Deep-Learning based reduction of uncertainty in MUAC's Operational System

MONDAIS 07/06/2021

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PART A: TRAJECTORY ENHANCEMENT

Context: iFMP

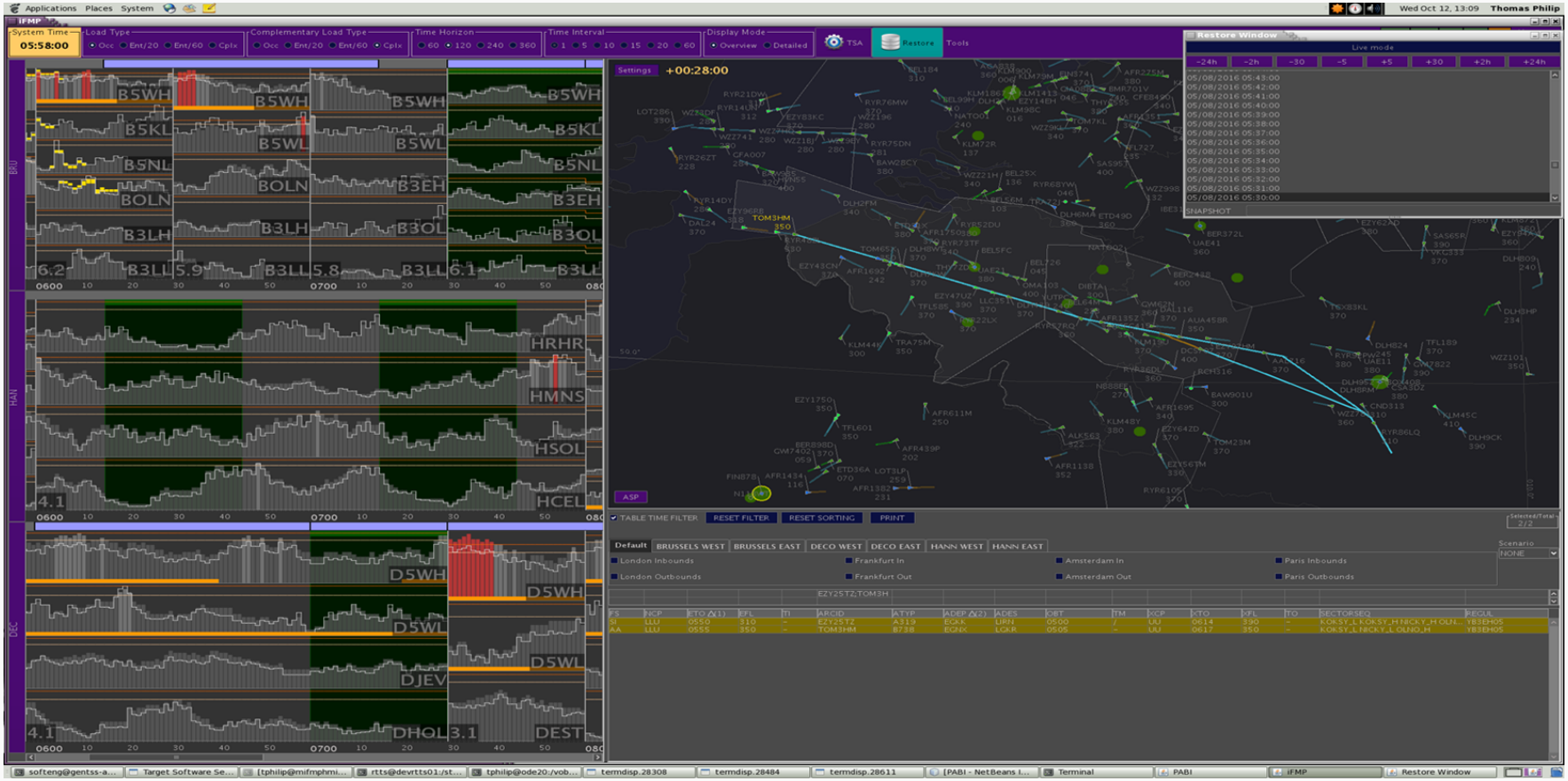

Figure 1: Overview of iFMP displayed information

Objectives

ML objective

Improve the flight plan adherence to the flown trajectories up to 6h before the flight enters MUAC area of responsibility.

Operational objective

The downstream desired effect is an improvement of the sector occupancy counting prediction.

Requisites

Decision Support System

iFMP is a DSS and as such includes a list of tools to simulate potential future situations (e.g. activate/deactivate military restricted areas, combine/split sectors, etc.) in order to make informed decisions.

