SIMBAD

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Combining Simulation Models and Big Data Analytics for ATM Performance Analysis

INTRODUCTION

In a system like ATM, with few opportunities for large-scale experimentation, modelling and simulation is often the only way to evaluate the performance impact of new concept/solutions at network-wide level.

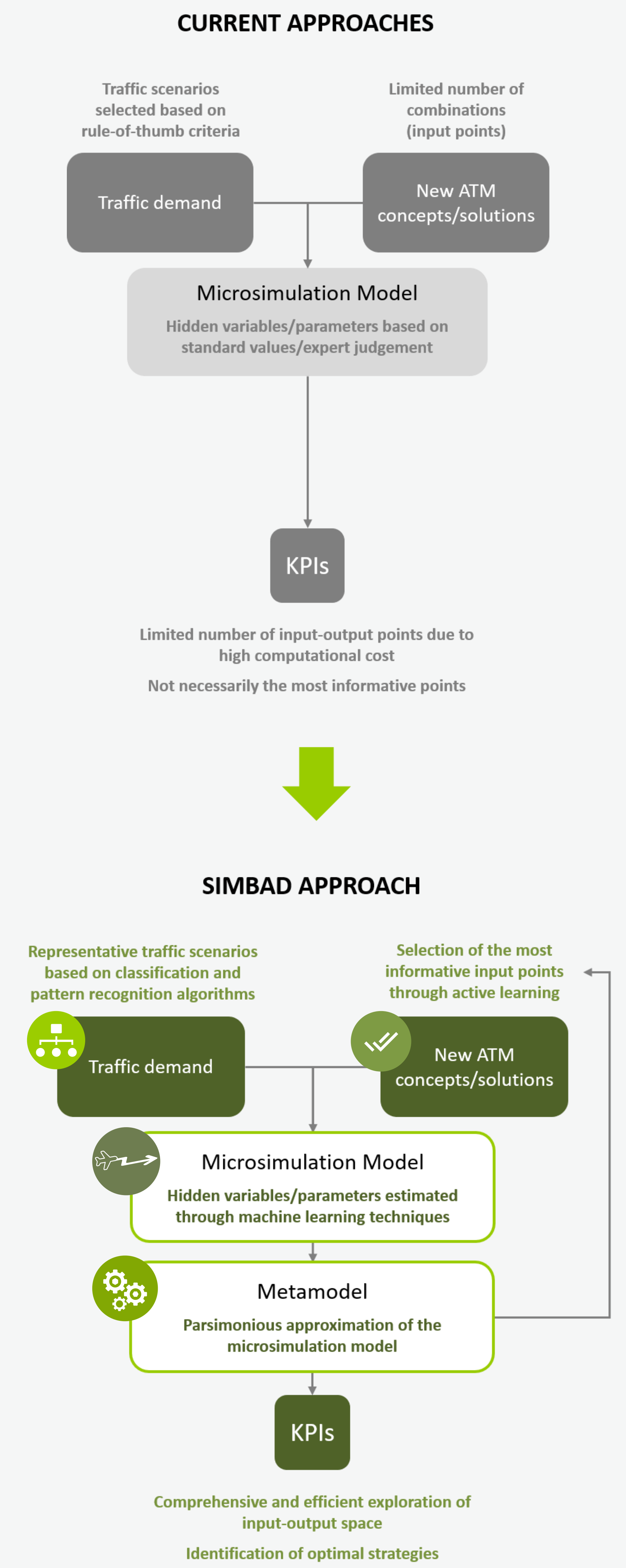
Reductionist modelling approaches are ill-suited to deal with complex systems like the ATM system. The assessment of the performance of a certain ATM concept/solution at a network-wide level requires for **complex simulation models** able to capture all the interactions between the heterogenous components of the systems and the impact of such interactions in the system as a whole. In spite of the existence of such complex models, its practical application for strategic ATM performance assessment and decision-making is hindered by the presence of latent variables, computational complexity, and interpretability issues.

Recent advances in machine learning can help overcome these problems, by developing data-driven simulation techniques that facilitate **latent variable estimation and increase the tractability and interpretability** of large-scale, complex, fast-time ATM simulation models.

OBJECTIVE

The goal of SIMBAD is to develop and evaluate a set of **machine learning approaches** aimed at providing state-of-the art **ATM microsimulation models with the level of reliability, tractability and interpretability** required to effectively support performance evaluation at network level.

METHODOLOGY



1.CASE STUDY DEFINITION AND DATA COLLECTION

Definition of case studies based on two state-of-the-art ATM simulation tools:

- **R-NEST** (EUROCONTROL simulation tool).
- **DYNAMO** (UPC aircraft trajectory prediction and optimisation tool).

2. TRAJECTORY MODELLING AND PREDICTION

Estimation of **latent variables related to airspace users:**

- **Machine learning** techniques for efficient model calibration based on historical data.
- **Reinforcement learning** for trajectory modelling.

3.MULTI-SCALE TRAFFIC PATTERN CLASSIFICATION

Optimal selection of a **sufficiently representative set of traffic scenarios** to allow a comprehensive impact assessment of new SESAR solutions at ECAC level:

- Identification of the most **relevant traffic features**.
- **Clustering and classification** techniques at different spatial and temporal scales.

4. APPLICATION OF ACTIVE LEARNING TO AIR TRAFFIC SIMULATION

Improvement of the **computational tractability and interpretability** of simulation results:

- ATM microsimulation models can be computationally expensive.
- **Active learning metamodelling** to facilitate a more **efficient exploration** of the input output space of complex simulation models.

5. EVALUATION AND DEMONSTRATION OF THE SIMBAD TOOLSET

- Integrate the proposed techniques with existing, **state-of-the-art ATM simulation tools**.
- Demonstrate and evaluate the newly developed methods and tools through their applications to the selected **case studies**:
  - Performance assessment of the **Free Route Airspace*** solution.
  - Performance assessment of the **Dynamic Airspace Configuration**** solution.

***Free Route Airspace:** Airspace users are able to plan flight trajectories without reference to a fixed route network or published directs, so they can **optimise their associated flights**.

****Dynamic Airspace Configuration**: Improves the use of airspace capacity by **increasing the granularity and flexibility** in the airspace configurations to better accommodate the demand.