

AI Support in ATM



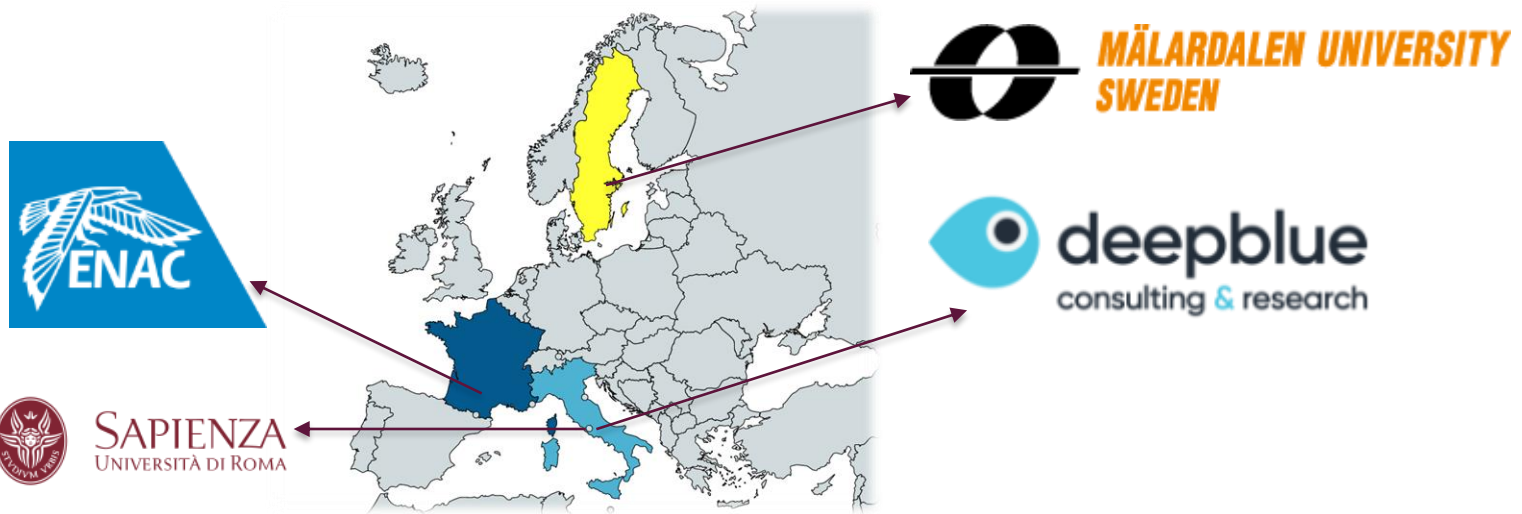
11th EASN Virtual Conference
“AI and Future Scenarios in Aviation” Session
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Presenter:
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Deep Blue s.r.l.



ARTIMATION:

Transparent ARTificial Intelligence and AutoMATION to Air Traffic Management Systems



<https://artimation.eu>

Challenge and Context

- Decision Making Process in ATM is already associated algorithms
- However, automation systems do not provide additional information on top of the Data Processing result
i.e. a Black Box
- ARTIMATION's goal is providing a transparent and explainable AI model (XAI) giving (when needed) understandable outcome through an understandable process
i.e. White Box



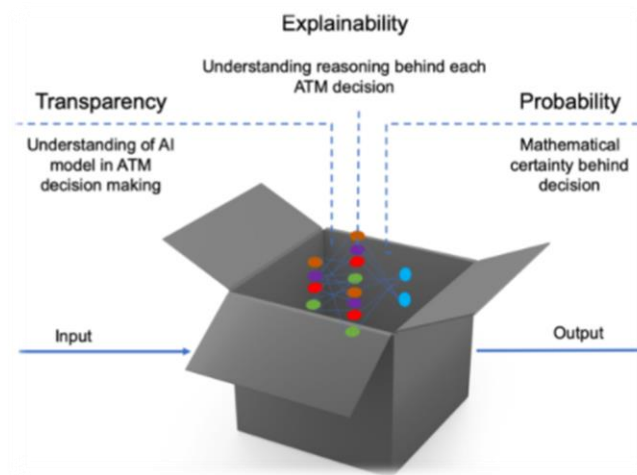
WHY Implement XAI in ATM?

