Supporting
European
Aviation

EUROCONTROL

AI4CNS

FLY AI Forum 2023

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EUROCONTROL
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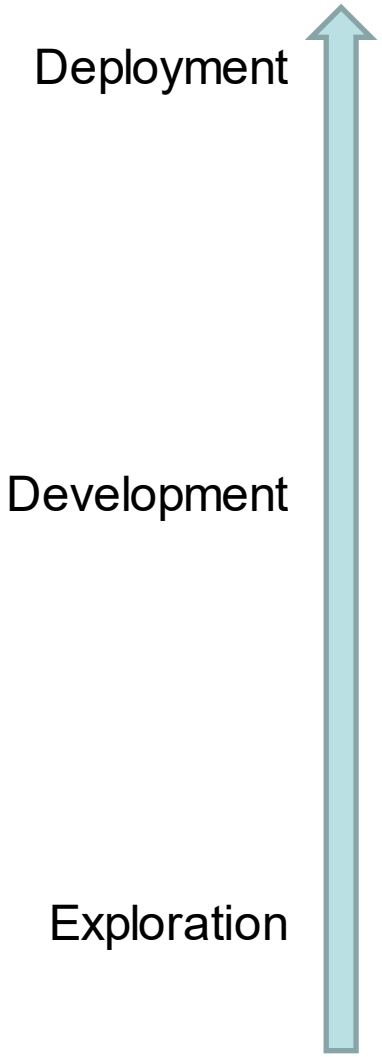
CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER
FOUNDING MEMBER sesar JOINT UNDERTAKING
NETWORK MANAGER

CNS Monitoring AI project



Surveillance monitoring
- Mode S replies decoding
- Supervised learning
- Natural Language Processing

Surveillance monitoring
- Mode S replies allocation
- Unsupervised learning
- Linear regression

GNSS monitoring
- Ionosphere gradients classification
- Supervised learning
- Neural Network

Support to MIL PBN
- Measure aircraft performances
- Supervised learning
- Neural Network

Drone monitoring
- Trajectory classification
- Unsupervised learning
- Clusterization

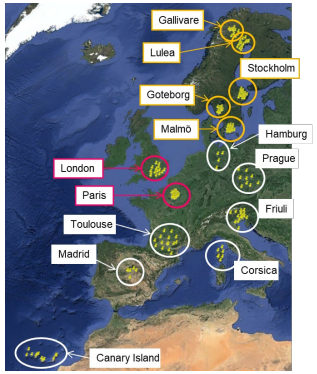
Datalink monitoring - DAISY
- DL messages anomalies
- Unsupervised learning
- Hidden Markov Model

Datalink monitoring
- DL Burst monitoring
- Supervised learning
- Neural Network

Ionosphere Monitoring in support to GBAS

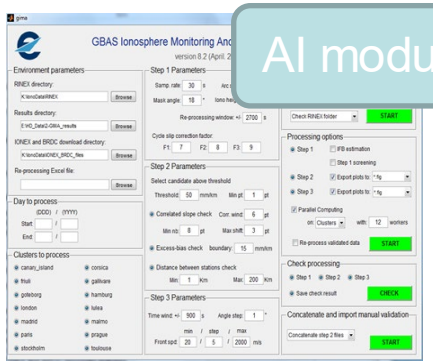
- Context and objectives: detect and characterize specific ionosphere structure potentially impacting GBAS performances and deployment
- AI technology: Machine learning on historical database, using neural network (convolutional & LSTM)

