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ARTIMATION

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Founding Members

EUROPEAN UNION EUROCONTROL SESAR JOINT UNDERTAKING

SESAR-ER4-01-2019

ARTIMATION Project nr: 894238

TRANSPARENT ARTIFICIAL INTELLIGENCE AND AUTOMATION TO AIR TRAFFIC MANAGEMENT SYSTEMS

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Excellence

Aims to improve **the transparency and the explainability** of AI application in ATM system.

- Investigate the applicability of AI methods from the domain of XAI, i.e., post hoc interpretability and understanding
- Design and develop a proof-of-concept of transparent AI models including
  - visualization, explanation, generalization with adaptability over longer time
  - and user acceptability in the domain of ATM systems to ensure safe and reliable decision support.

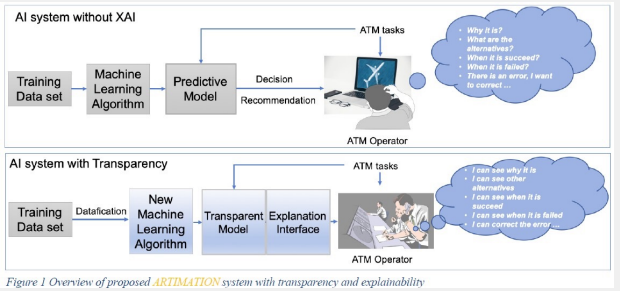


Figure 1 Overview of proposed ARTIMATION system with transparency and explainability

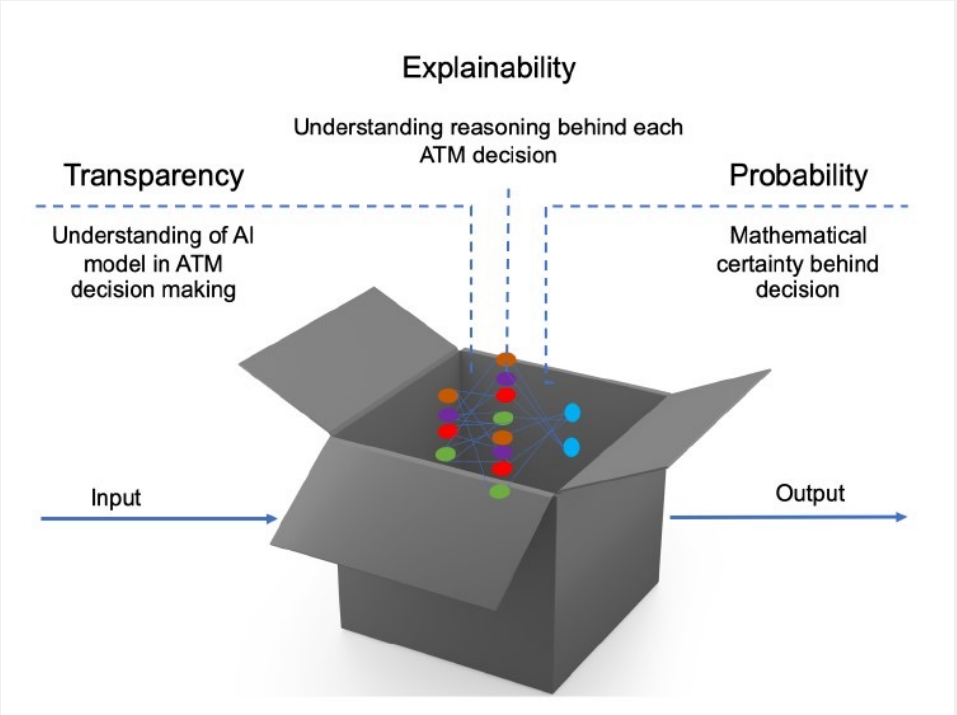
Objectives: *Predicting air transportation traffic and optimizing traffic flows*

Research Objectives:

- Provide **transparency and explainability** to the AI algorithms based on *data drivern storytelling, immersive analytics and visualization* for predicting air transportation traffic and optimizing traffic flows in ATM domain.
- Provide a conceptual framework for building **human-centric XAI** based on *an extensive review* across the fields ATM domain
- Provide a new **generalized and optimized** AI predictive model for predicting air transportation traffic and optimization traffic flows in ATM based *on machine lifelong learning and integration of casuality*
- Provide **user guidelines** for further AI algorithm development and application with AI transparency in ATM domain

Methodology: Concept

Level 0: Current Black Box Level
Level 1: Can give no/little information
Level 2: Give full explanation
Level 3: User can input some information



