SUPPORTING
EUROPEAN
AVIATION

AI4CNS

FLY AI FORUM 2024

Emilien Robert
April 2024

CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER

FOUNDING MEMBER sesar JOINT UNDERTAKING

NETWORK MANAGER

AI4CNS: The use of AI in CNS

1) **Where do we use AI?** Where the data stands: CNS Monitoring Function

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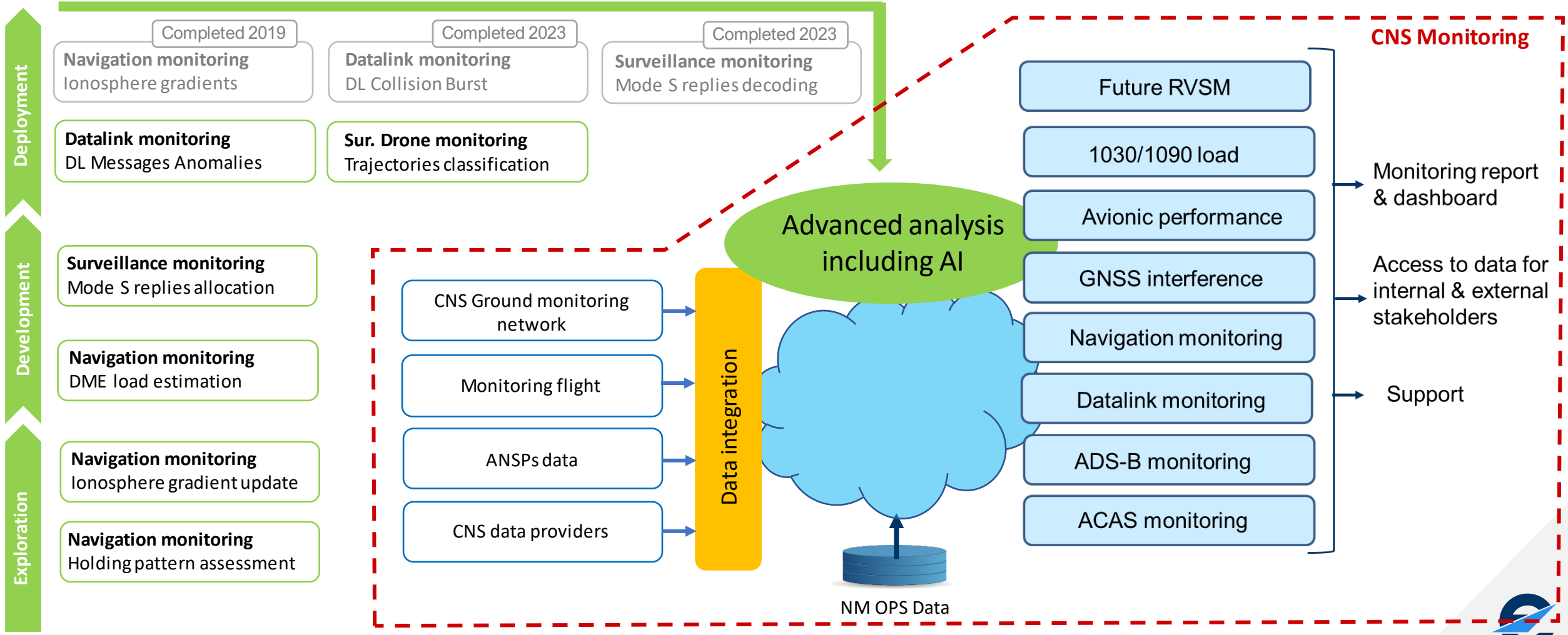
AI4CNS: CNS Monitoring enhanced by AI

AI-Based Projects enhancing CNS monitoring capability



AI4CNS: The use of AI in CNS

1) **Where do we use AI?** Where the data stands: CNS Monitoring Function

2) **What do we use AI for?**
    1) Automating data processing and outliers detection

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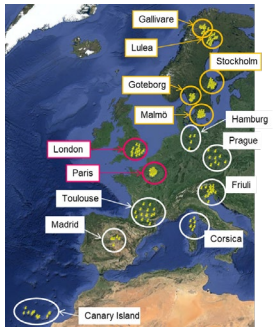
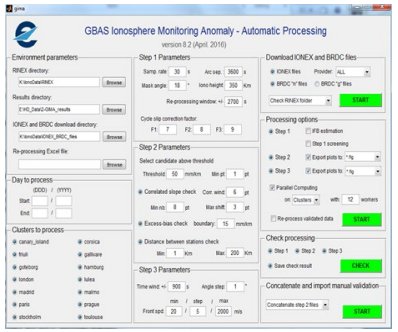
AI4CNS: Automating data processing