1. Data collection



- Download data from public network
- Format data into a single archive

2. Data processing

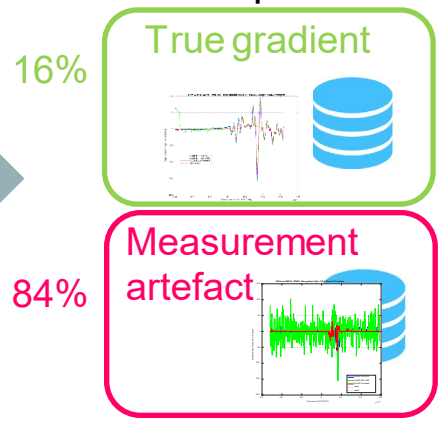


- Copy and archive all data
- Process data

3. Manual validation & results

- Manually validate all detected gradient
- ~2000 gradients/Quarter

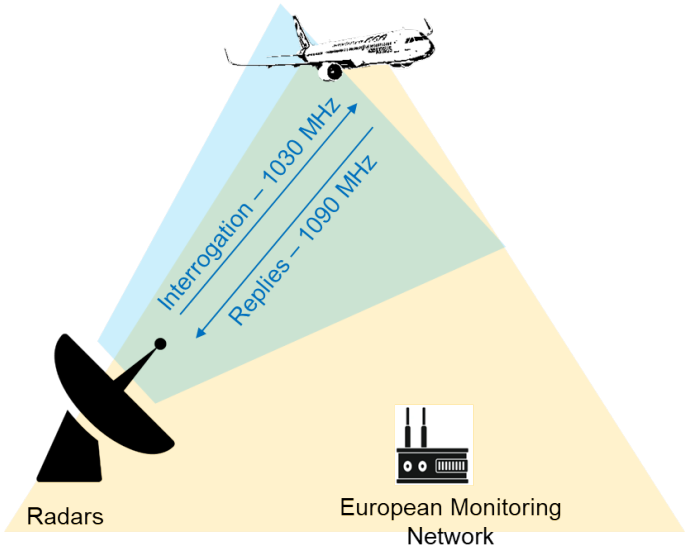
4. Report

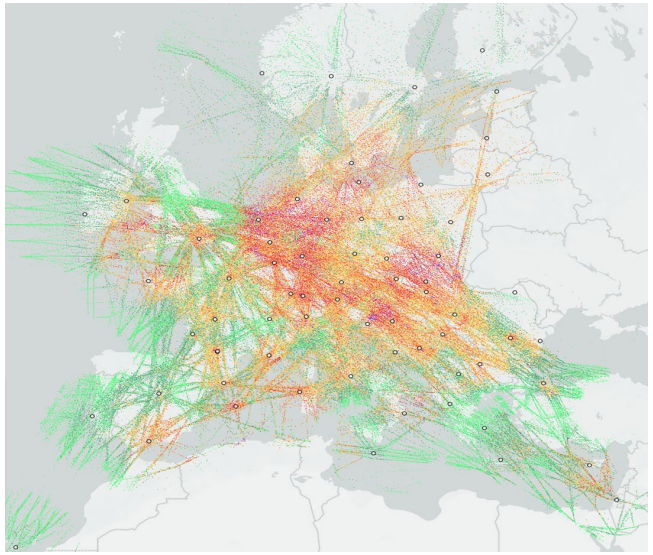


- SESAR report
- ECTL WG: LATO, IGWG
- Support to states

- Performance: Accuracy detection improvement from **8%** to **16%**

Surveillance monitoring – Mode S Context & Objectives





Aircraft – Interrogator (radar) communication characteristic:

- Ground monitoring network can receives all replies from aircraft but not the interrogations
- Only a part of the replies contains a non-unique interrogator (radar) code
- Only a part of the replies contains the message code identifier

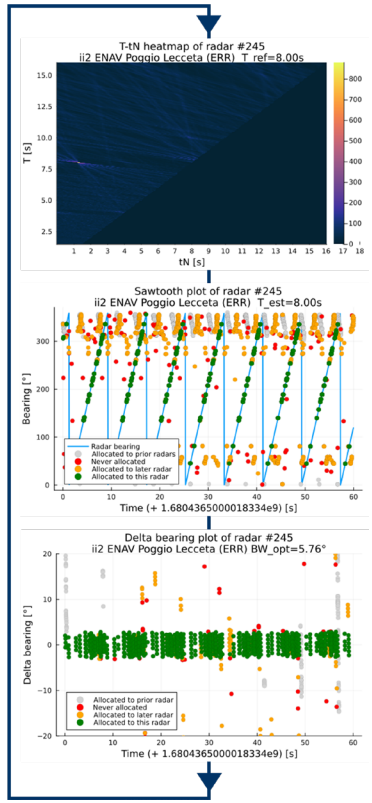
Two AI CNS surveillance monitoring projects:

