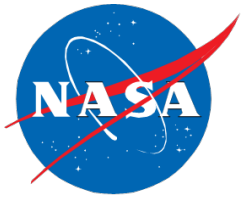

ATD-2 Integrated Arrival/ Departure/Surface (IADS) System Machine Learning Services

Arrival Runway Model (ARM)

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Table of Contents

Model Name

Arrival Runway Model (ARM)

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 land, beginning several hours before that landing 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
Look-ahead: time between when model is asked for a prediction and when flight is expected to land	9295 seconds
Expected arrival fix name	BRDJE
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	TRUE
Arrival runway assigned by TBFM	17C
Airport configuration name	D_17R_18R_A_17C_17R_18R
Aircraft engine class	JET
Wake turbulence category	C

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 airport configurations used to train the model. The actual landing 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	0.636	0.625	0.627	0.625	0.936
KDAL	0.751	0.736	0.729	0.736	0.885
KCLT	0.804	0.794	0.791	0.794	0.932
KEWR	0.962	0.962	0.961	0.962	0.884
KJFK	0.799	0.778	0.778	0.778	0.944
KLGA	0.984	0.977	0.977	0.977	0.991
KBOS	0.966	0.962	0.955	0.962	0.968
KPHL	0.882	0.872	0.861	0.872	0.957
KIAH	0.738	0.714	0.717	0.714	0.930

Open Source Repository

https://github.com/nasa/ML-airport-arrival-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

Arrival Runway OVC Client

1.0.0-dev22 OAS3

Arrival Runway OVC Client

Mosaic ATM - Website
Send email to Mosaic ATM

Servers

http://localhost:9104/ - Arrival Runway OVC Client

Computed URL: `http://localhost:9104/`

Server variables

port 9104

default

POST /arr-rwy-ovc

Schemas

ArrivalRunwayOvcRequest {

airport* string
example: KIAH

airport name

flights* [...]

}

ArrivalRunwayOvcRequestFlight {

```
aircraftEngineClass                 string
                                    example: JET
                                    nullable: true

                                    aircraft engine class

airportConfigurationLifetimeSeconds number($float)
                                    example: 3404
                                    nullable: true

                                    (time airport configuration was last updated - now),
                                    in seconds

airportConfigurationName            string
                                    example: D_15L_15R_8R_A_26L_8L
                                    nullable: true

                                    airport configuration name

arrivalFixSourceData                string
                                    example: LINKK
                                    nullable: true

                                    arrival fix source data

arrivalRunwayAssigned               string
                                    example: 27
                                    nullable: true

                                    arrival runway assigned

filedFlight                         boolean
                                    example: TRUE
                                    nullable: true

                                    filed flight

gufi                                string
                                    example: ABC123.IAH.MEX
                                    nullable: true

                                    globally unique flight identifier

lookahead                           number($float)
                                    example: 15136
                                    nullable: true

                                    (best arrival time - now) in seconds

wakeTurbulenceCategory              string
                                    example: D
                                    nullable: true

                                    wake turbulence category, using recat categories
```

}

ArrivalRunwayOvcResponse {

airport*	string *example: KIAH* airport name	
flights*	[...]	

}

ArrivalRunwayOvcResponseFlight {

error	string *example: ABC123.CLT.MEX* error description	
gufi	string *example: ABC123.IAH.MEX* globally unique flight identifier	
pred	string *example: 8L* arrival runway predicted	

}