- Ionosphere monitoring: detect and characterize specific ionosphere structure potentially impacting GBAS performances and deployment

1. Data collection

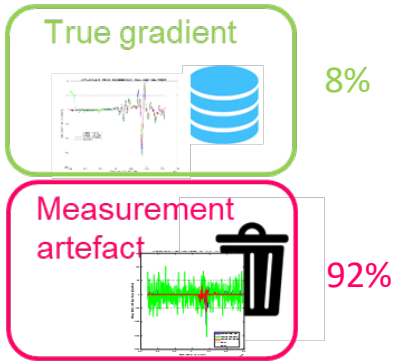


2. Data processing



3. Manual validation

4. Report



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AI4CNS: Automating data processing

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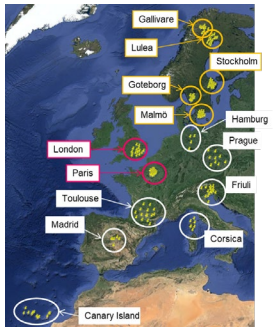

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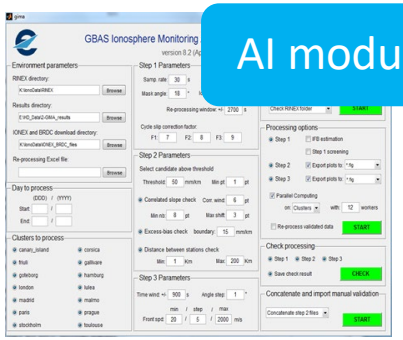

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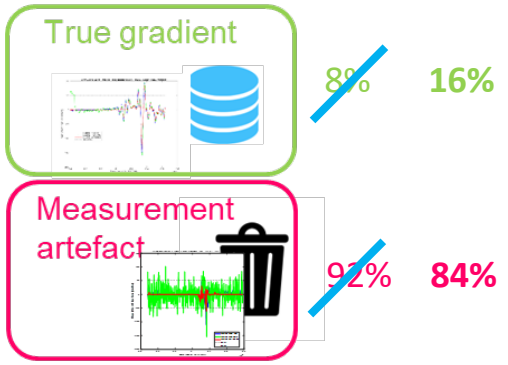

AI4CNS: Automating data processing

- **Ionosphere monitoring:** detect and characterize specific ionosphere structure potentially impacting GBAS performances and deployment

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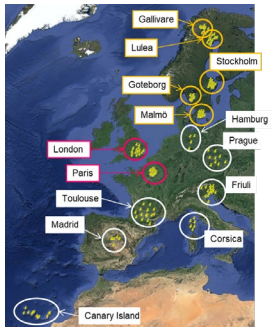

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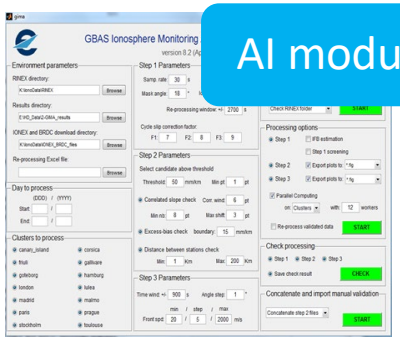

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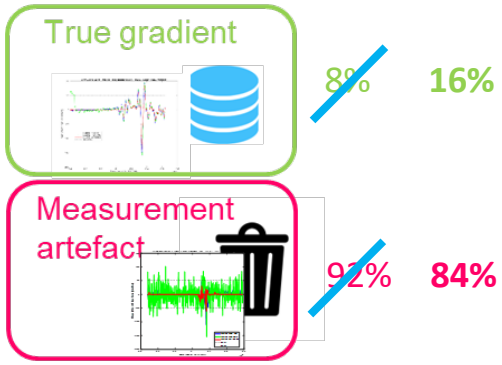
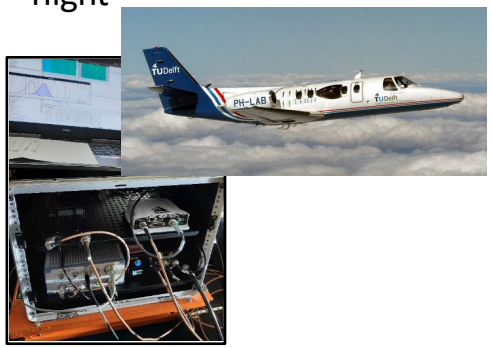
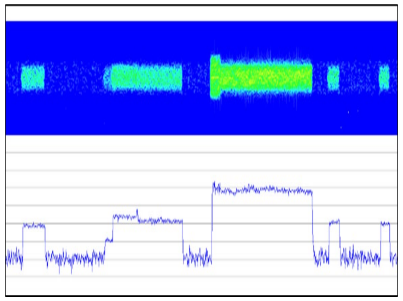


- **Datalink burst collisions assessment:** Detect and characterize VDL2 burst collisions from RF monitoring flight sensing.

