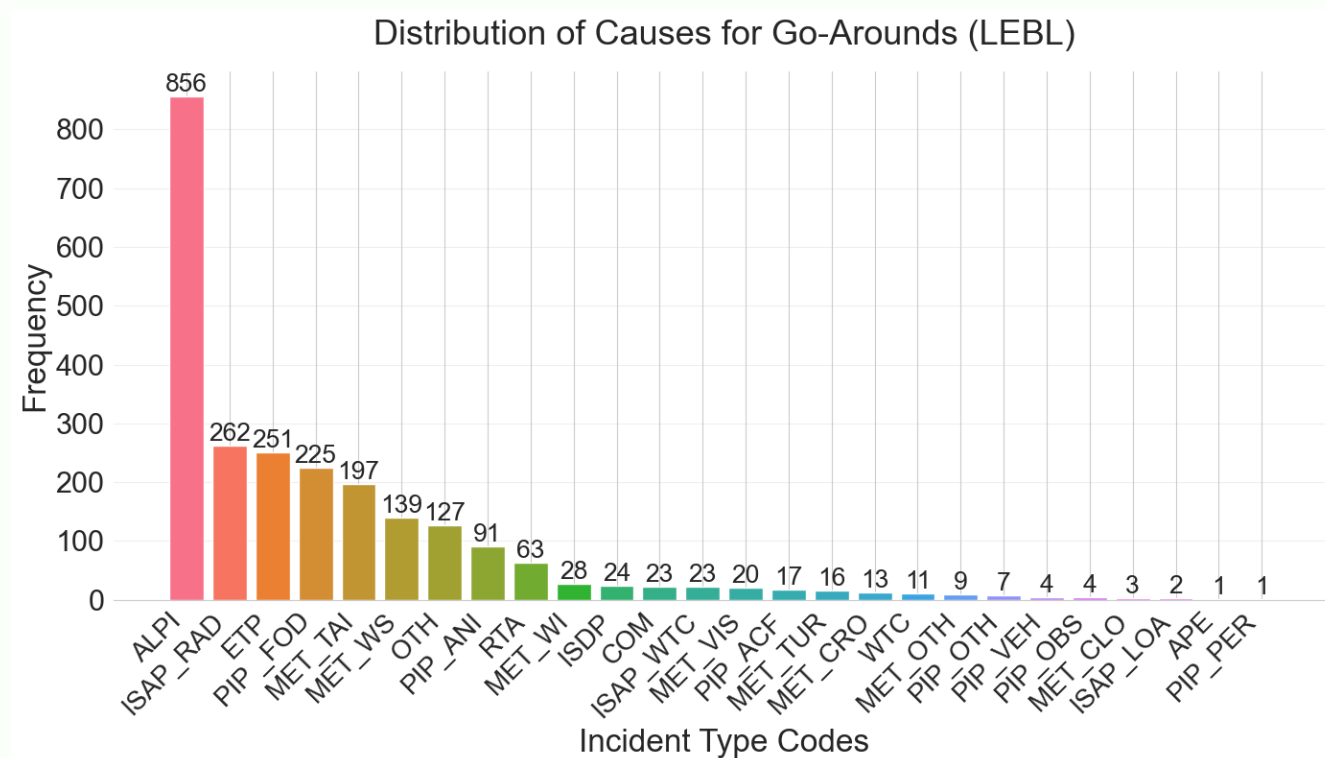
- LSTM
- LSTM + Attention
- Transformers
- RF



Metodología y Datos Utilizados

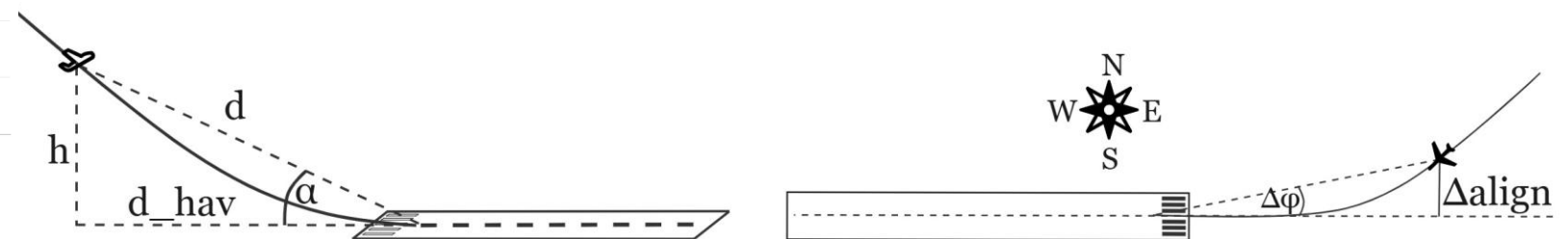
Data Sources

- Database from CRIDA
- 8 years: ~2.600 missed approaches at LEBL
- Data: ADS-B, Meteo

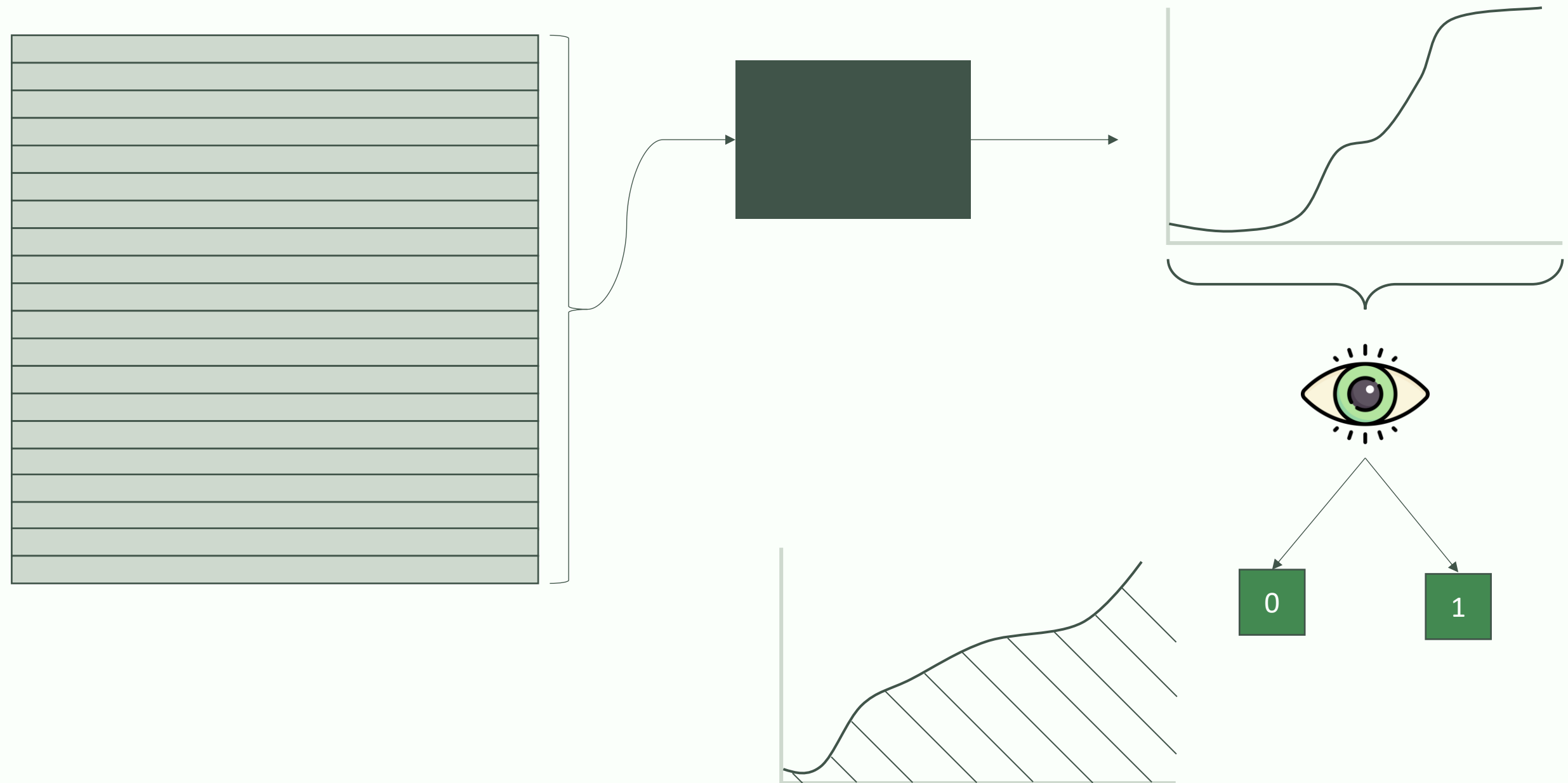


Preprocessing and Features

- Data Cleansing and Filtering
 - GNSS Errors
 - Classification Errors
 - eDina-notated Causes
 - Military, Recreational, etc. Flights
 - Different wake categories
 - Meteo
 - ...
- Feature Engineering
 - Distance to Preceding Arrival
 - Runway Distance
 - Lateral Deviation
 - ...