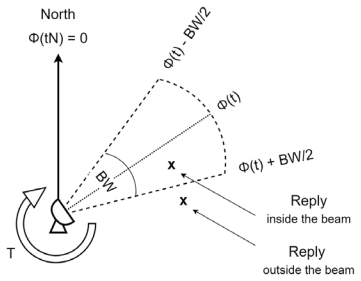
- Mode S replies allocation: **to who the aircraft is talking to?**
- Mode S replies decoding: **what is the aircraft saying?**

Surveillance monitoring – AI models

Mode S reply allocation:
Who the aircraft is talking to?

AI technology: Ordered Linear Regression



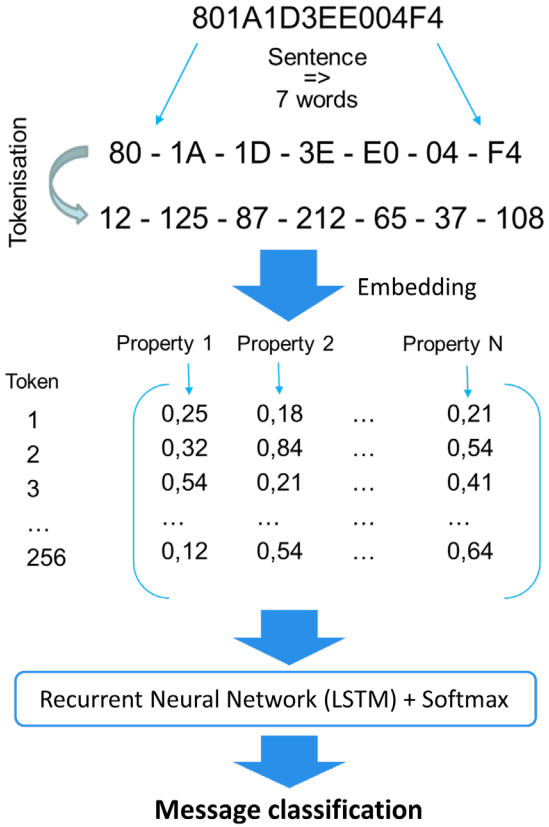


Performances:

- 91% All-Calls allocated
- 76% Roll-Calls allocated (51% to one radar only)

Mode S reply decoding:
What is the aircraft saying?

AI technology: ML based on Natural Language Processing



Performances:

Well–classified messages:

- Heuristic Approach: 99.8633%
- Py Mode S: 93,1690%
- **NLP Neural Net.: 99.9987%**

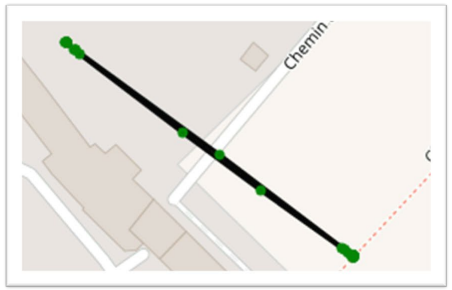
Publication:

Best of Conference paper: "Artificial Intelligence For Unidentified Mode S Registers Decoding", ICNS 2022, J. Lopez Araquistain, E. Robert, J. Ceballos Gutierrez, E. Guillot

Drone monitoring – Trajectory classification

- Context and objectives: measure the reality of drone traffic for decision based on actual data, support research projects with real traffic densities and trajectories, using a cost effective solution
- AI technology: Frugal AI – used of a priori knowledge – clustering with pseudo neural network