1. Data collection from monitoring flight



2. Data processing



3. Manual collision estimation

4. Report

Based on 2% sub-samples of data

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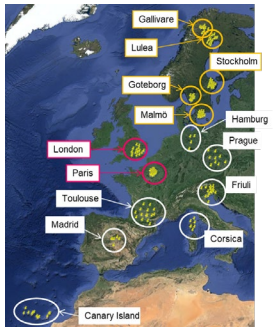
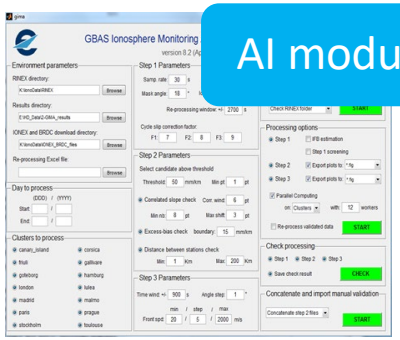
AI4CNS: Automating data processing

➢ Ionosphere monitoring: detect and characterize specific ionosphere structure potentially impacting GBAS performances and deployment

1. Data collection



2. Data processing



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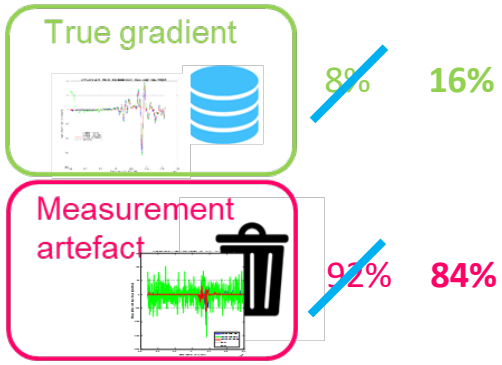

➢ Datalink burst collisions assessment: Detect and characterize VDL2 burst collisions from RF monitoring flight sensing.

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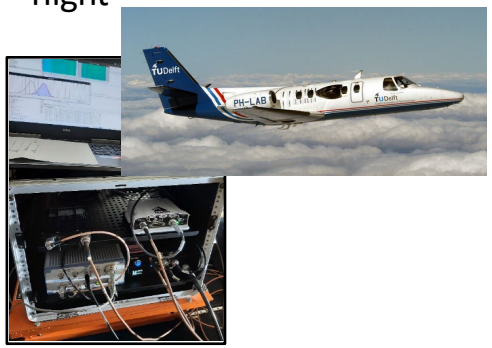
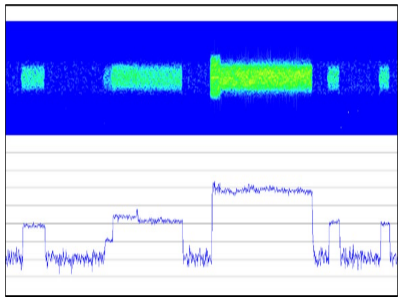