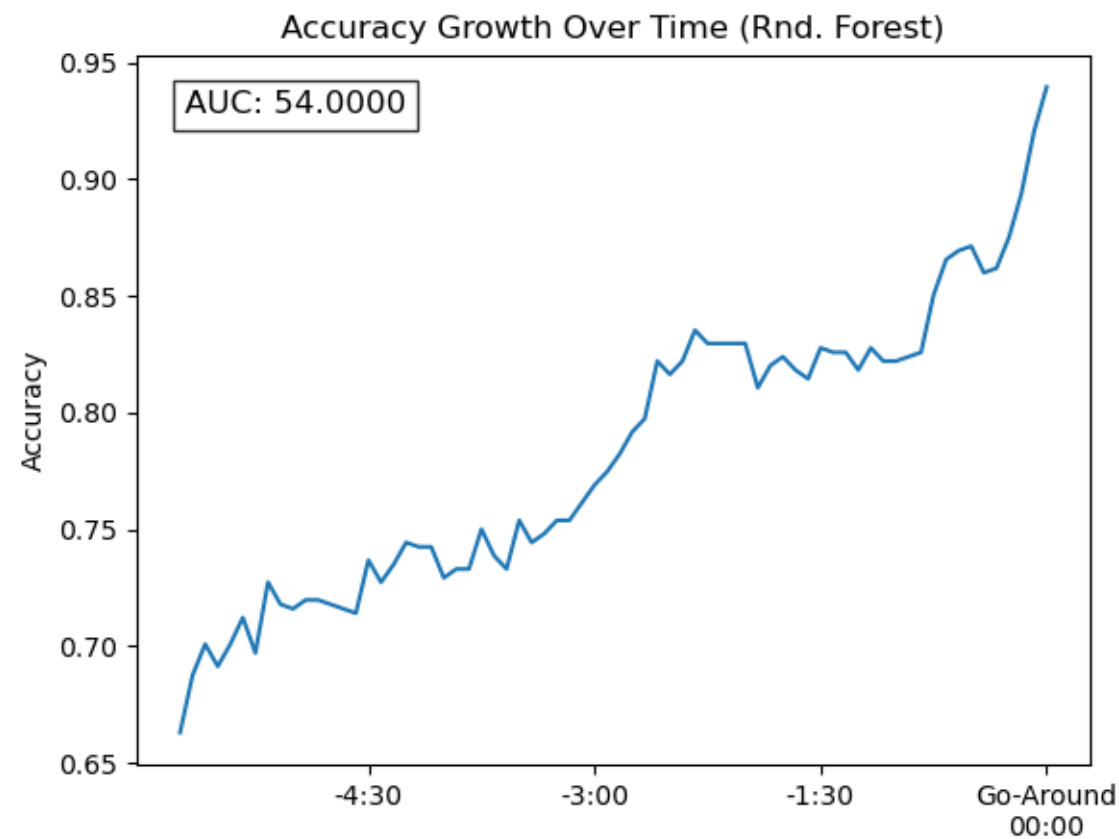


Model Schematic (regressor + observer)