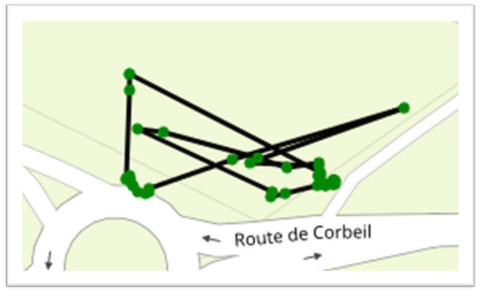
Class “H” Hover



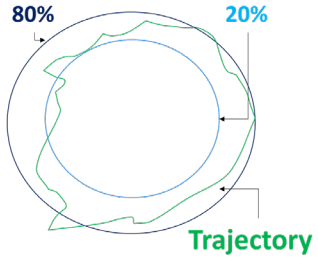
Class “S” Straight

Class “C” Circular

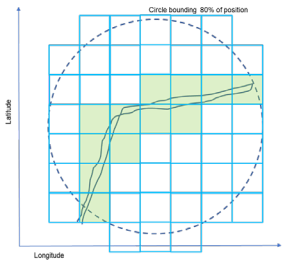
Class “M” Monitoring



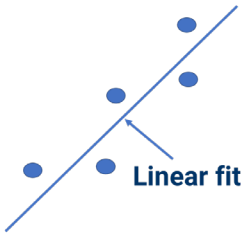
Class “K” Knot bag



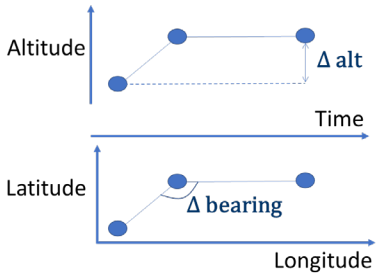
- Outer radius
- Ratio inner/outer radius