In order to:

- Justify
- Control
- Discover
- Improve

AI systems need to be as transparent as possible, but also to be trusted and accepted.

«opening» the black box



HOW Implement XAI in ATM?

An effective human-machine collaboration requires adaptations of
-at least- 3 levels of explanation:

Level 1
Simple or no explanations

Level 1
Issue instruction

present
moment

Level 2

Full explanation of the proposed solution

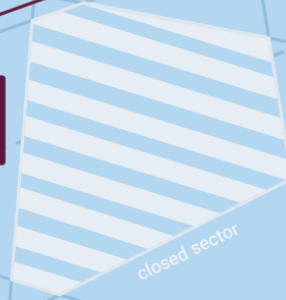
Level 1

Simple or no explanations

Level 2
Clearance delivery



closed sector



Level 1
Issue instruction



1-2 days
before the flight

present
moment

Level 3

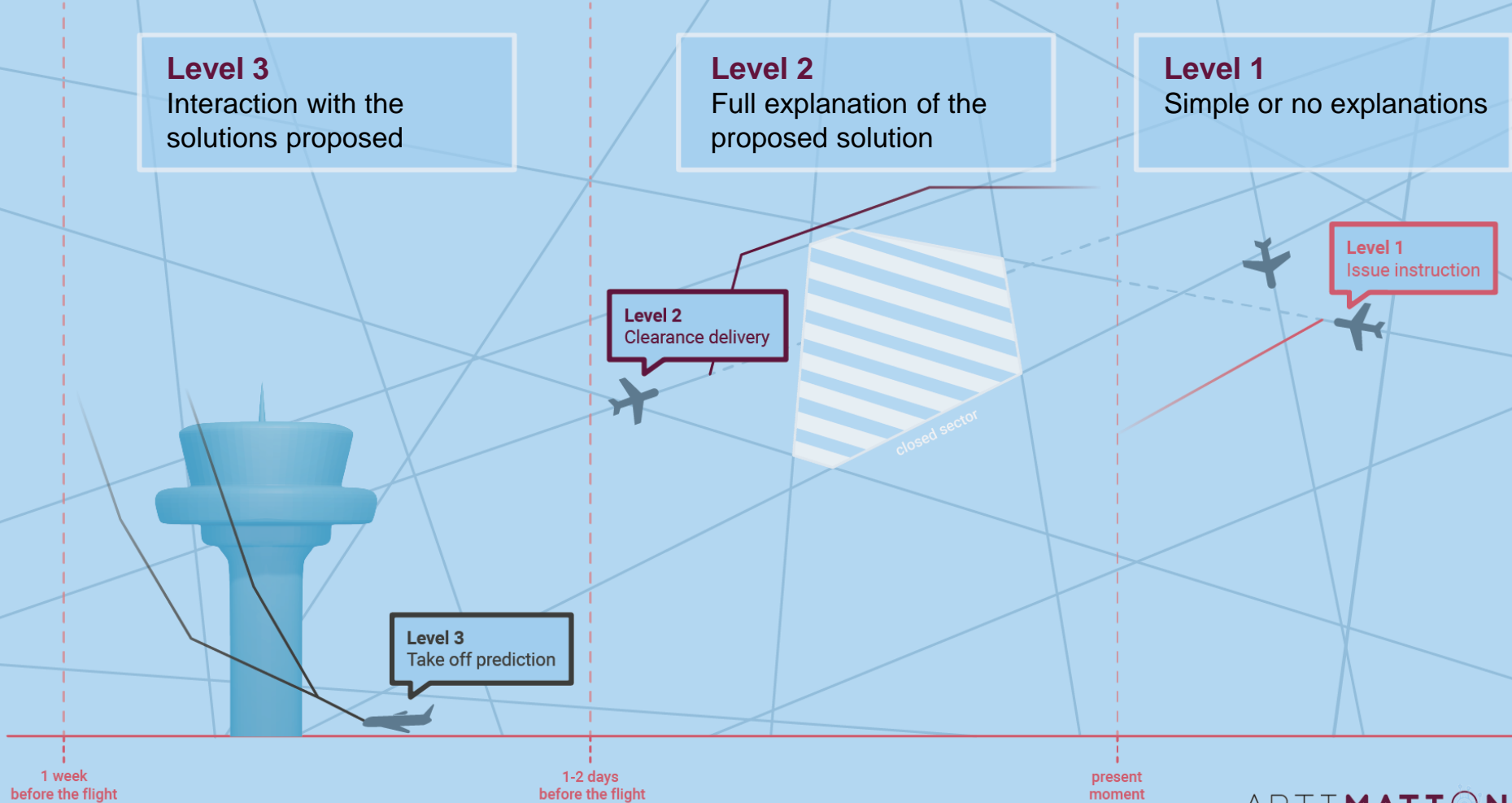
Interaction with the solutions proposed

Level 2

Full explanation of the proposed solution

Level 1

Simple or no explanations



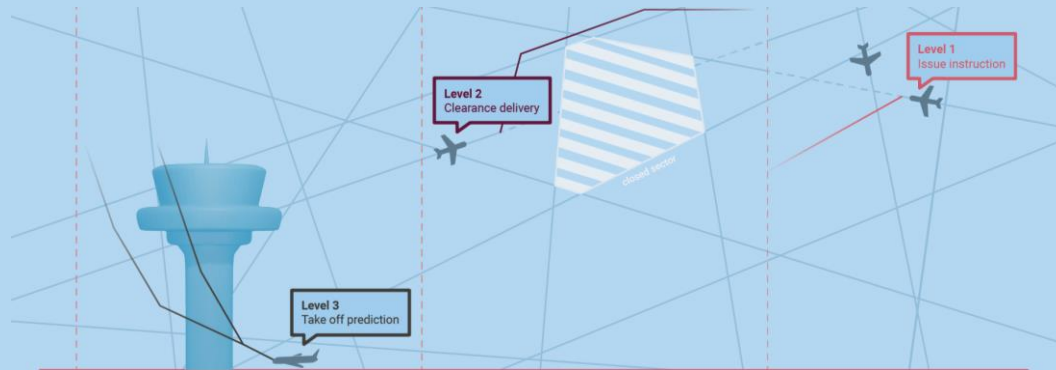
1 week
before the flight

1-2 days
before the flight

present
moment

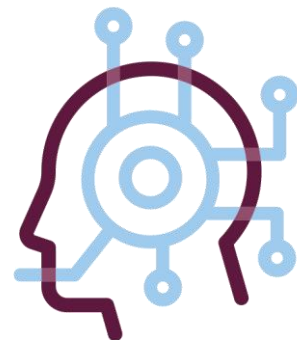
HOW Implement XAI in ATM?