Key Results

Best Model: Transformer



Métricas de Rendimiento



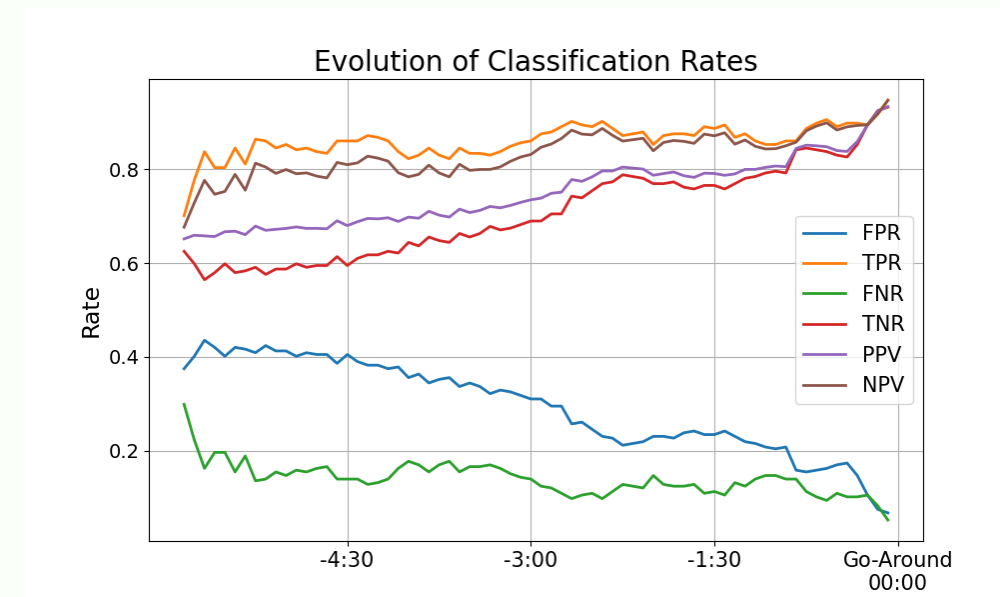
LSTM: AUAC = 48,39



LSTM + Attention: AUAC = 47,04



Transformers: AUAC = 54,00

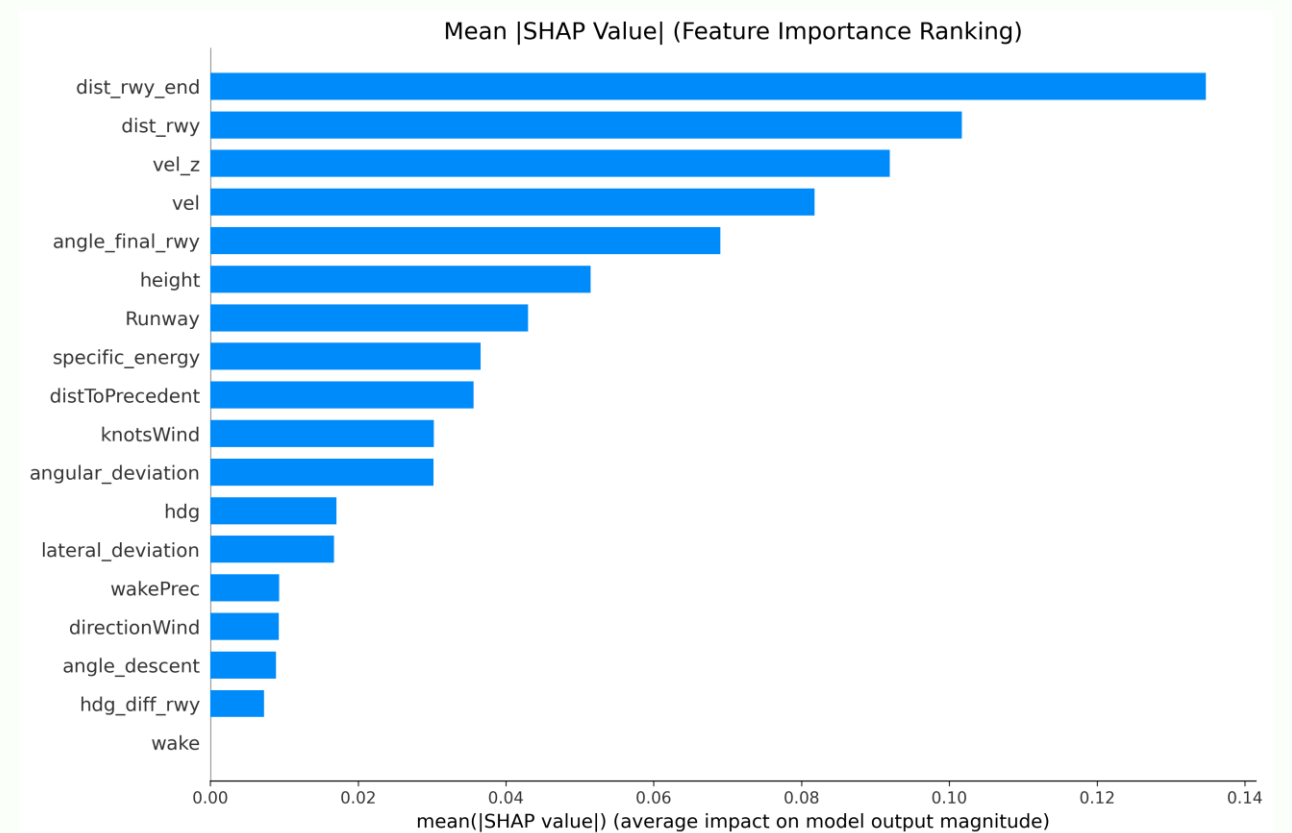
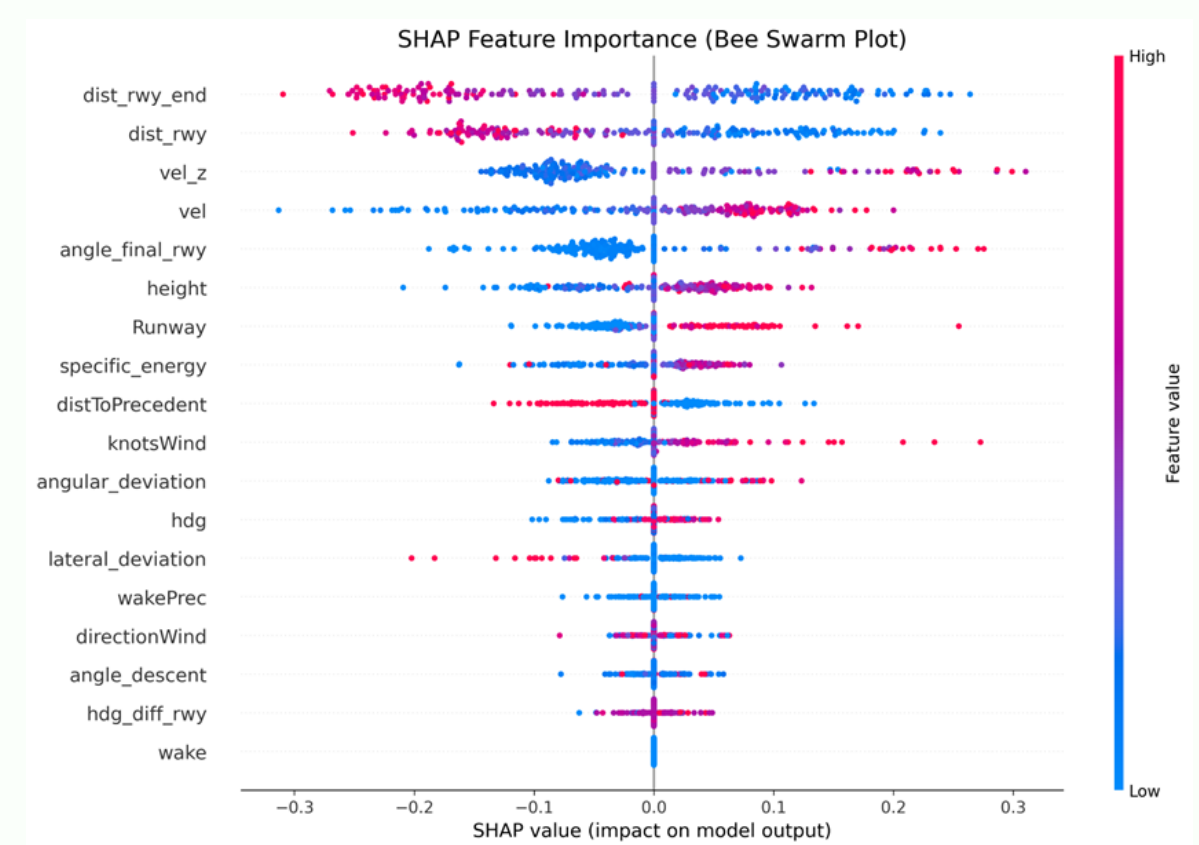


SHAP Analysis

Intuitive Behavior

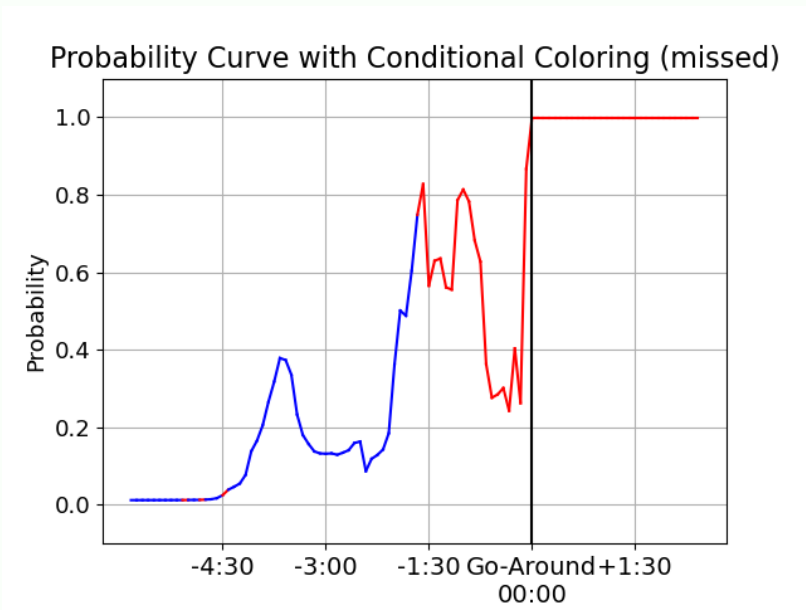
Most influential variables:

- *Distance to the runway (and angle relative to it)*
- *Vertical speed*
- *Altitude*
- *Intended/assigned runway*
- *Specific energy*
- *Distance to the preceding arrival*
- *Wind speed*

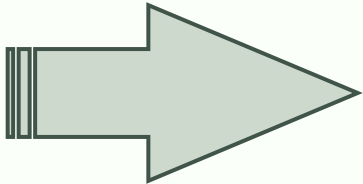


Model Accuracy Exploration

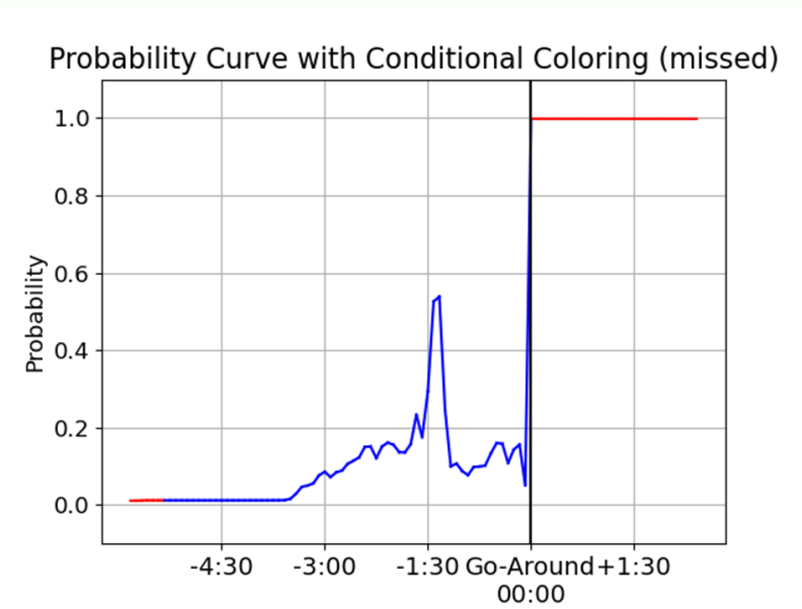
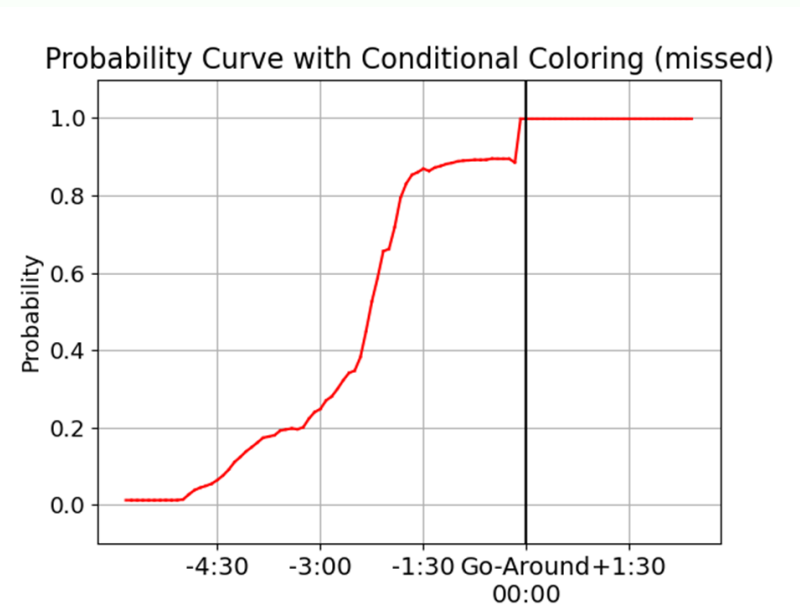
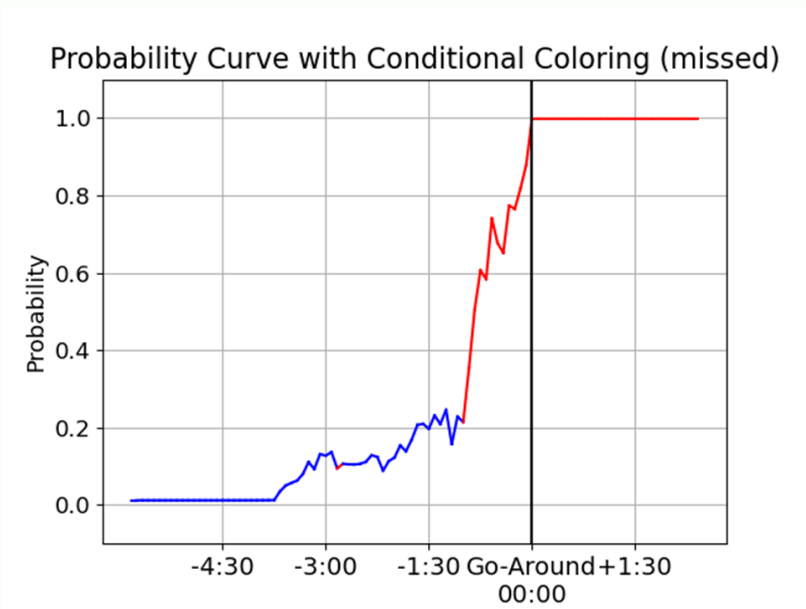
Question: Is the model better at detecting go-arounds that occur farther from the runway?