- %Covered



- Correlation coefficient

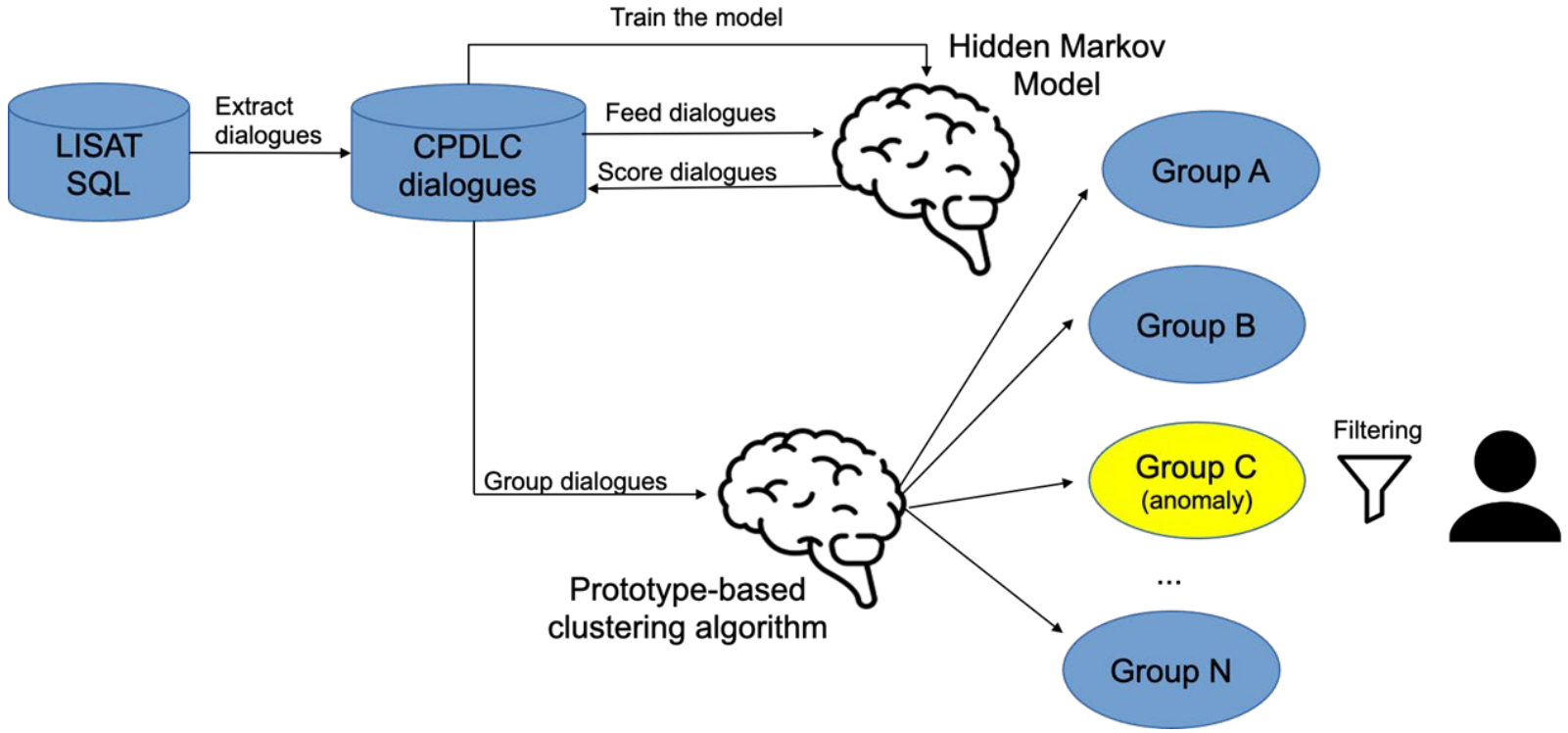


- Steady Altitude
- Median (Δ bearing)

- Performance: **78%** of trajectories well classified: H: 95%, S: 92%, K: 86%, C: 52%, M: 50%

Datalink Monitoring - DAISY

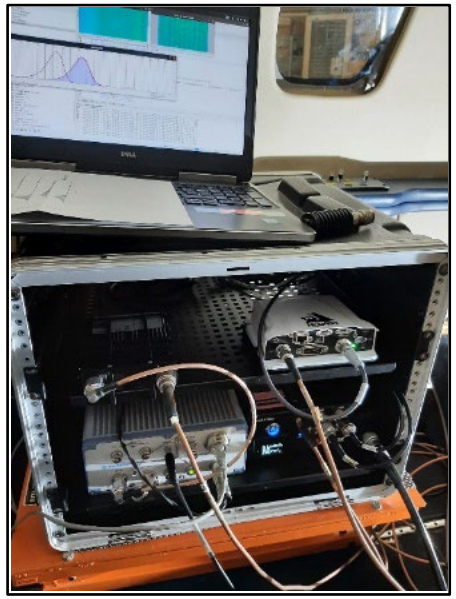
- Context and objectives: Leverages datalink monitoring data, identifies and groups patterns in sequences of datalink events, reduces investigation effort in finding anomalies
- AI technology: Hidden Markov Model & K-mean clustering