2. Data processing



3. Automatic collision estimation

AI module

98% accurate

4. Report

Based on 100% of data

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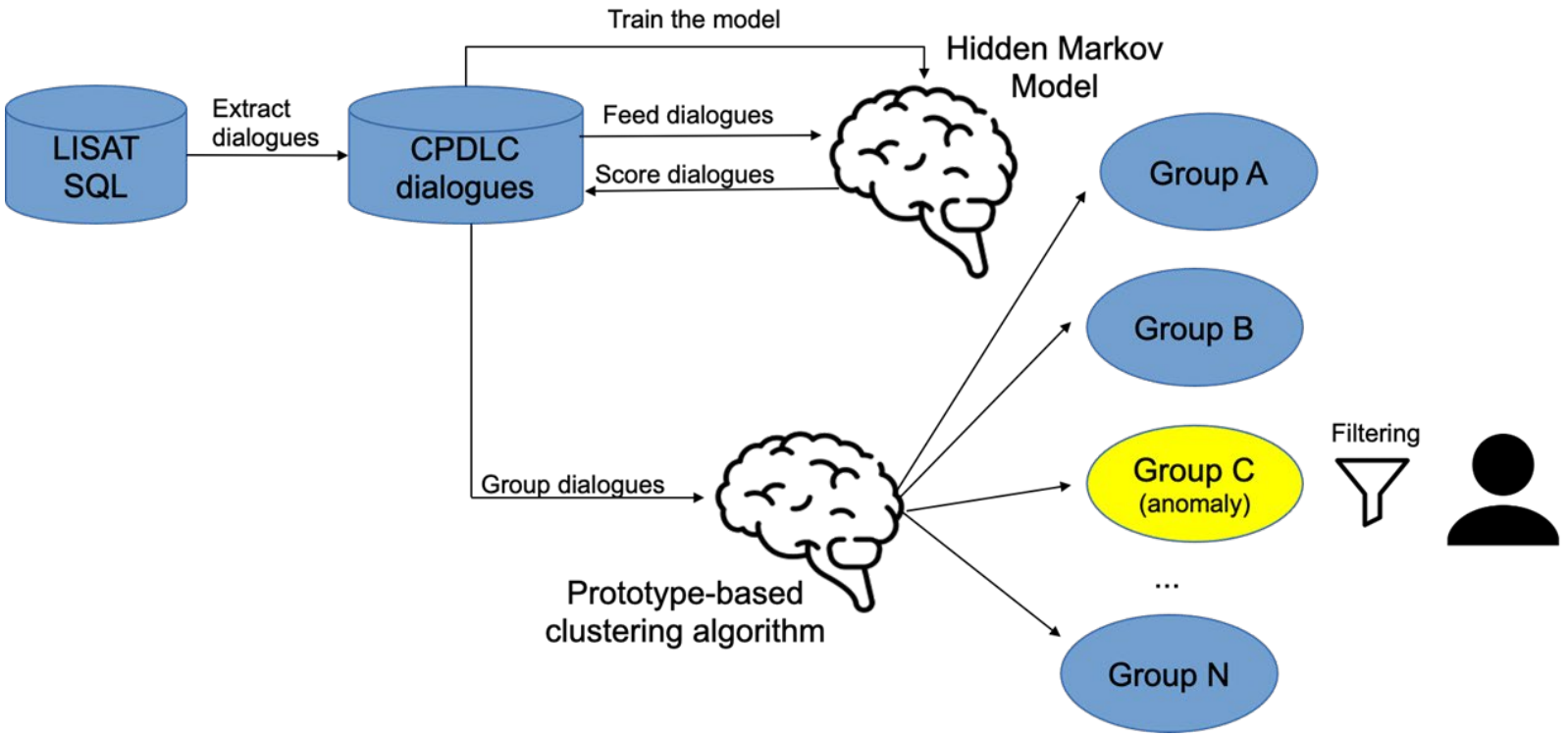
AI4CNS: Automating outliers detection

- 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.**

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AI4CNS: The use of AI in CNS

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    2) Improve data quality & completeness, creating more data

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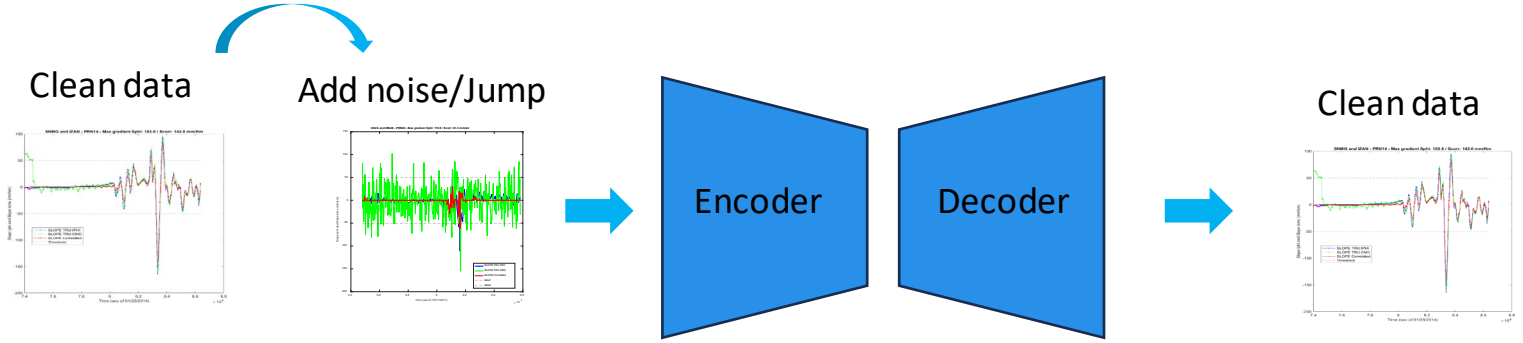
AI4CNS: Improving data quality