(0.02, 0.03, 0.06, ..., 0.65, 0.87)
(0, 0, 0, 0, ..., 1, 1, 1)

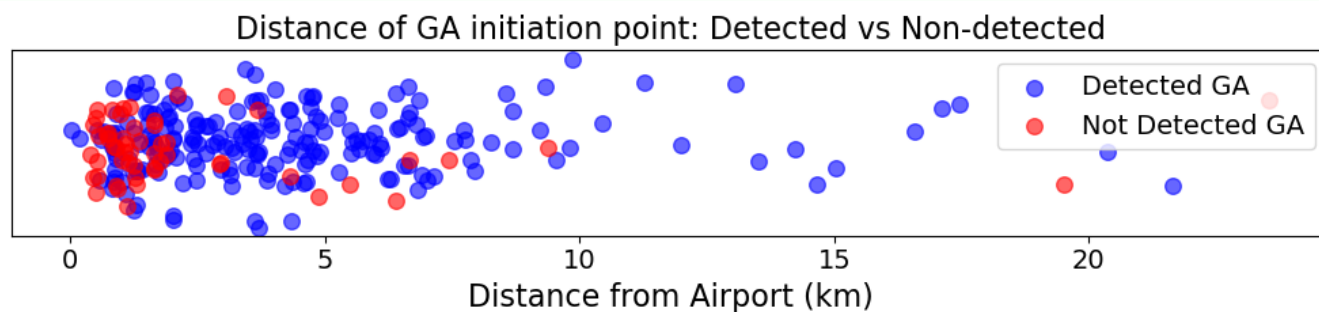


Accuracy = 80%



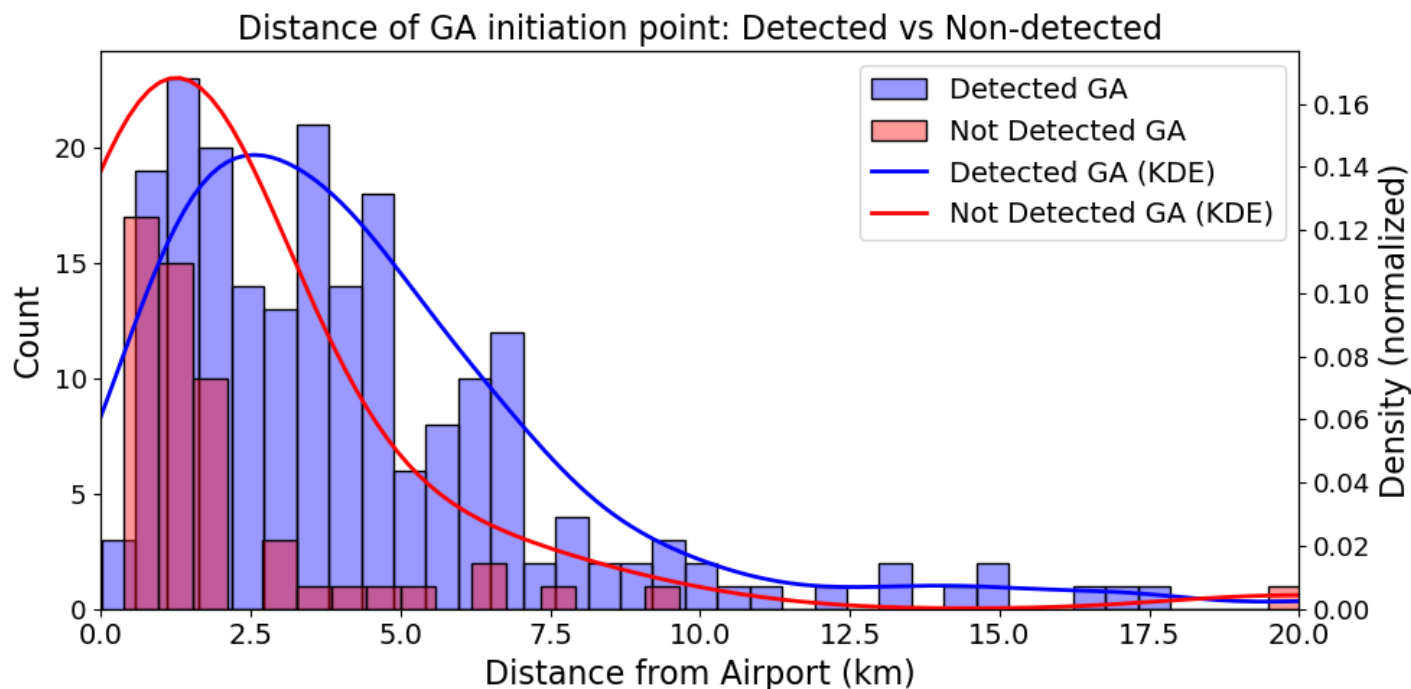
Model Accuracy Exploration

Question: Is the model better at detecting go-arounds that occur farther from the runway?