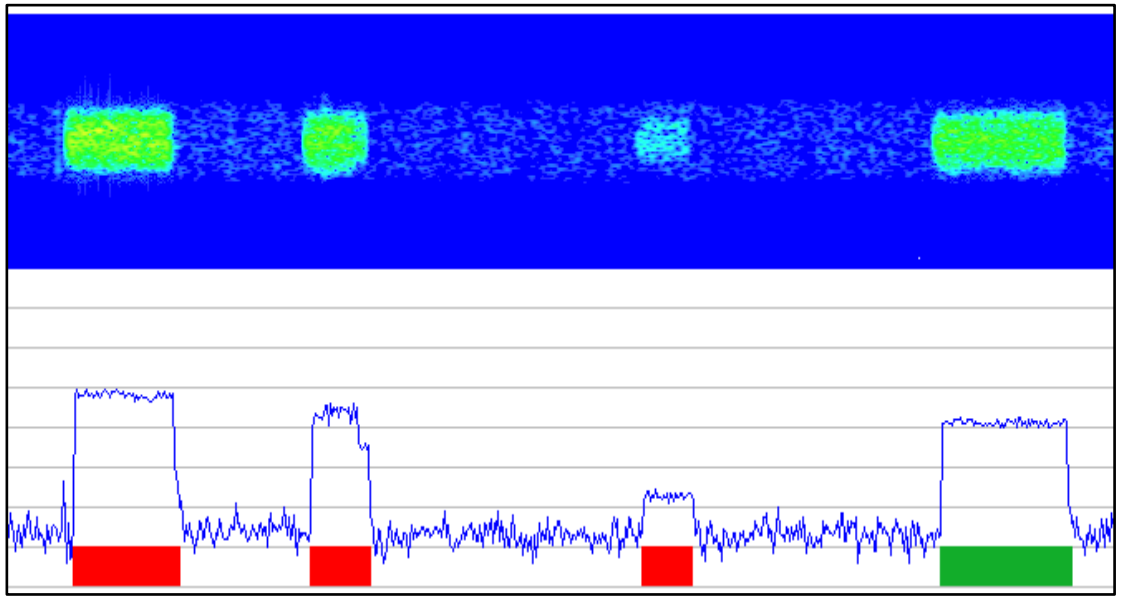


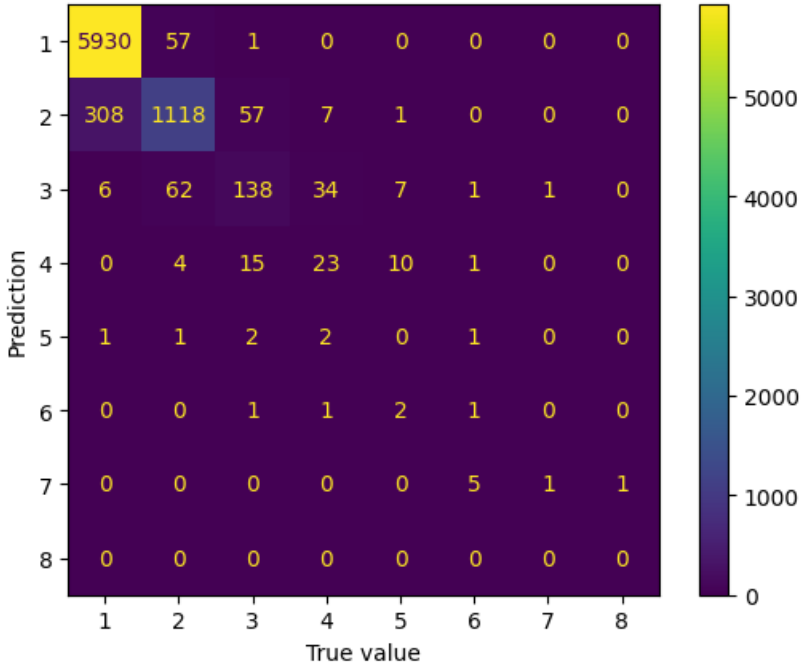
- Performance: Reduction of analyst's time to find data patterns – **from hours to minutes.**

Datalink Monitoring – Burst collisions assessment

- Context and objectives: Detect and characterize VDL2 burst collisions from RF monitoring flight sensing.
- AI technology: Machine learning using neural network (convolutional & LSTM)