As such, the proposed solution should:

- Be reactive to Military activation changes
- NOT be dependant on system changes (e.g. way-point names, military area design, letter-of-agreements with upstream and downstream centers on operational procedures, etc.)
- Be validated and monitored automatically (i.e. without OPS staff manual screening)

Learning Tricks

Our current solution is built on (i.e. inputs) an original flight plan, a military schedule and some static information about the flight (e.g. ADEP, ADES)

- Flight Plans are processed in coordinates instead of way-point names
- Military areas are mapped to a 2D grid
- Military opening times are adjusted to the flown trajectory (i.e. our target) during training
- Model is built on top of our in-house ”hard-coded” logic

Results

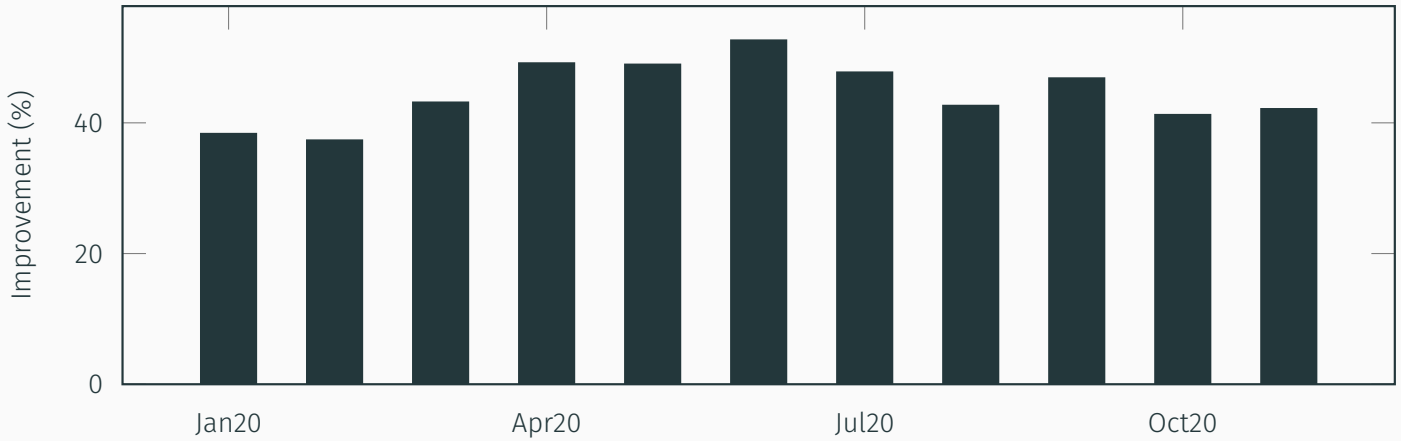

Figure 2: Horizontal Improvement of TPI over FlightPlans for South-West Flow.

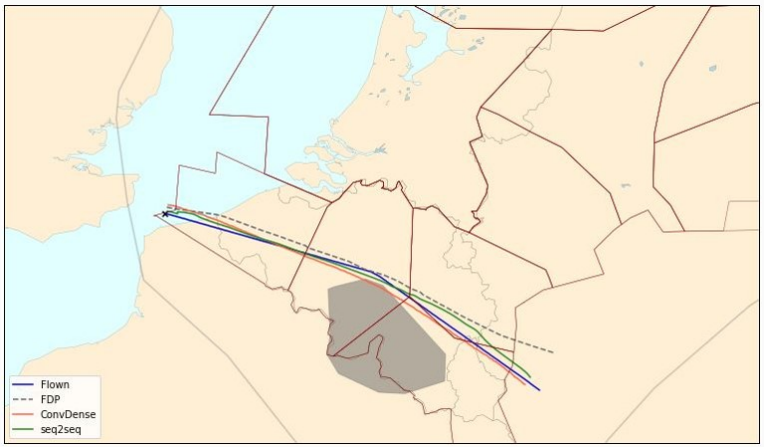

Figure 3: Situation with an activated military area

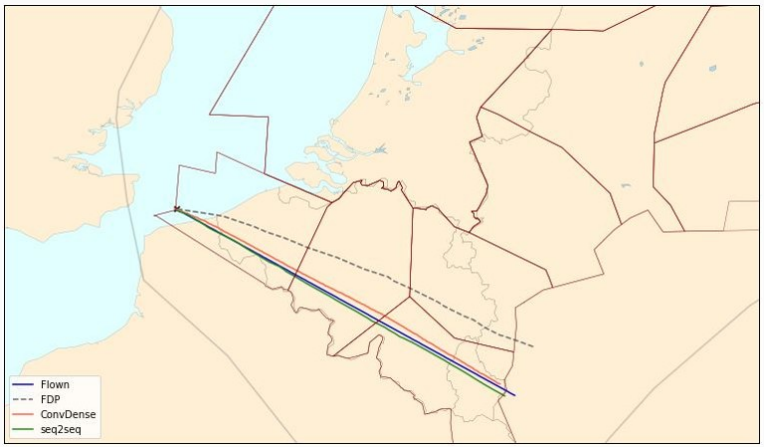

Figure 4: Situation with no military restrictions

Sector sequence artefacts

Better Trajectory do not equate to a more correct sector sequence!