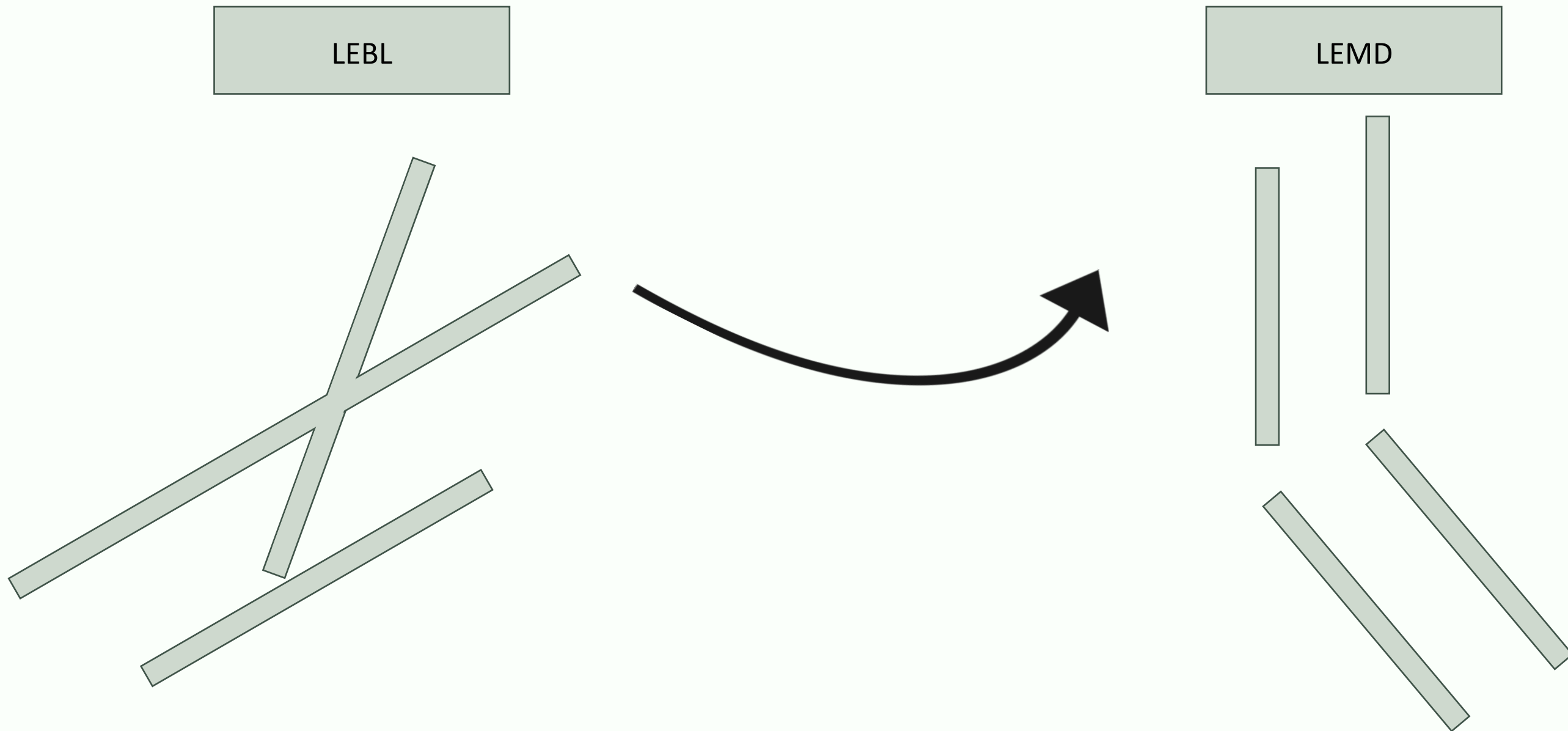
Kolmogorov-Smirnov: $p\text{-value} = 2.433e-10$

Yes, the model predicts go-arounds better when they are initiated farther from the runway.



Generalization Study

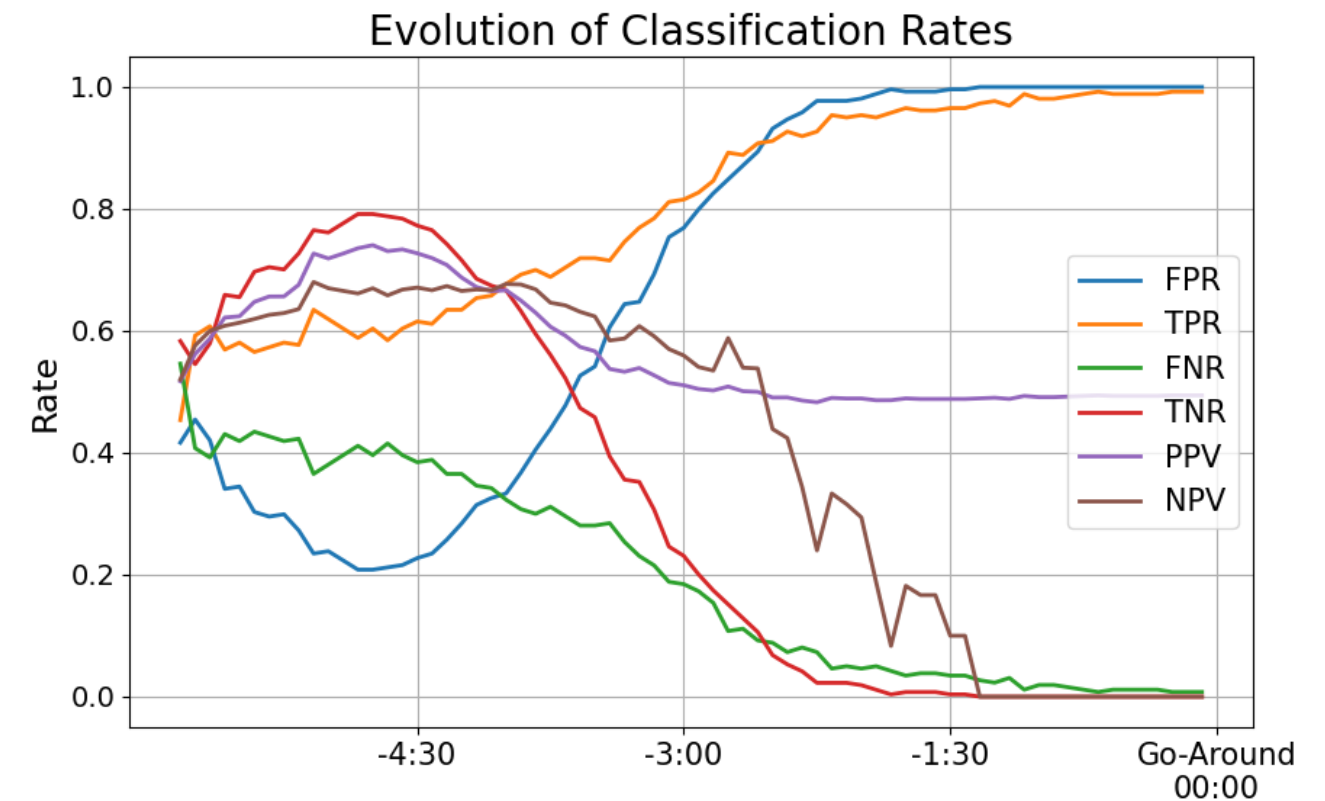
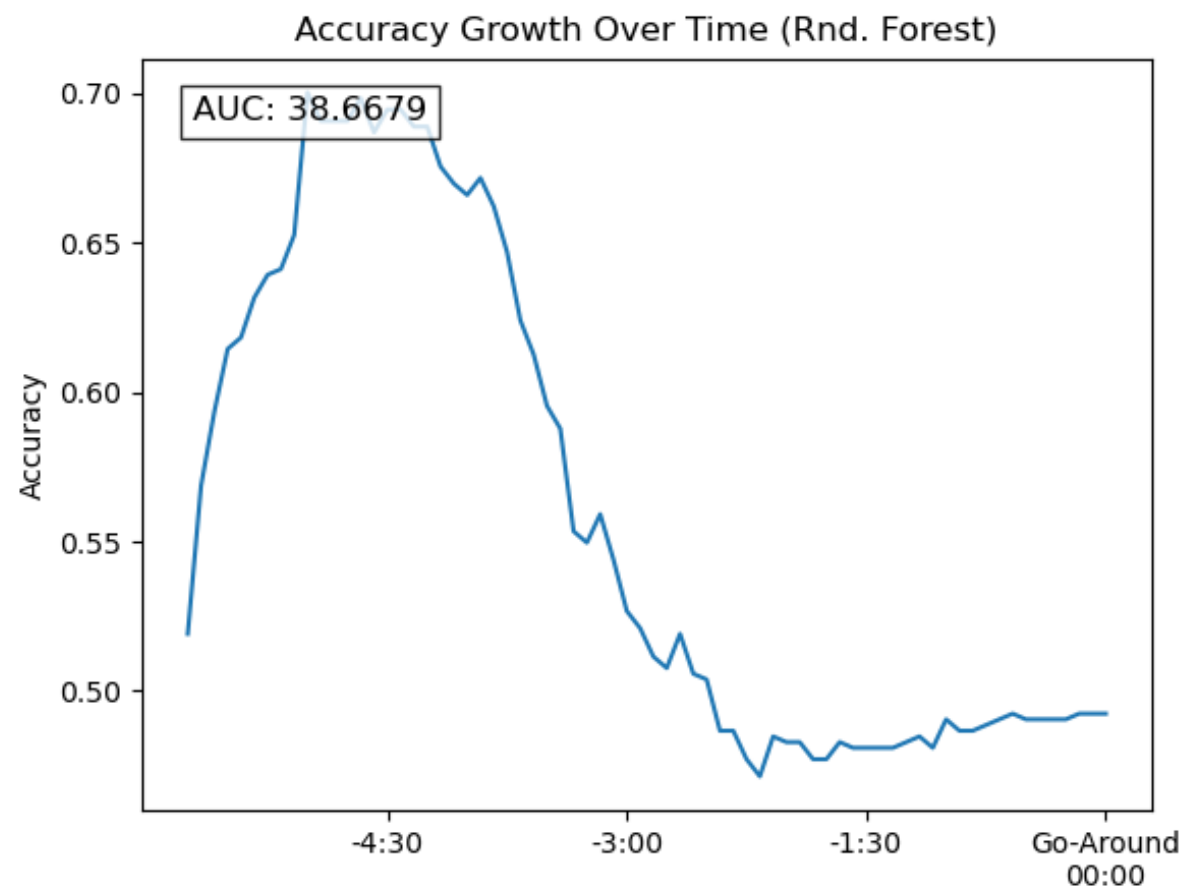
Question: Can a model trained for one airport be implemented at another without additional training?