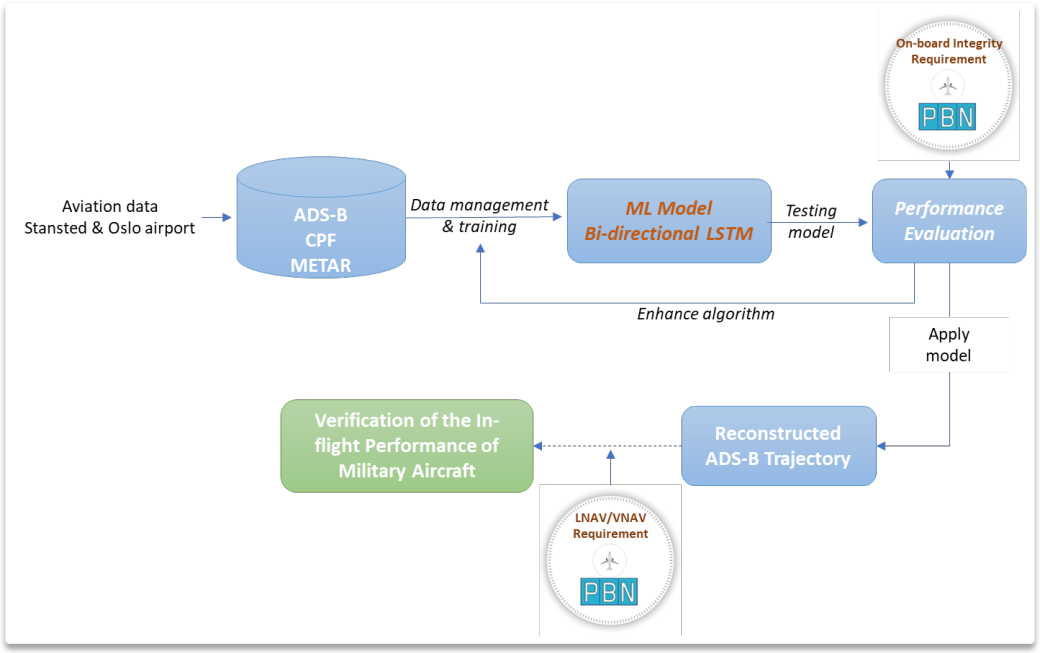


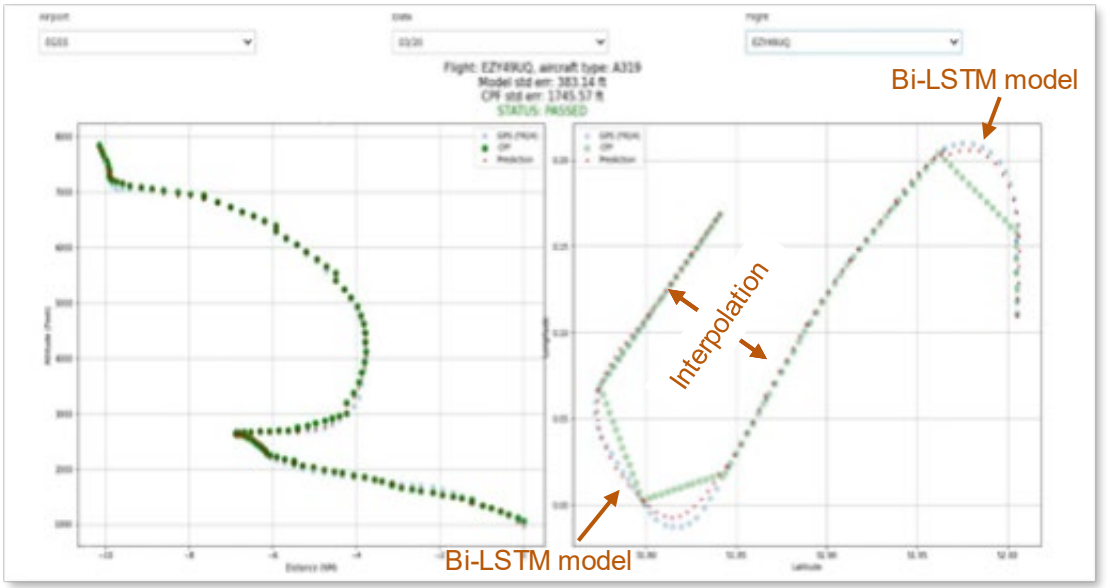


- Performance: **99.55%** correct number of +/- 1 collision estimates

Helping military aircraft fly Performance-Based Navigation

- Context and objectives: Measure the total system error of military aircraft to support certification processes of on-board GPS PPS receiver
- AI technology: Machine learning using neural network (Bi-directional LSTM)