Methodology: Concept

1)Multivariate data analytics and AI model development

1) Representation
2) Translation
3) Alignment
4) Fusion
5) Co-learning

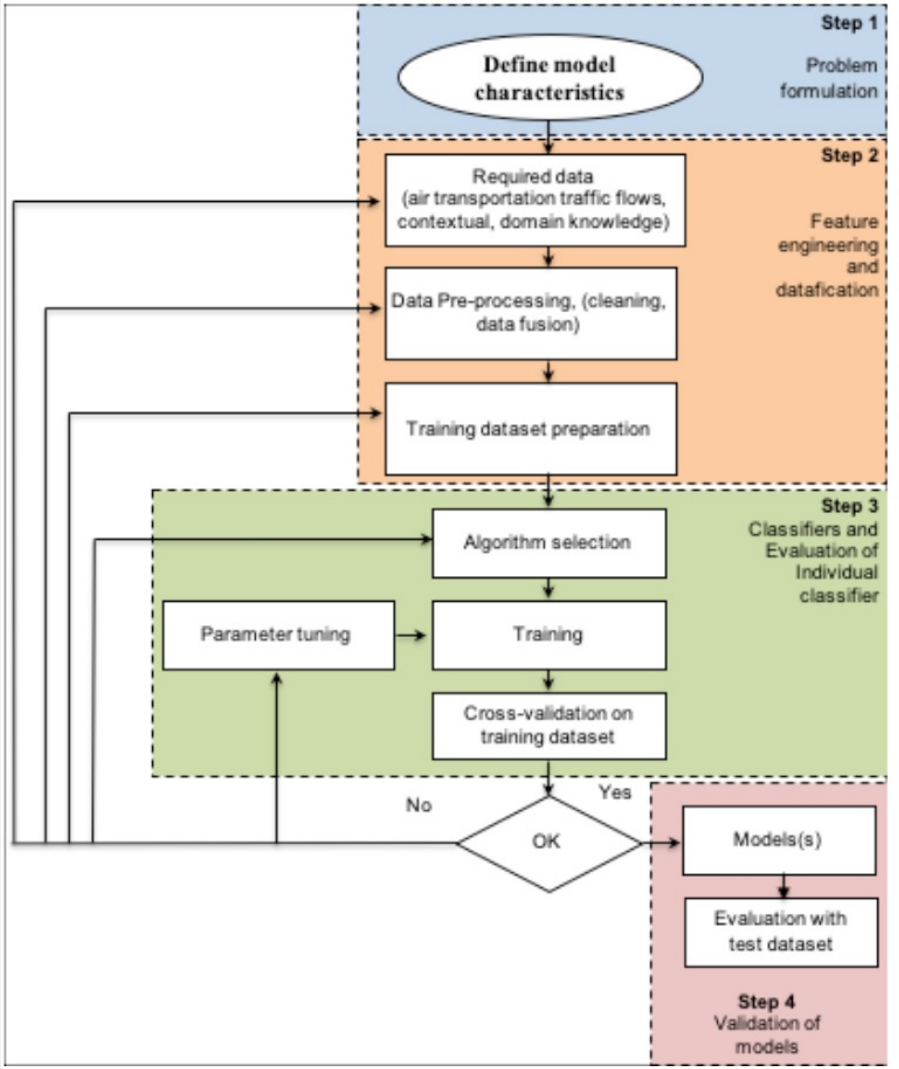


Figure 3. Step diagram will be used in AI model development

Methodology: Concept

2) AI model with Transparency and Explanability

1) Visualization : an efficient way to display, understand and communicate with data

- Screen dimension and/or Pixel-based techniques
- Charts, node-link diagrams, tornado diagrams, saliency heatmaps
- super-pixels for image-based models/highlighting on paragraph text

2) Data-Driven Storytelling

- Arrows on a 2D/3D map
- Interactive visualization

3) Immersive Analytics

- Virtual Reality, Mixed Reality and Augmented Reality

Methodology: Concept

3) User centric AI and lifelong learning

Here, the framework describes how human reasoning processes and informs XAI techniques.

- Points describe different theories of reasoning, XAI techniques, and strategies for designing XAI.
- Arrows indicate path way connections:
  - red arrows for how theories of human reasoning inform XAI features, and
  - grey for inter-relations between different reasoning processes and associations between XAI features