Generalization Study

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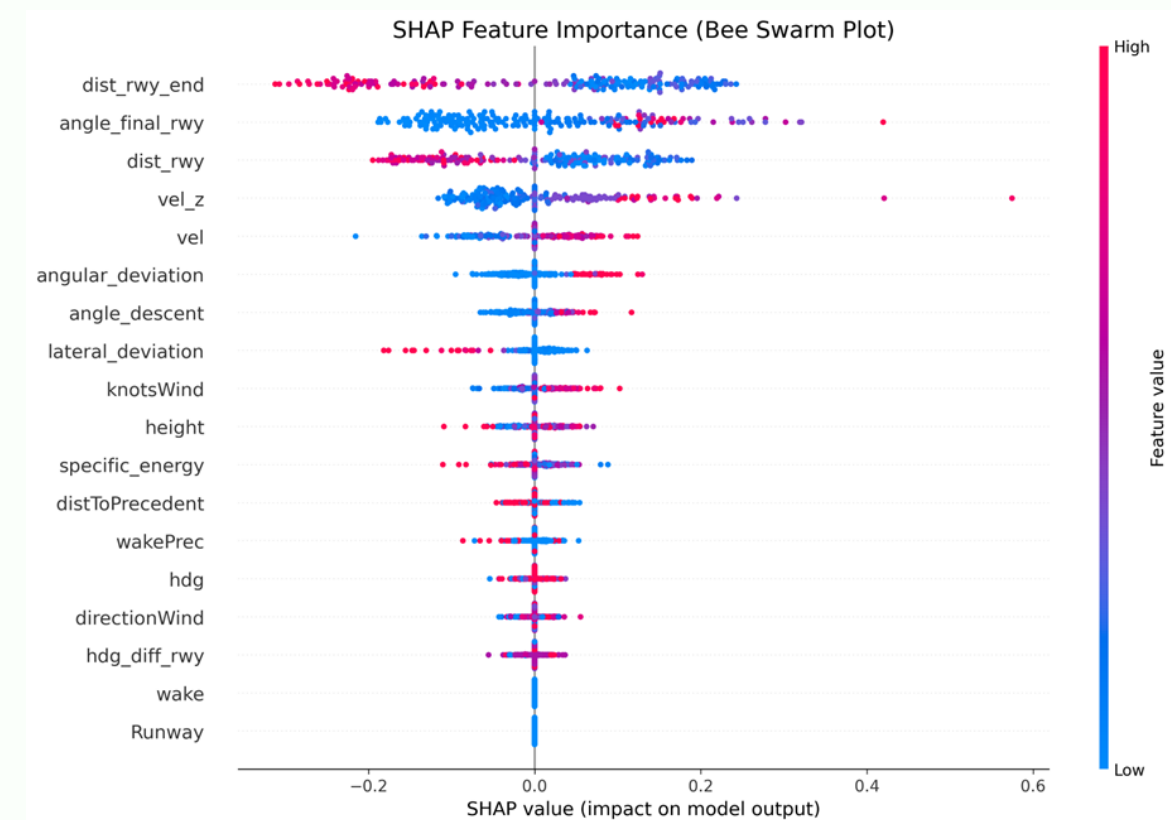
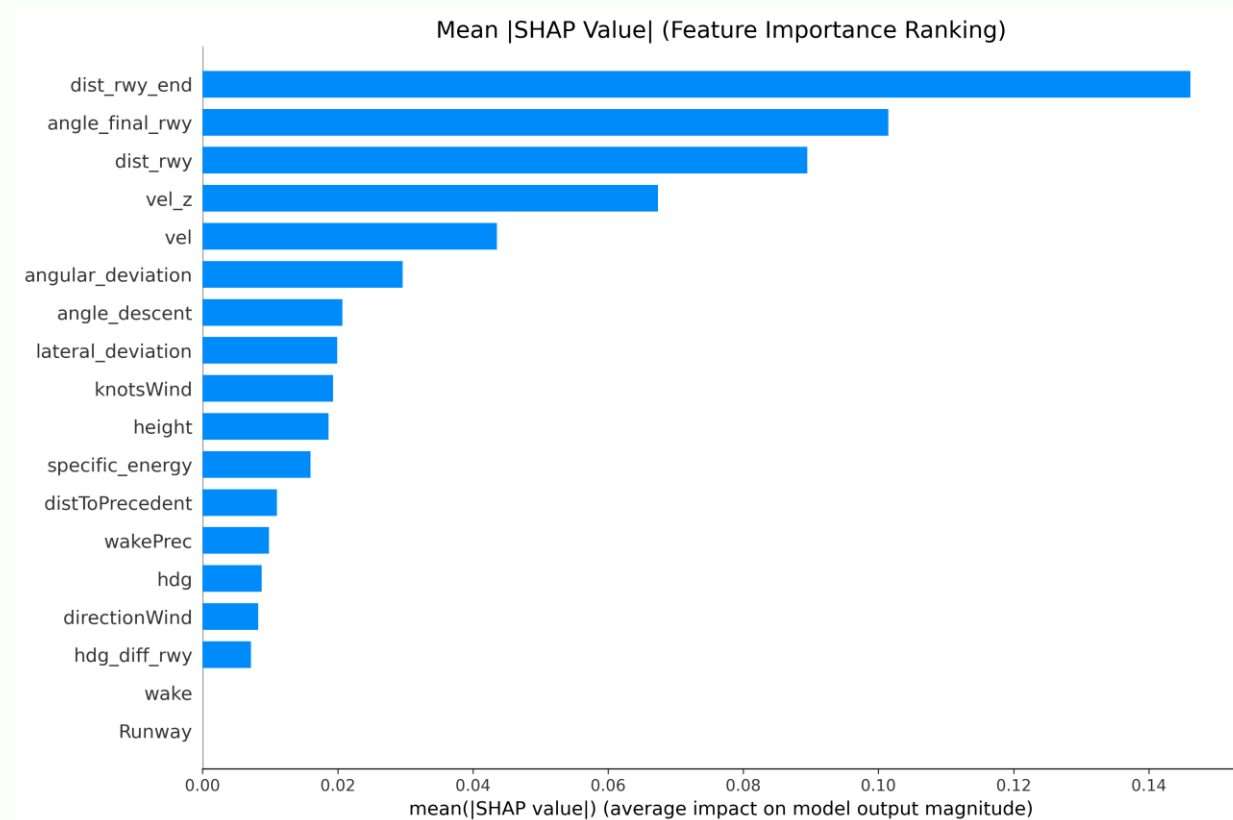
Initial Results



Generalization Study

Question: Can a model trained for one airport be implemented at another without additional training?