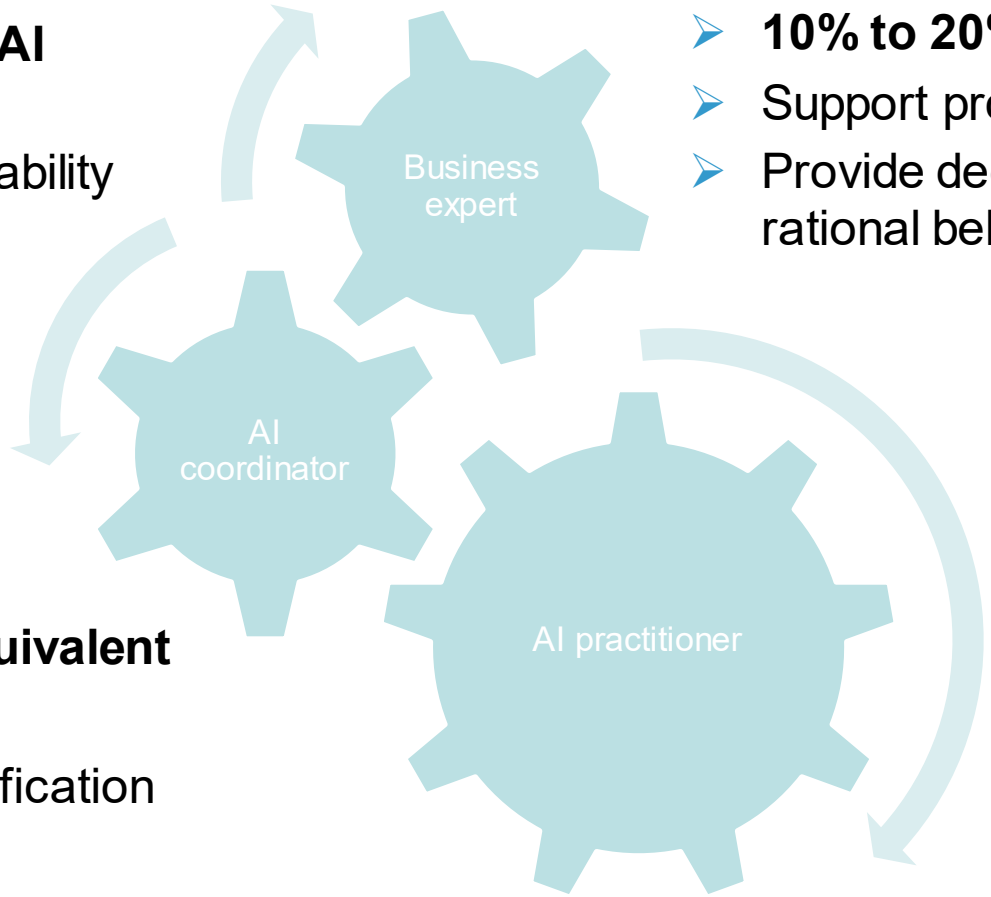


- Performance: Usability rate of **90%** for business application

Building an AI model - Effort and organisation considerations

Typical project

- **4-6 month for prototype & AI model development**
- High-end computational capability may be required



Business expert

- **10% to 20% Full-Time-Equivalent**
- Support problem definition
- Provide deep understanding of data, Identify rational behind data outliers

AI coordinator

- **10% to 20% Full-Time-Equivalent**
- Link AI practice to business
- Support opportunities identification
- Support AI model selection

AI practitioner

- **Full-time activity**
- 20% AI model development
- 80% data preparation, cleaning, augmentation….

Conclusion & Take-home messages

Identify miss-classified – Improve dataset – optimize model
Do it again!!

ML can only be as good as the **data** you use to **train** it

Feature extraction is key. Most of the time and effort goes into **data cleansing** and **feature engineering**

Use **simple models first**, use complex ones as a second step

Today's AI systems are trained to do a **clearly defined task**

AI **can learn** to do something but still **don't understand it**