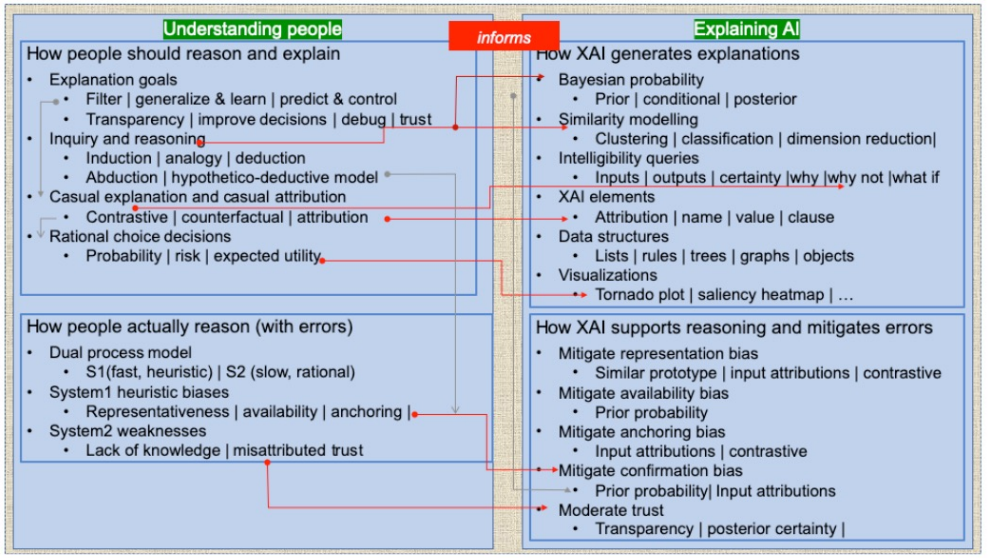


Figure 4. Conceptual framework for reasoned explanations, adapted from [24]

Lifelong Machine Learning focuses on developing versatile systems that accumulate and refine their knowledge over time

Methodology: Methodology

An **iterative and cyclic** approach, with a close collaboration between work packages

Phase 1: Definition which consist in the definition of specifications (WP3)

- use user-centric design principles,
- to define the possible decision support tasks in ATM e.g. predicting air transportation traffic and optimizing traffic flows.
- the specific ATM segment to be investigated within the ARTIMATION project (i.e. en-route, approach, tower, etc).

Methodology: Methodology

Phase 2: Development Cycles (WP4, and WP5) that will include multivariate data analysis, data driven AI modelling, transparency, visualization, explanation and adaptation framework.

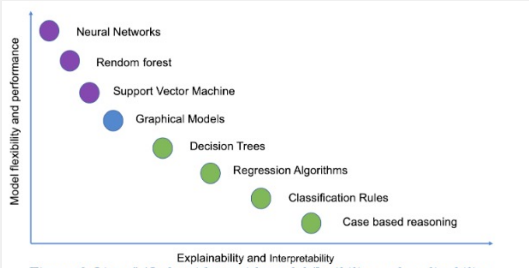


Figure 6. List of AI algorithms with model flexibility and explainability

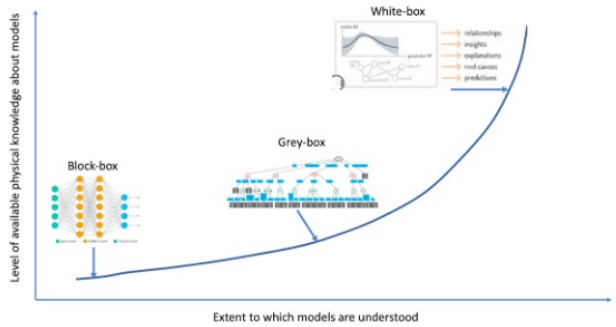


Figure 7. Black-box to White-box by providing explanation

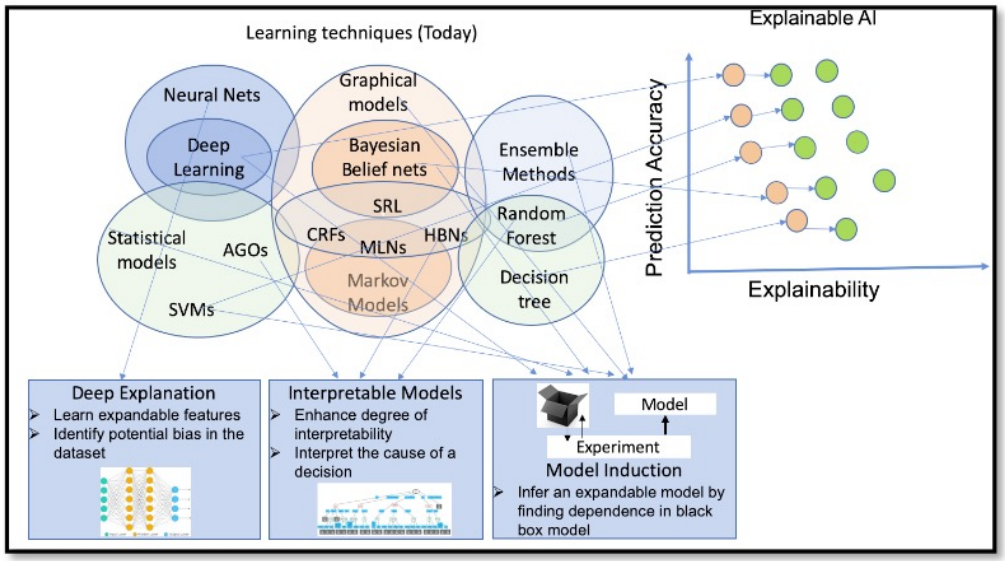


Figure 8. Development of transparent AI system in ATM domain

Methodology: Methodology

Phase 3: Test and validation (WP6) where two different types of tests will take place, for the development of the models, and the user tests.