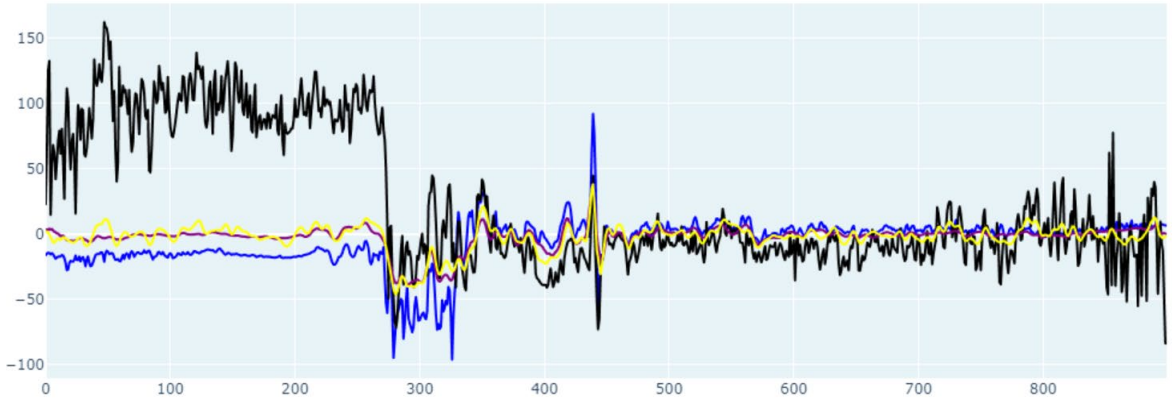
➢ Ionosphere monitoring update: improving data quality before classification

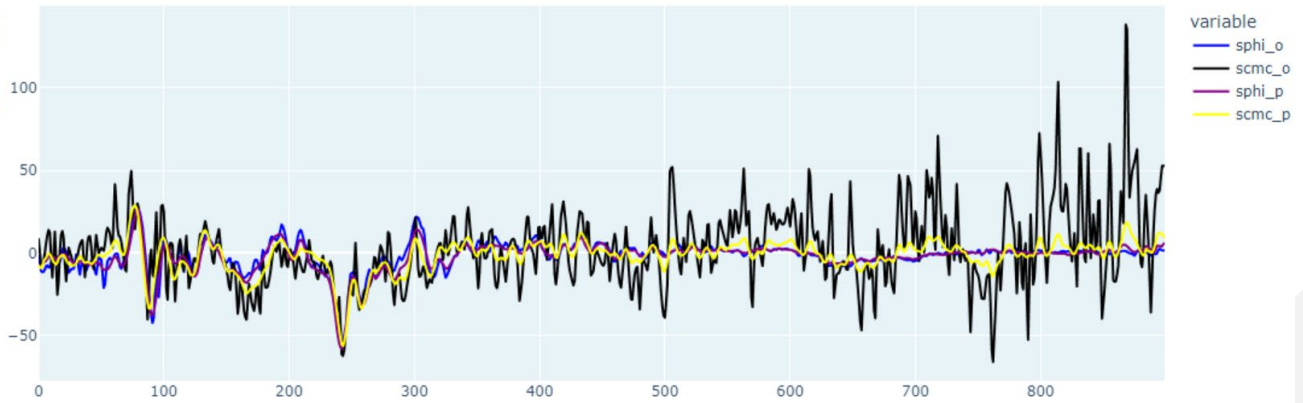
Training an encoder/decoder

- A large part of data include noise and data jumps
- An encoder/decoder has been trained on “clean” data on which typical noise and data jump have been added



Applying the encoder/decoder on all data to improve data quality





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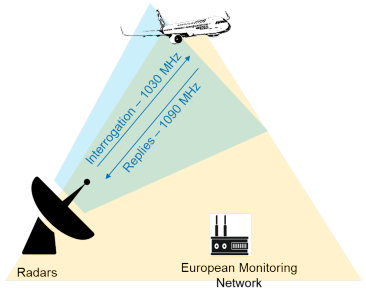
AI4CNS: Completing collected datasets

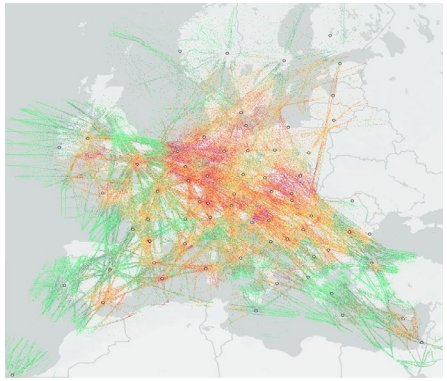


Aircraft – Interrogator (radar) communication characteristic:

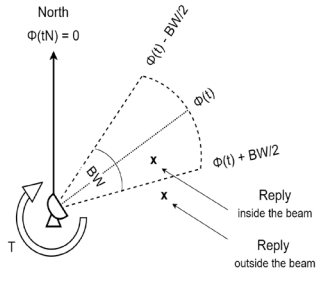
- Ground monitoring network can receives all replies from aircraft but not the interrogations
- Only a part of the replies contains a non-unique interrogator (radar) code
- Only a part of the replies contains the message code identifier

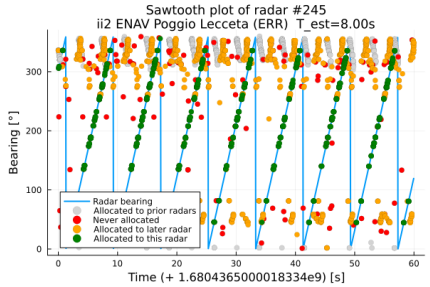
Mode S reply allocation:

Who the aircraft is talking to?

