**EUROCONTROL - Traineeship Opportunity**

**Directorate/Service**

Directorate DECMA – INO – Brétigny/Orge – (France)

EUROCONTROL, the European Organisation for the Safety of Air Navigation, is a pan-European, civil-military organisation dedicated to supporting European aviation. EUROCONTROL supports its Member States and stakeholders (including air navigation service providers, civil and military airspace users, airports and aircraft/equipment manufacturers) in a joint effort to make aviation in Europe safer, more efficient, more cost-effective, and with a minimal environmental impact.

DECMA strategically positions the Agency within the European aviation landscape, contributes to European R&D, manages high-level relations with European & global partners including military-military & civil-military coordination, and supports States, with the overall objective of contributing to the achievement of SES objectives.

The Innovation Division manages Agency research and innovation projects, including the Agency contribution to all H2020 and S2020 research projects and relations with other research bodies; and manages the Agency's simulation environment.

We are offering:

* A traineeship of 3 to 6 months (exceptionally up to 12 months)
* A flat-rate allowance of EUR 900 per month as a contribution to living expenses.
* The reimbursement of travel expenses (based on distances and related-ceilings) as well as visa costs incurred by non-EU nationals.
* A mentoring system that guarantees supervision and coaching by a dedicated staff member.
* A quality-working environment with state-of-the-art facilities and an international environment.
* An active and welcoming Trainees Community to be part of...
* **Place of work:** [**EUROCONTROL Experimental Centre**](https://www.eurocontrol.int/eec/public/standard_page/visiting_us_eec.html)

# Enhancement of a Reinforcement Learning system for training Air Traffic Control (ATC) policies

**Purpose**

Artificial Intelligence has been proclaimed as successful to provide timely decision support advice in many real-life applications. The recent advancements of reinforcement learning algorithms have been a key for many of these achievements. The Network Research Unit (NET) of EUROCONTROL has implemented a reinforcement learning system for training Air Traffic Control (ATC) policies. The system is composed of a fast-time ATC simulator that generates experiences, and a reinforcement learning algorithm that uses these experiences to continuously improve the policy. The trained policies will determine the ‘best’ resolution actions to take given a traffic situation (state), such that a certain reward function is maximised. At present, the simulator does not consider the vertical dimension (i.e., all aircraft are assumed to be at the same altitude), and consequently the policy can only learn speed and heading resolution actions. Furthermore, the simulator does not include uncertainty, meaning that the policy may not perform well in real-life situations, where uncertainty is inevitable. Last but not least, a simple reward function that penalises a weighted sum of losses of separation, number of ATC instructions and flight inefficiency is used.

The main objective of this internship is to extend the capabilities of the simulation environment by including the vertical dimension and uncertainty. The second objective is to improve the reinforcement learning algorithm already implemented in the system, as well as to investigate new reward functions, state and action space definitions and policy models.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* Implement the vertical dimension in the simulation environment
* Implement uncertainty in the simulation environment
* Improve the reinforcement learning algorithm
* Investigate new reward functions, observation and action spaces as well as policy models
* Perform a comprehensive study by comparing different forms of reward function and architectures of the policy model
* Gather ATC controllers’ feedbacks on the RL algorithm behaviour and model accordingly
* Validate the trained model on real sectors and real planned traffic

**Preferred profile**

* Master Degree in Maths / Computer Science
* A field of education which integrates Maths / Computer Science, Data Science and Air Traffic Management would be ideal.
* Excellent programming skills in Python
* Experience with Pytorch and Pandas is a plus
* Knowledge of neural networks (also recurrent neural networks)
* Knowledge of basic single-agent reinforcement learning algorithms (DQN, PG, PPO, DDPG, etc.)
* Knowledge of advanced multi-agent reinforcement learning algorithms (MAAC, MADDPG, COMA, etc.) is a plus
* Aircraft performance (would be an advantage, but not absolutely required)
* Air Traffic Management (would be an advantage, but not absolutely required)

**Contacts**

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# Prediction of SID and STARs and integration with other ML algorithms

**Purpose**

Improving Traffic demand prediction is key for an efficient Network and Artificial Intelligence has been identified as a key enabler to achieve this goal. The Network Research Unit (NET) of EUROCONTROL has already implemented an AI algorithm able to predict runway configurations at given airports. NET is also currently developing another AI algorithm to predict flight plans between city pairs. Using the information of runway configurations (being real information or coming from the previously mentioned AI module), the purpose of this traineeship is to predict the SID and STAR of a flight between two airports. This information will then be used by the other AI algorithm to provide a better prediction of the flight plan using the predicted SID and STAR information.