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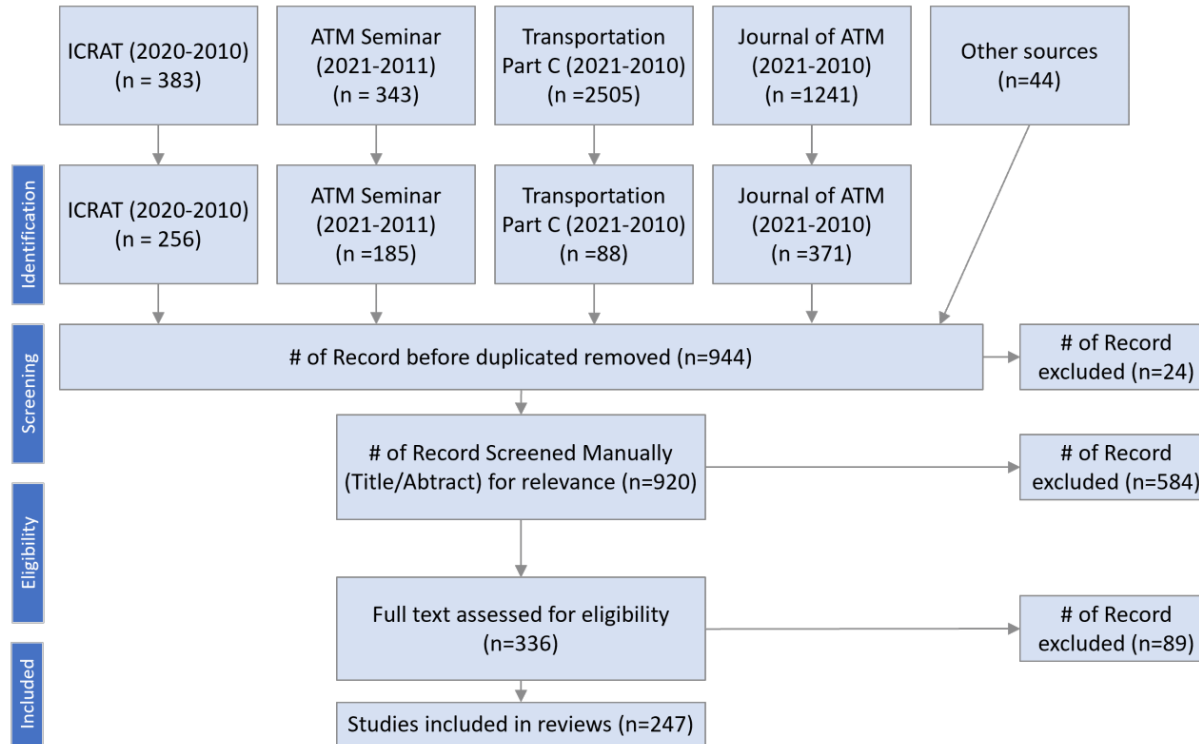


But it is not enough: For each of the 3 levels, different algorithms, explanations, and visualisations tools should be considered, in order to build and maintain trust, acceptance, efficiency and safety; for different context of application

State of The Art of XAI in ATM



Review of Ten year of research of AI (2010-2021)

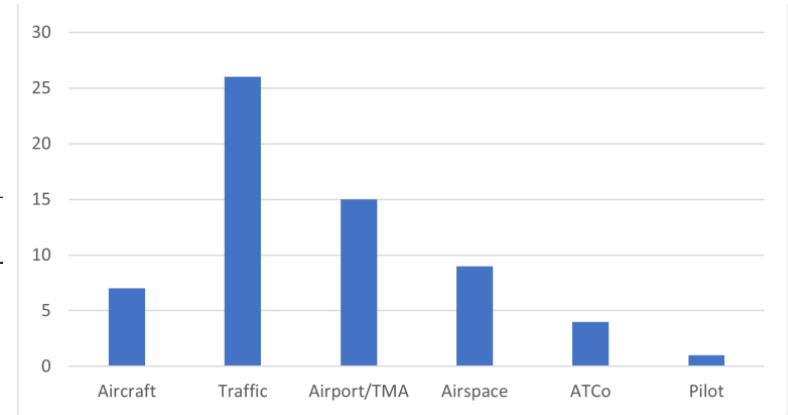
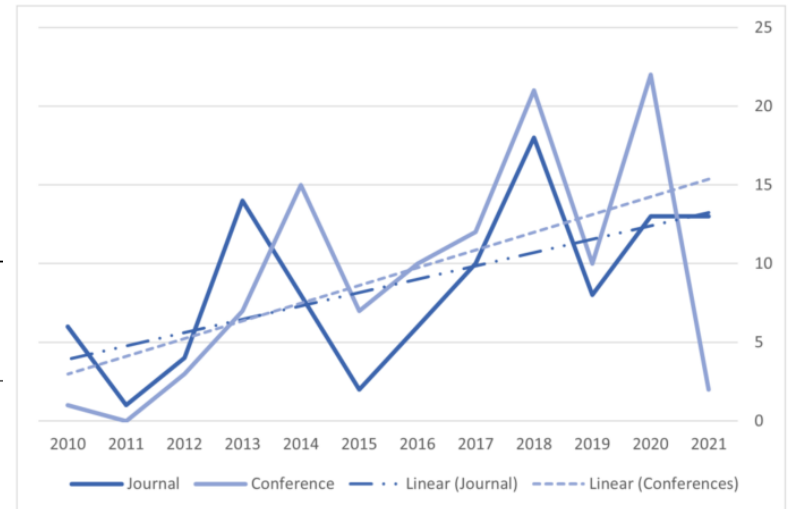