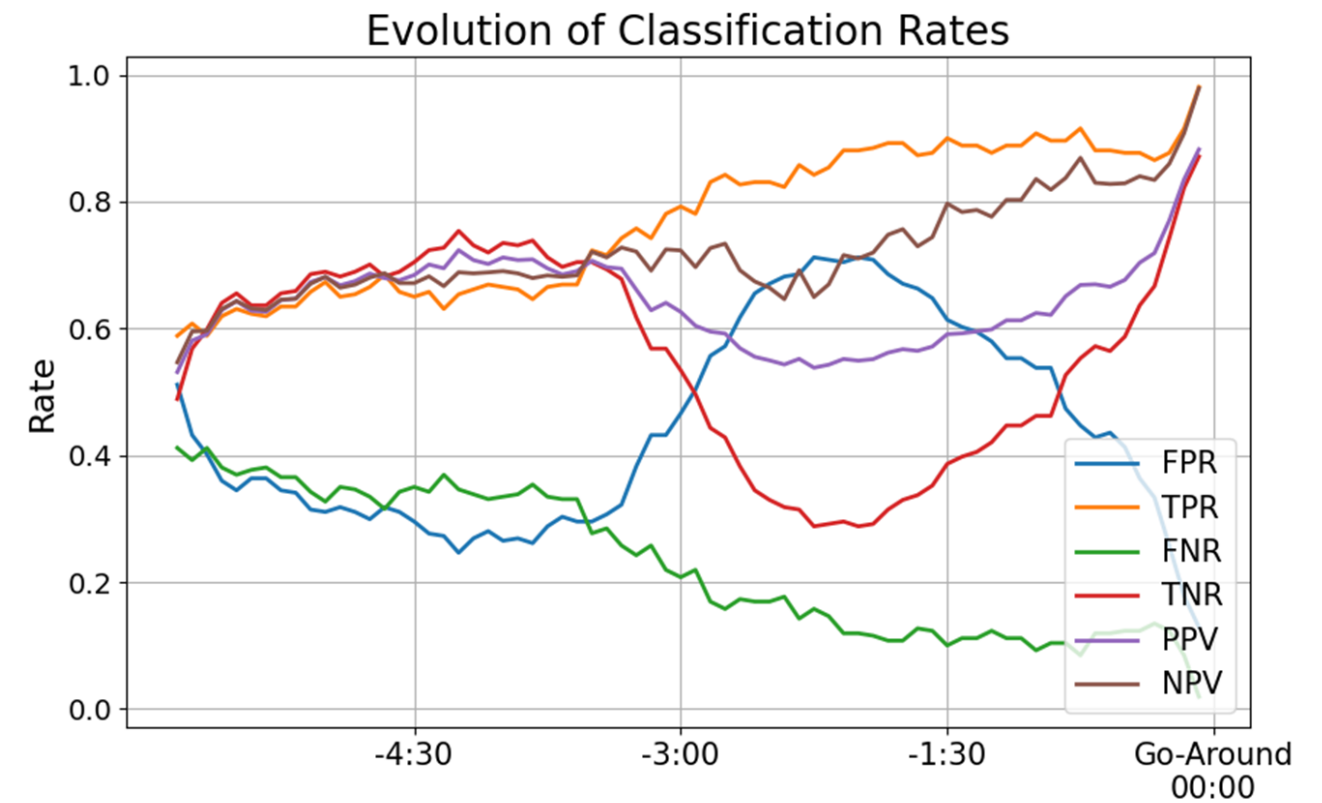
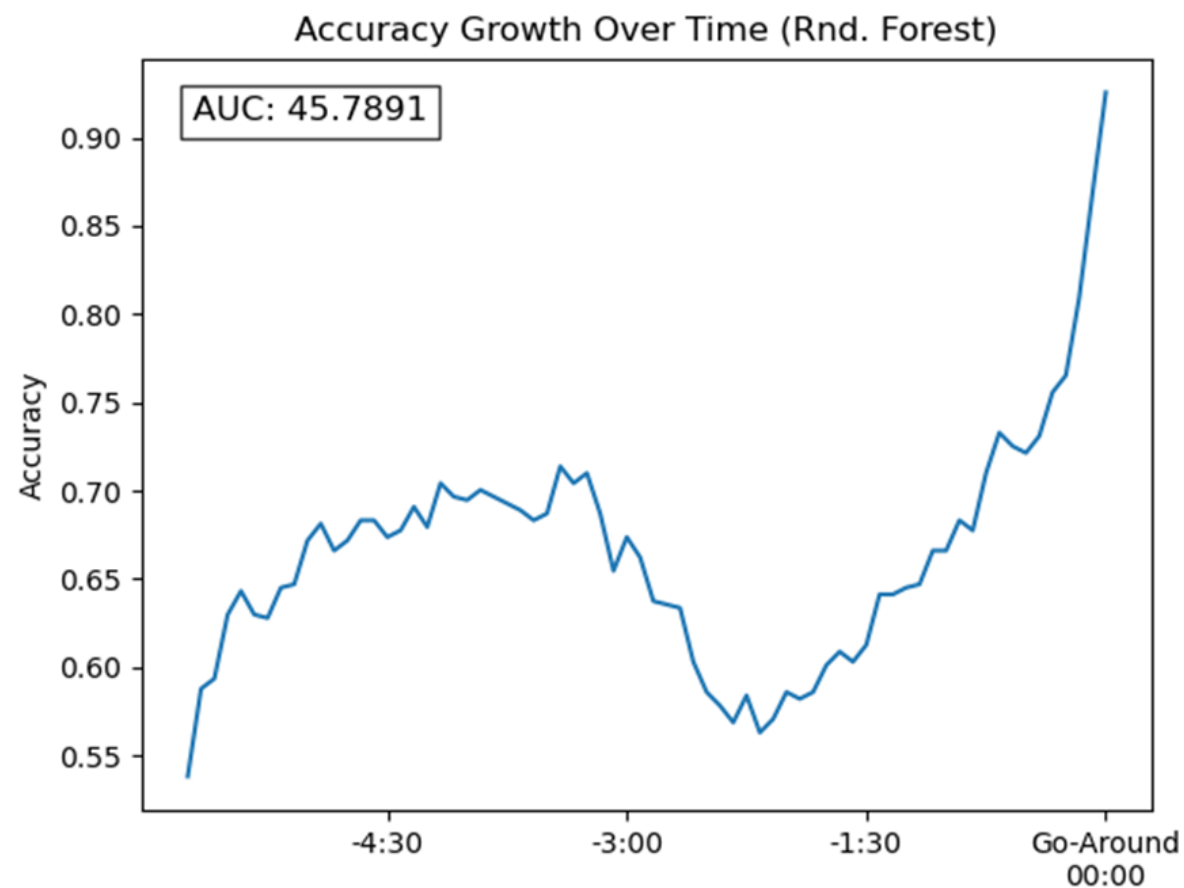
SHAP Analysis



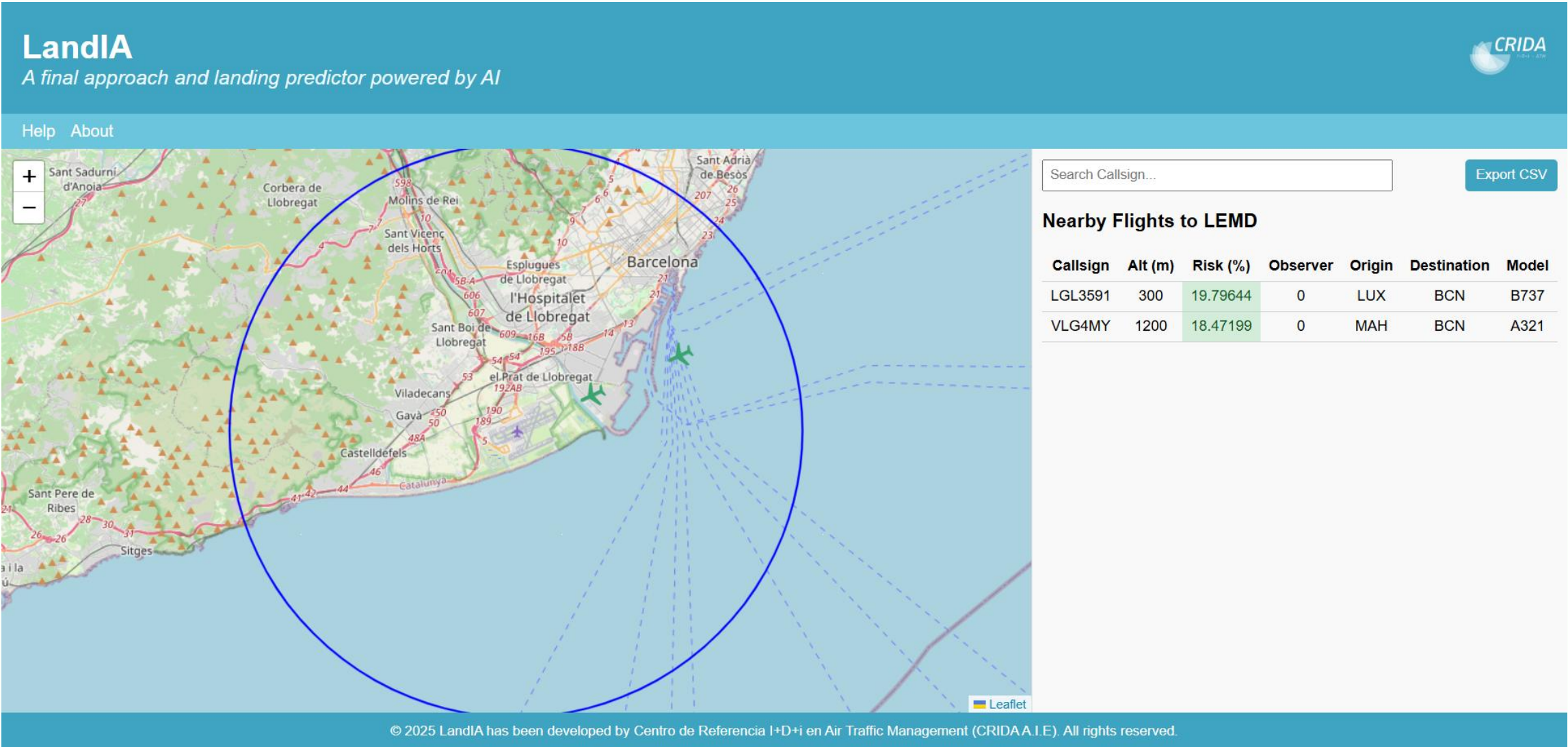
Generalization Study

Question: Can a model trained for one airport be implemented at another without additional training?