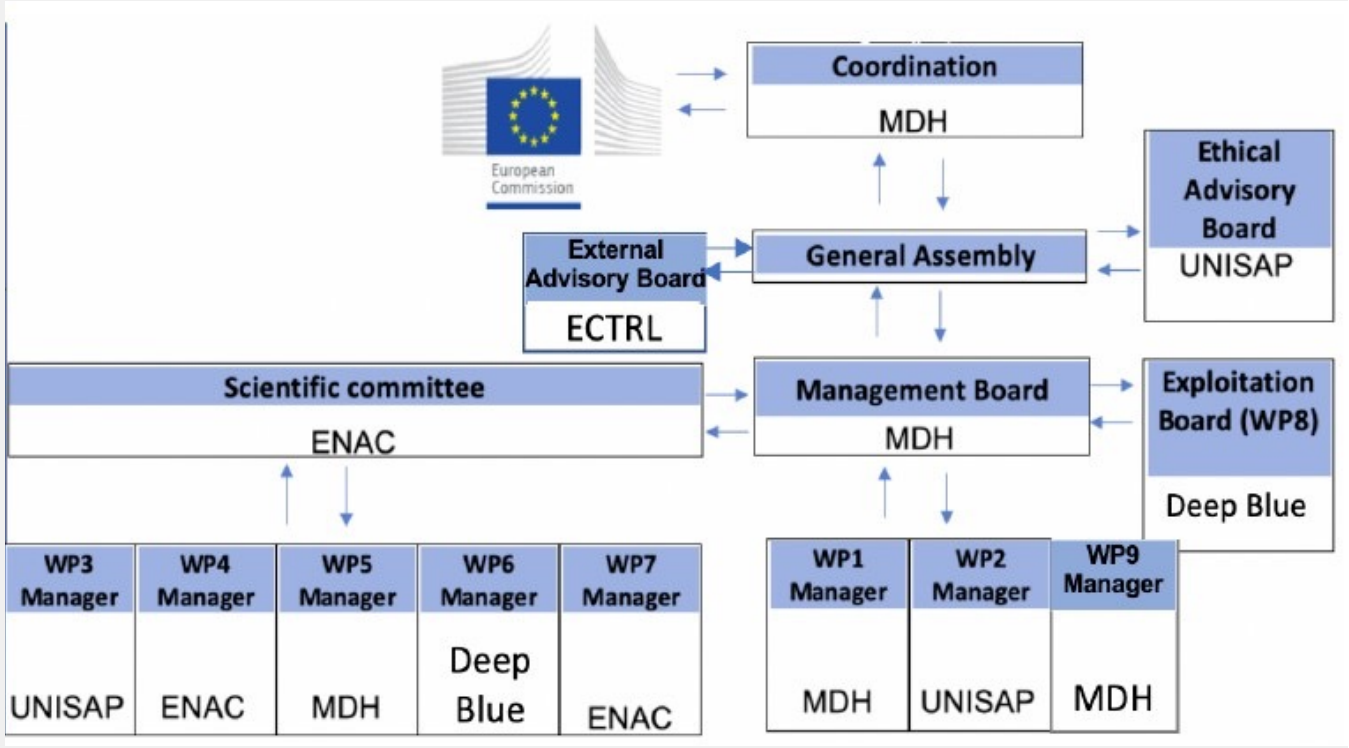
The user tests will be performed in simulated environment with realistic traffic scenarios (i.e. baseline and alternative scenarios) both considering existing and new data sets.

Professional ATCOs will be involved as experimental subjects by using ENAC facilities.

Phase 4:Guidelines and Training(WP7),in which a set of guidelines to optimize the training process of ATCOs in using new XAI-based solutions will be provided.

Implementation: Work package and Timeline

WP Number[9]	WP Title	Lead beneficiary[10]
WP1	PROJECT MANAGEMENT	1 - MDH
WP2	ETHICS AND SECURITY	2 - UNISAP
WP3	DEFINITION OF SPECIFICATIONS and SoA	4 - UNISAP
WP4	MULTIVARIATE DATA ANALYTICS AND AI MODEL DEVELOPMENT	3 - ENAC
WP5	LIFELONG MACHINE LEARNING WITH HUMAN-CENTERED AI	1 - MDH
WP6	Test and Validation	2 - DEEP BLUE
WP7	Guidelines and Training	3 - ENAC
WP8	Dissemination, Communication and Exploitation	2 - DEEP BLUE
WP9	Ethics requirements	1 - MDH



Thank you

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