PRISMA flow of Review

AI Object Feature





Table 1: Paper selection result at the identification phase.

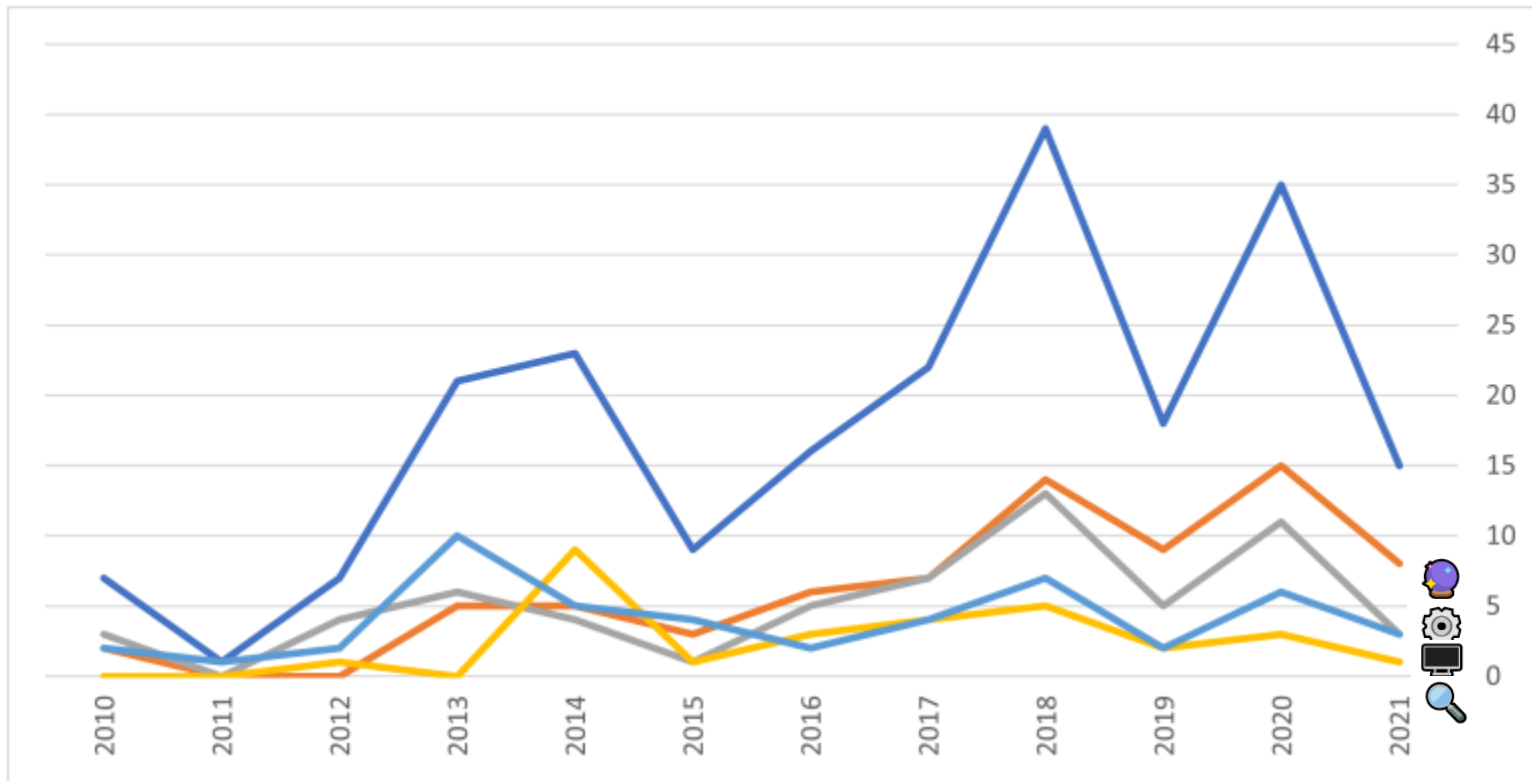
Keyword	ICRAT	ATM Seminar	Transportation Research Part C: Emerging Technologies	Journal of Air Transport Management	Total
"Predict*"	39	23	15	18	95
"Estimat*"	17	12	6	20	45
"Optim*"	26	27	24	26	103
"Cluster*"	5	3	0	7	15
"Analy*"	33	38	12	171	254
"Visual*"	2	2	1	1	6
"Learn*"	13	11	10	14	48
"Explain*"	0	0	0	3	3
"Model*"	38	43	30	134	245
"Plan*"	9	9	12	37	67
"Conflict"	17	13	9	2	41
"Classif*"	1	1	0	8	10
Total (without duplication)	160	141	88	371	760