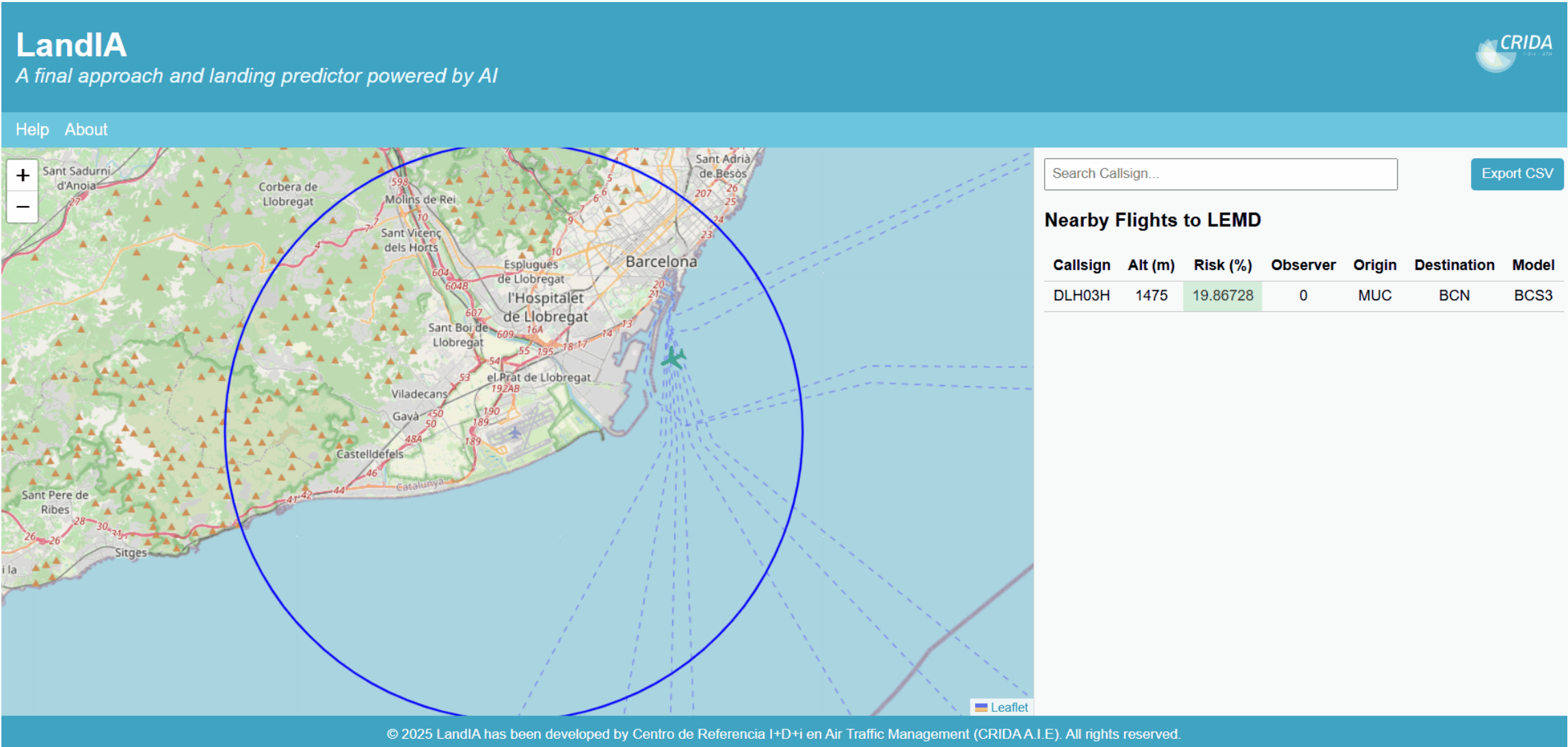
Results after removing runway-limit-related variables



Real-Time Application Prototype – LandIA



Real-Time Application Prototype – LandIA



Conclusions and Value of the Work



Decision Support

Provides proactive alerts, enabling anticipation and mitigation of potential issues.



Safety Improvement

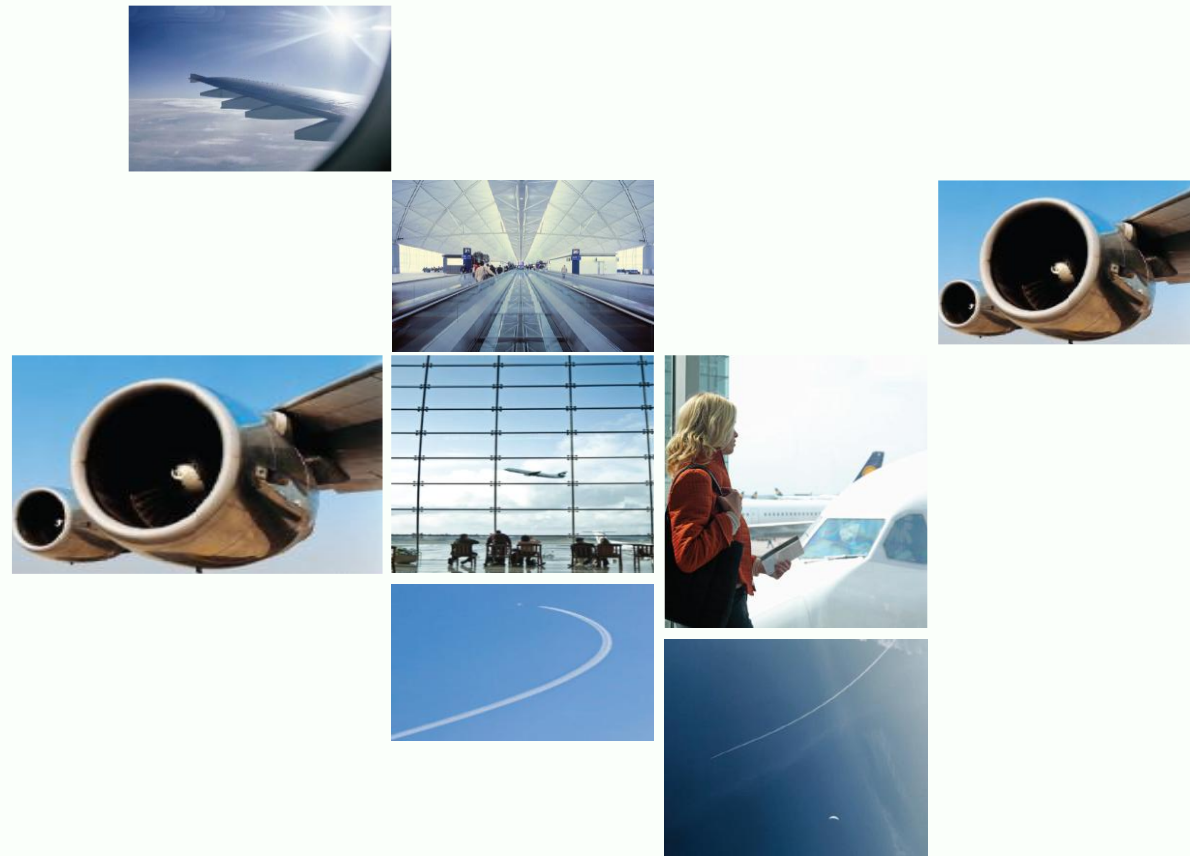
Allows for preventive adjustments, reducing the likelihood of landing-related incidents.



Capacity Optimization

Reduces delays and enables more efficient runway usage. Improves traffic flow.

Centro de Referencia I+D+i ATM



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