CHALLENGE
DART aims to deliver data-driven techniques to improve the performance and accuracy of single and multiple trajectory predictions, accounting for ATM network complexity effects.

RESEARCH ISSUES
- What are the supporting data required for robust and reliable trajectory predictions?
- What is the potential of data-driven machine learning algorithms to support high-fidelity aircraft trajectory prediction?
- How the complex nature of the ATM system impacts the trajectory predictions?
- How can this insight be used to optimize the ATM system?

SHAPING THE FUTURE: DART VISION
DART explores the applicability of a collection of machine learning and agent-based models and algorithms to derive a data-driven trajectory prediction capability. Advanced visual analytics techniques are used to facilitate data exploration, quality assessment, and algorithms parameters and features selection.

During the 1st consultation meeting we had with stakeholders on September, we shaped the DART vision: To advance collaborative decision-making processes that support multi-objective optimization taking the requirements of the different actors in the ATM system into account at the planning phase (i.e. few days before operation):
- Aircraft Operators (AOs): Minimizing the cost thought maximizing the adherence to the airlines preferred FPs.
- Network Manager (NM): Decide which flights to modify to resolve sector imbalances and potential conflicts.
- Air Navigation Service Providers (ANSPs): Minimizing the sector imbalances and potential conflicts.

The overall workflow in collaborative decision making is shown in the following picture.
DART ALGORITHMS

**Hidden Markov Models (HMM):** trajectory prediction using discrete spatio-temporal state-transition models.

**Similarity-based Retrieval (Clustering):** trajectory prediction by means of an N-dimensional clustering task of data series.

**Regression Models:** trajectory prediction using an N-dimensional regression task w.r.t. data series.

**Reinforcement Learning:** Markov Decision Process (MDP/POMDP): trajectory prediction using a state-action-reward model in order to obtain an optimal policy on any instant of the flight.

**Joint (Collaborative) Trajectory Predictions:** Formulate the problem as a multi-agent Markov-Decision-Process and solve it via collaborative, decentralized reinforcement learning methods.

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VISUALIZATIONS AND VISUAL ANALYTICS

Visualization, interaction techniques and interfaces support the exploration and evaluation of results of trajectory prediction algorithms, particularly, comparison of predicted trajectories to real ones and comparison of predictions obtained with different algorithms or different parameter settings.

Visually supported detection of clusters of trajectories and flight plans:

Historical data provide recurrent patterns of trajectories (enriched with contextual information – e.g. weather) that data-driven methods learn. Prediction of a single trajectory involves choosing the pattern that fits better a flight plan w.r.t. contextual data.

Visual exploration of results is beneficial for analysts and stakeholders (e.g. Aircraft Operators), to fine-tune prediction algorithms and to understand better the reasons for deviations.

**Communication & Dissemination Activities**

- **DART Presented in SID 2017, Belgrade, Servia, the article DART: A Machine-Learning Approach to Trajectory Prediction and Demand-Capacity Balancing**

- **Alongside the International Conference for Research in Air Transportation (ICRAT) 2018, DART (in collaboration with datAcron project) will be organizing a workshop on Data-Enhanced Trajectory Based Operations. Please visit the following webpage for additional details: http://icrat.org/icrat/upcoming-conference/data-tbo-workshop/**

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**Results & Benefits**

- Data-driven trajectory prediction capabilities;
- Agent-based multiple trajectory prediction abilities;
- Interactive visual interfaces for supporting interactive exploration of modelling results in space and time, supporting decision making.

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