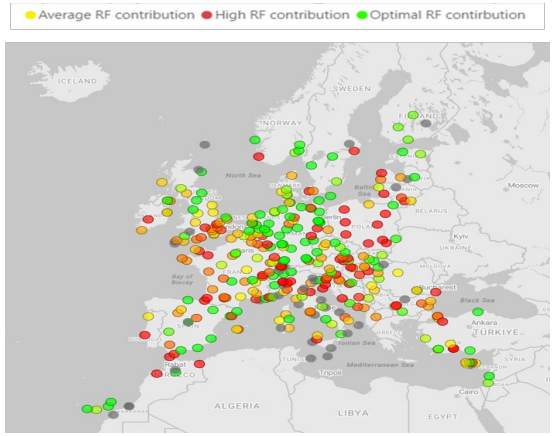


Ordered Linear Regression





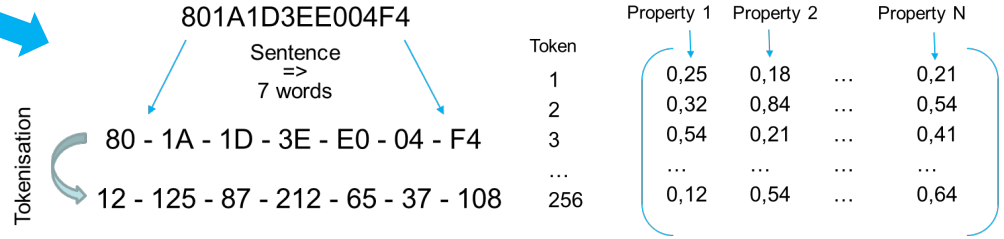
Monitoring KPI



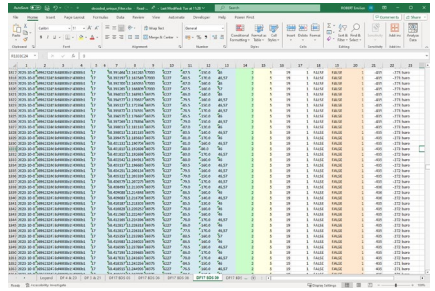
Mode S reply decoding:

What is the aircraft saying?

AI based on Natural Language Processing



Fully decoded data for investigations



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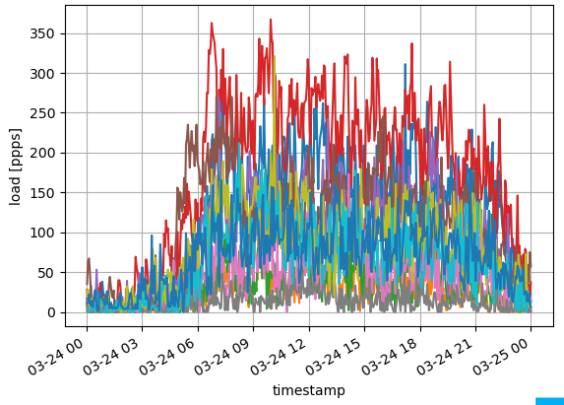
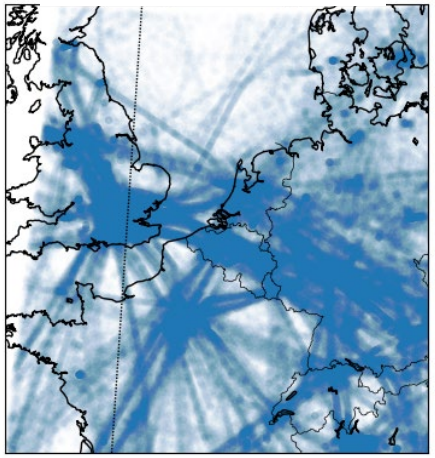
AI4CNS: Creating more data

- DME Load assessment: assess fleet equipage in term of DME interrogator and identify on-board DME selection rules