The main objective of this internship is to enhance the accuracy of the flight plan prediction by adding in the toolset of AI algorithms already available a new one able to predict this SID & STAR information.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* Identify features needed to predict SID and STAR for a given flight
* Identify data sources allowing to extract these features
* Define and prepare a training dataset
* Identify and develop candidate algorithms to predict SID & STAR
* Define architecture to connect to airport runways configuration prediction and trajectory prediction algorithms
* Connect the 3 algorithms to enhance flight plans prediction for specific city-pairs

**Preferred profile**

* Master Degree in Maths / Computer Science
* A field of education which integrates Maths / Computer Science, Data Science and Air Traffic Management would be ideal.
* Excellent programming skills in Python
* Experience with Keras, Tensorflow, lightGBM and Pandas is a plus
* Knowledge of machine learning techniques (especially supervised learning)
* Airport operations (would be an advantage, but not absolutely required)
* Air Traffic Management (would be an advantage, but not absolutely required)

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# Data Science – Refined characterisation of operating regimes for arrivals and sensitivity to operational parameters

**Purpose**

Within the Innovation division of the Directorate European Civil-Military Aviation, the Advanced Traffic Services unit (ATS) carries out research and innovation projects related to air traffic control (ATC). Our studies range from development to validation of innovative concepts, procedures and tools for air traffic controllers or pilots, for arrivals, departures or en-route (cruise) operations.

One of the concept under investigations is the notion dynamic route structures in the terminal area. The idea is to enable an agile response to traffic demand variations (e.g. low or high) by deploying a route structure with appropriate characteristics (e.g. short or long routes). This requires an analysis and characterisation of the traffic variations along the day.

The trainee will support the “dynamic TMA” project. Following an initial feasibility study, this second phase aims at refining the characterisation of operating regimes for arrivals. The study will use large amounts of trajectory data available in house over the EUROCONTROL NM area.

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* Collect and organise relevant trajectory data from existing/available sources on a representative/selected set of airports (e.g. top 30 European airports);
* Re-use, and if necessary refine the metrics developed during the first phase to apply on the selected dataset;
* Use data visualisation techniques to share the results;
* Build a simple model to explore the relationships between operational thresholds on the one hand (typically look ahead times limits for regime transitions and regimes minimum transitions) and the extent of potential benefits for the concept;
* Apply this model in a generic environment to conduct a sensitivity analysis;
* Actively interact with operations and data specialists within the team to characterise the problem, interpret the results and progress/orientate the study.

**Preferred profile**

* Master Degree in Maths / Computer Science/ applied mathematics or Engineering degree, with a specialisation in data science.
* Advanced IT skills, especially:
  + knowledge of data science techniques (visualisation, data exploration, clustering, supervised and unsupervised modelling, ..) and tools (R or Python with libraries such as numpy, pandas, matplotlib, ..),
  + knowledge of the Unix environment (bash commands, scripts...) and database.
  + Fundamental knowledge of MS Office tools (Excel, Word, etc.).
* Autonomous, organised and methodical.
* Good capacity for analysis, synthesis and planning.
* The working languages of the Agency are English and French. For this particular internship position, candidates must have an excellent command of English.

**Desired duration/start date**

From 4 to 6 months, start date from February 2021, latest: May/June 2021

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# Encounter model validation through data visualization

**Purpose**

This internship involves supporting the development and use of an aircraft close encounter model to evaluate the next generation of Airborne Collision Avoidance Systems (ACAS) for Europe. Detailed analysis of inputs, internal variables and outputs is required to ensure model realism appropriate for safety studies and operational acceptance both with today’s traffic and future remotely piloted traffic.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry out the following tasks:

* Run platform tools to generate model encounters, simulate ACAS and generate metrics
* Improve a prototype dashboard using interactive data visualization techniques
* Define metrics supporting the expert analysis of the model
* Display results graphically suitable for publication

**Preferred profile**

* Master’s Degree in Maths / Computer Science
* Scientific or Engineering degree with advanced IT skills
* Autonomous, organised and methodical.
* Good capacity for analysis, synthesis and planning.
* Fundamental knowledge of MS Office tools (Excel, Word, etc.).
* The working languages of the Agency are English and French. For this particular internship position, candidates must have an excellent command of English.

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# Encounter model evolution to rotorcraft and UAS

**Purpose**

This internship involves supporting the development and use of an aircraft close encounter model to evaluate the next generation of Airborne Collision Avoidance Systems (ACAS) for Europe. Evolution of the encounter model is required to incorporate piloted and remotely piloted rotorcraft for future traffic scenarios in lower airspace such as class G.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* Explore new sources of data
* Prepare data and suggest modifications to the currently implemented model
* Create an encounter model for helicopters, drones, low performance GA

**Preferred profile**

* Master Degree in Maths / Computer Science
* Scientific or Engineering degree with advanced IT skills
* Autonomous, organised and methodical.
* Good capacity for analysis, synthesis and planning.
* Fundamental knowledge of MS Office tools (Excel, Word, etc.).
* The working languages of the Agency are English and French. For this particular internship position, candidates must have an excellent command of English.

