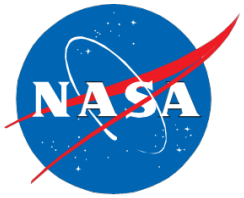

ATD-2 Integrated Arrival/ Departure/Surface (IADS) System Machine Learning Services

Departure Runway Model (DRM)

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August 2021

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Model Name

Departure Runway Model (DRM)

Problem Statement

Assigning flights to runways at an airport is a critical function that influences all aspects of airport operations and performance. These assignments, made by air traffic controllers, indicate the runway on which a flight must land or take off from. While considerable previous research has been devoted to optimizing these assignments (e.g., to maximize throughput), the data-driven models developed for this work focus on predicting runway assignments based on previously-observed operations.

This model predicts the specific runway on which a flight will depart, beginning several hours before that takeoff is expected to occur. Separate models are trained for each airport.

Technical Approach

The deployed models use an XGBoost Classifier for making predictions. This ML model is wrapped in a scikit-learn Pipeline to handle imputation and encoding of input data. The scikit-learn Pipeline is further wrapped in custom code developed for the project to apply a rule-based approach to exclude unknown or invalid data that may be presented in a live setting.

Model Features

Feature	Sample Value
Lookahead: time between when model is asked for a prediction and when flight is expected to pushback	12480 seconds
Expected departure fix name	GRABE
Filed flight plan indicator: indicator as to whether the flight plan from which the fix value is derived was actually filed by the operator, or was assumed by the automation systems	FALSE
Airport configuration name	D_17R_18R_A_17C_17R_18R
Aircraft engine class	JET
Wake turbulence category	D

Model Inputs & Outputs

See OpenAPI specification in the appendix.

Data Sets

The model training and test dataset was extracted from a fused dataset of the TFMS, TBFM, and STDDS SMES feeds. Features were derived from all three of these data sources. The D-ATIS feed provided the time series of airport configurations used to train the model. The actual takeoff runways that are the target value for the models are not available in any of these sources. As a result, these were derived using a custom process that uses airborne and surface surveillance data, and airport layout information.

Because the various input data are available at different instants and at different intervals, the data were resampled at 60 second intervals, with values carries forward. Thus, the dataset is very large, with significant repeated data.

The dataset for these models was drawn from January 1, 2021 - June 30, 2021. Of the full dataset, 10% of the observations are reserved for model testing.

Model Results / Evaluation

Airport	Accuracy: training dataset	Accuracy: test dataset	Precision	Recall	AUC
KDFW	0.888	0.888	0.891	0.888	0.966
KDAL	0.711	0.699	0.726	0.699	0.922
KCLT	0.919	0.915	0.917	0.915	0.985
KEWR	0.993	0.994	0.993	0.994	0.904
KJFK	0.981	0.978	0.972	0.978	0.976
KLGA	0.988	0.984	0.984	0.984	0.989
KBOS	0.891	0.896	0.905	0.896	0.978
KPHL	0.965	0.962	0.960	0.962	0.979
KIAH	0.809	0.803	0.806	0.803	0.962

Open Source Repository

https://github.com/nasa/ML-airport-departure-runway

Reference Documentation

Churchill, A., Coupe, W., Jung, Y., “Predicting Arrival and Departure Assignments with Machine Learning,” AIAA AVIATION Forum, Washington, DC, USA, 2021.

Appendix: OpenAPI Specification

Explore

Departure Runway OVC Client

1.0.0-dev17 OAS3

Departure Runway OVC Client

Servers

http://localhost:9094/ - Departure Runway OVC Client

Computed URL: `http://localhost:9094/`

Server variables

port 9094

default

POST /

Schemas

DepartureRunwayRequest {

airport* string
example: KEWR

airport

flights* [...]

}

DepartureRunwayRequestFlight {

```
    aircraftEngineClass      string
                             example: JET
                             nullable: true

                             aircraft engine class

    airportConfigurationName string
                             example: D_22R_A_22R
                             nullable: true

                             airport configuration name

    departureFixSourceData   string
                             example: NEWEL
                             nullable: true

                             the departure fix from source data

    filedFlight              boolean
                             example: TRUE
                             nullable: true

                             filed flight

    gufi                     string
                             example: N338LS.EWR.LAS.200422.1601.0003.TFM
                             nullable: true

                             gufi

    lookahead                integer($int32)
                             example: 14127
                             nullable: true

                             lookahead

    wakeTurbulenceCategory   string
                             example: D
                             nullable: true

                             wake_turbulence_category

}
```

DepartureRunwayResponse {

```
    airport*                 string
                             example: KEWR

                             airport

    flights*
                                 [...]
}
```

DepartureRunwayResponseFlight

```
{
    departureRunwayPredicted*           string
                                        example: 4L

                                        departure_runway_predicted

    departureRunwayPredictedProbability* number
                                        example: 0

                                        departure_runway_predicted_probability

    error                               string
                                        example: ABC123.CLT.MEX

                                        error description

    gufi*                               string
                                        example: N338LS.EWR.LAS.200422.1601.0003.TFM

                                        gufi

}
```