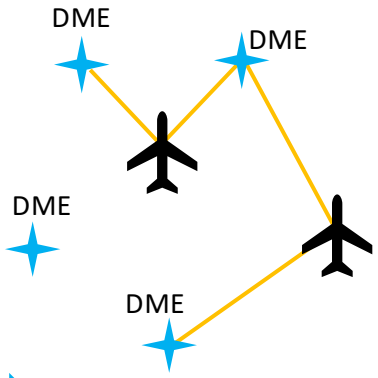
Measure DME load over Belgium

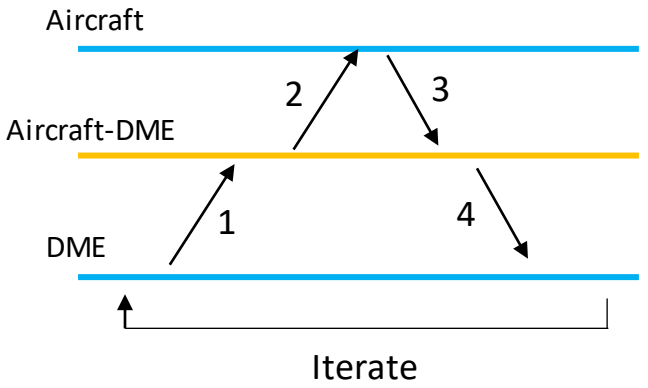


Actual Traffic



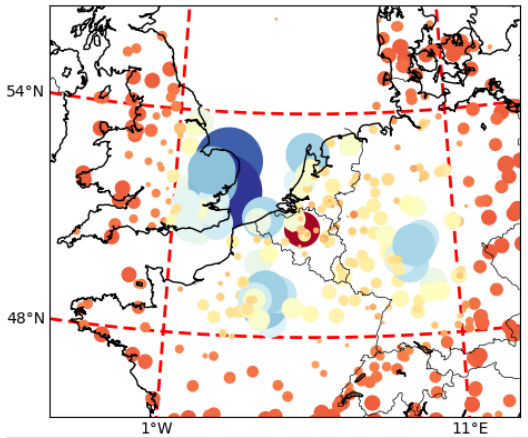
Graph Neural Network Symbolism

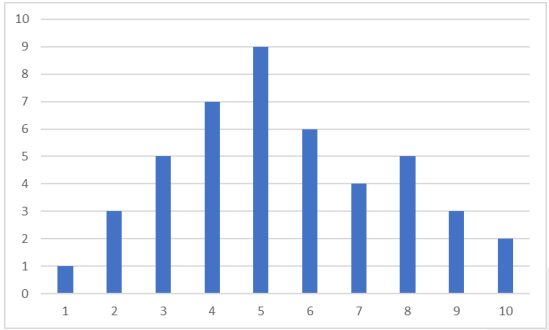




1. Distribute load over possible aircraft in range
2. Update aircraft configuration (number of DME & selection rules)
3. Recompute load between Aircraft and DMEs
4. Compute error of estimated load – measured load

Model Performance





Aircraft configuration

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    3) Classify trajectories

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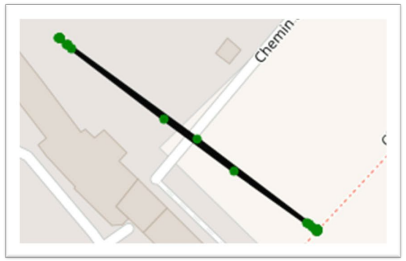
AI4CNS: Trajectory classification

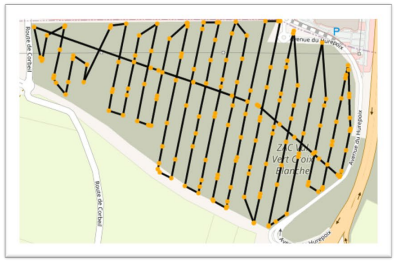
- Drone trajectory classification: measure and classify the reality of drone traffic

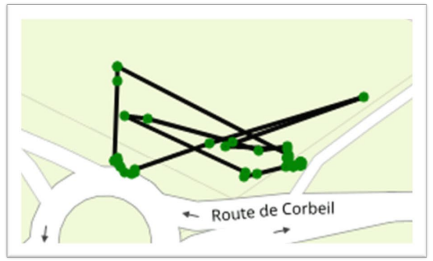
Class “H” Hover



Class “S” Straight

Class “C” Circular


Class “M” Monitoring



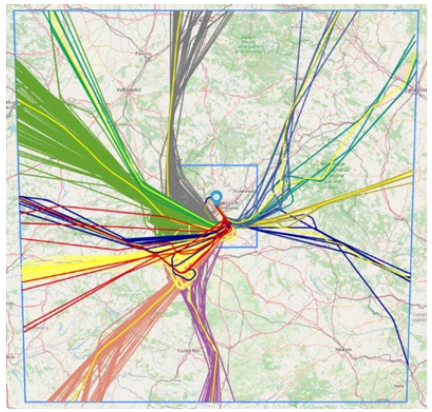
Class “K” Knot bag

93% of trajectories well classified: 100% for H, 100% for M, 98% for S, 94% for C, 90% for K