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# *(PJ1802 sol56)* Datalink : advanced metrics visualisation (interactive Dashboard)

**Purpose**

Advanced Traffic Services unit (ATS) carries out research and innovation projects related to air traffic control (ATC). Studies range from development to validation of innovative concepts, procedures and tools for air traffic controllers or pilots, for arrivals, departures or en-route (cruise) operations.

ATS Validation team is involved in assessing new working methods and tools (e.g. Air/Ground datalink exchanges) in terms of acceptability and impact on air traffic management from different perspectives (e.g. safety, capacity, efficiency).

In particular, in the frame European SESAR programme, Real Time Simulation (RTS) are conducted at EUROCONTROL Experimental centre (Brétigny) to validate the concept of “Air/Ground” synchronisation through datalink (CPDLC) complex clearances and automation”. Quantitative (recordings from simulator) and qualitative (questionnaires) data are collected to set up metrics and indicators in order to provide “proof of concept” to stakeholders.

The trainee is expected to develop advanced data visualisation modes (e.g. through interactive dashboard) and, if needed, propose new indicators, to provide direct insight of the data from various perspectives (Air traffic controller, human factor, decision maker…).

To do so, the trainee should get familiar with current internal collection process (in particular platform recordings and questionnaires items), metrics, data analysis process and visualisation tool.

**Main responsibilities**

* Get familiar with data analysis practices and data visualisation tools currently used in EUROCONTROL
* Process existing metrics on quantitative material
* Develop data visualisation using dashboard tool and navigation principles (e.g. Tableau) applied to specific 2021 RTS results
* Propose new metrics, if needed, to provide further evidences on the concept tested

**Preferred profile**

* Postgraduate Diploma (Master Degree or equivalent) in Data science, HMI.
* Knowledge of visual analytics.
* Knowledge of data management (data collection and analysis).
* Knowledge of operational concept validation techniques (metrics applied to platform recordings and questionnaires) would be an asset.
* Knowledge of Windows pack office (word, powerpoint, excel).
* Awareness of Air traffic Control domain would be an asset.
* The working languages of the Agency are English and French. Therefore, candidates must have an excellent command of English and/or French (written and verbal).
* Capacity for autonomy and teamwork orientation (listening skills, collaborative work) would be an asset.

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# *(SPO/PJ33)* Single Pilot Operations: distributed cognition and task reallocation

**Purpose**

Single Pilot Operations introduces drastic change in the whole ATM system. Beyond redistributing tasks and functions across air team members (on-board pilot, remote ground pilot, automation), it may also impact air traffic controllers’ tasks and working practices.

The purpose of this traineeship is to apply the distributed cognition framework to this complex sociotechnical system and use it to assess the acceptability and impact on air and ground actors of Single Pilot Operations.

The main objective of this internship is to support the identification of advantages and limitations of different task allocation and contribute to select the most relevant one, in terms of safety, efficiency and operational acceptance.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* To explore new source of data
* To prepare data and suggest modification to the currently implemented model
* To create an encounter model for helicopters, drones, low performance GA

**Preferred profile**

* Master Degree in Maths / Computer Science
* Scientific or Engineering degree with advanced IT skills
* Autonomous, organised and methodical.
* Good capacity for analysis, synthesis and planning.
* Fundamental knowledge of MS Office tools (Excel, Word, etc.).
* The working languages of the Agency are English and French. For this particular internship position, candidates must have an excellent command of English.

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# Analysis of operational data to identify emerging safety risks

**Purpose**

To enhance the understanding of operational flight data being able to derive safety implications by developing a model capable to predict potential safety events. Decomposing the potential safety events into possible factors and precursors will allow to better understand how and how much these could influence in the risk of collisions and/or loss of separations.

**Main responsibilities**

With the support and coaching of a mentor, the trainee will have to carry the following tasks:

* To get familiar with the available operational data (track data, flight plans, controllers inputs into the system, etc.) and prepare the data to be processed.
* To identify specific safety events (loss of separations, tactical conflicts, etc.) by processing the data using Safety Tools developed within the Safety Team.
* Define and determine additional features to further characterise the available data (for example specifying a complexity index or others) and identify the principle factors related to the safety events mentioned above (density of traffic, sector dimensions, spatial distribution of airways, etc.)
* Generate a predictive model for the previously mentioned safety events by using Machine Learning techniques.
* Validate the safety models generated with the operational data and present the results to the DECMA safety team and potential ANSPs users.

**Preferred profile**

* Students completing their Diploma (Graduate Engineering, Master or equivalent)
* Engineering on Aeronautical, Aviation, Air Traffic Management, Air transport system, Mathematics or Computer Science
* Knowledge and practice of Artificial Intelligence and/or machine learning algorithms
* Knowledge on Java, MATLAB, C#, Phyton, or other similar programming language
* Being familiar and competent using Microsoft tools (MS Word, Excel, etc.) and Visual basic
* Develop and conduct presentations to show results and findings in a clean, concise, and well-organized way.
* Candidates must have a good command of English. Good command of French at a conversational level would be seen as an advantage.

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