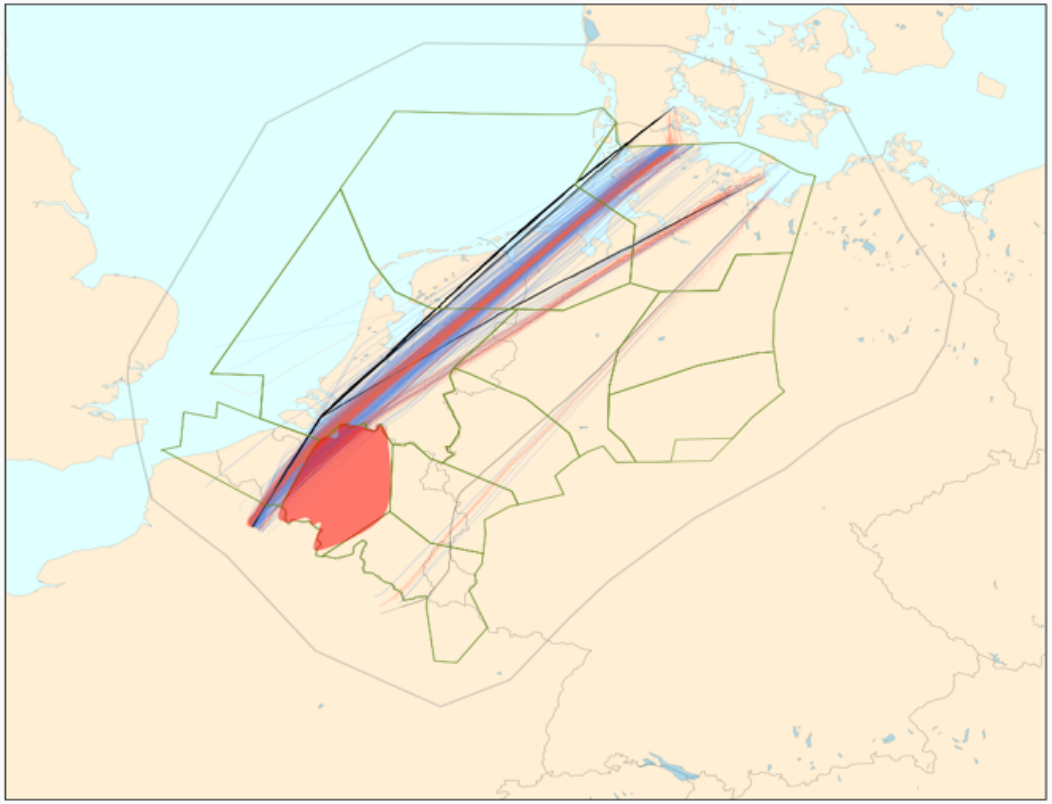

Figure 5: Example of artefact introduced by a better trajectory prediction

Current status

Development status

- Implemented since 2018 on East/South-West Flow
- 4 new flows (after ATCO validation session) added in December 2019
- TPI version updated in October 2020 to account for tracks/surveillance data
- Cover 10-15% of traffic

Framework

Tensorflow (ConvNet)

PART B: SECTOR SKIPPING

Objectives

ML objective

Binary prediction to predict sector crossed but potentially skipped because of operational working habits.

Operational objective

False Positive (i.e. yields under-counting) are more operationally critical than False Negatives. However, high level of False Negatives might hinder the ML solution credibility.

Automated validation protocol

Fair comparison of TPI+SKIP vs. FlightPlan effects on sector counting vs. reality (e.g. time adjustments, etc.)

Figure 6: Validation Dashboard screenshot

Current status

Development status

- Implemented in 2 weeks (first batch)
- Enables automatic validation and monitoring
- Theoretically enables a 100% coverage of traffic
- Cascaded implementation

Framework

Tensorflow (GRU)

TPI+SKIP

TPI

Potential improvements includes:

- Inclusion of vertical constraints in the predicted trajectory
- Expand track improvement via use of ADS-B (earlier detection of deviation)

SKIP

Potential improvements includes:

- Inclusion of surrounding traffic as predictors
- Automated selection of decision threshold per flow/situation etc.

Questions?