- Aircraft Approach & landing trajectories: to identify possible inefficiency along the trajectory

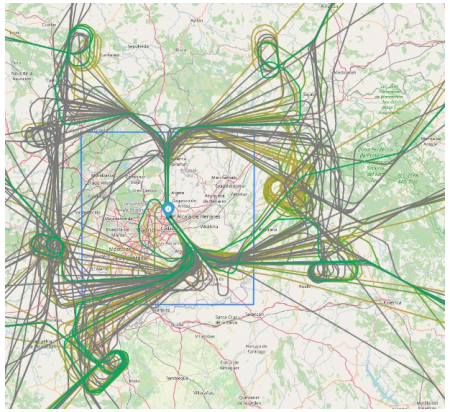
1. Clustering based on DBSCAN

2. Estimate reference trajectories



Filter based on difference to reference trajectories

Large difference



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3) **What AI technics do we use?** AI technics are highly customized to data and projects, finding the most promising approach is our biggest challenge!

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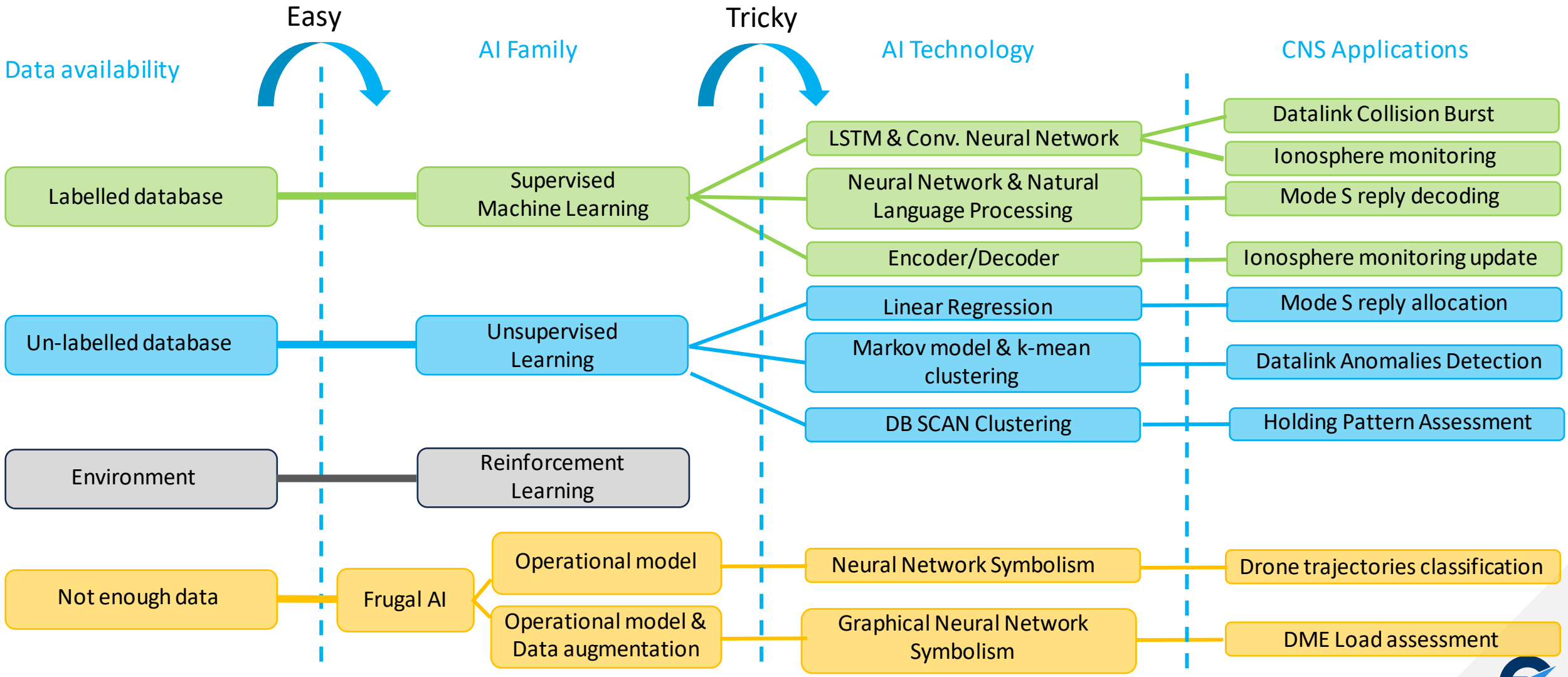
AI4CNS: Various AI families & technics



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