Trends of AI in ATM

Four main categories appeared from the data to be tightly connected with AI in general, that globally define the purpose of the application:

-  **Prediction:** AI foresees the future behaviour of an “Object”
-  **Optimisation/Automation:** AI enhances the behaviour of an “Object”
-  **Analysis:** AI seek to understand the past/observed behaviour
-  **Modelling/Simulation:** AI simulate the air traffic airspace



Stakeholder Prioritisation for XAI support to ATM

Task A - AI Issues instructions:

Conflict resolution instructions (headings, speed, levels);
 Quality of service improvement instructions (direct, good levels, free speeds);
 Instructions to meet ATC constraints (levels, speeds);
 Responses to aircraft requests; Verify readback;
 Update FPS;

Task B - AI Optimizes utilization of available capacity:

Sector Management;
 Balancing Arrival & departure Capacity;
 Find minor workload flights;
 Negotiating extra capacity; Co-ordinate with Military for airspace usage;
 Reduce the traffic complexity;
 Implementing Holding procedures;

Task C - AI does Clearance delivery:

Receive and check FPS;
 Receives Start-up call 10-15 mins before EOBT;
 Carry out checks;
 Check against FPS and update;
 Issue ATC and start-up Clearances;
 Transmit ATC and Start-Up Clearances simultaneously;
 Decide whether to send DEP MSG to GND;
 Pass on FPS to GND.

Task D - AI does Take-off time prediction:

Being one of the roots (indicator) of the delay of an airplane, it impairs all transportation network, and predicting it is a key to better predict and enhance air traffic.



TASK RANKING	AI NEEDED	XAI	PROS	CONS
1 B - OPTIMIZE CAPACITY	13	10	Accuracy	Risk of automation compliance
2 A - ISSUE INSTRUCTIONS	15	15	Safety, Accuracy	Situation awareness
3 D - TAKEOFF PREDICTION	15	11	Safety, Accuracy	Risk of automation compliance

To conclude / Next Steps

- **Roadmap on how to support ATM Tasks with XAI**
e.g.
 - Best Algorithms for the 3 different levels of XAI
 - Best Visualisation tools and strategies for the 3 different levels
 - Best ways to build Trust and Acceptance
- **Validate the “best” for the prioritized tasks**
- **Refine the prototype**



Thank You for Your Attention



For questions / more information:

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and/or <https://artimation.eu>